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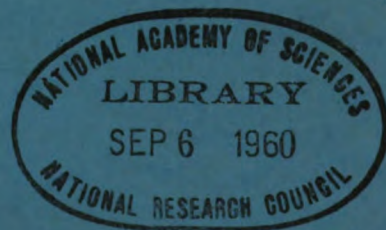
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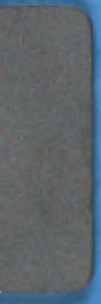
The Central Namib Desert
South West Africa

by
Richard F. Logan



National Academy of Sciences—

National Research Council



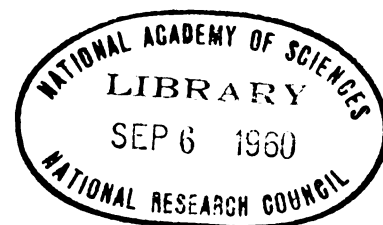
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SOUTH WEST AFRICA

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Dr. Richard F. Logan
"

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PREFACE

The present report is an outgrowth of a long continuing interest of this investigator in the desert areas of the world. During the first years of his residence in California (1949-1952), he spent much time in the desert familiarizing himself with the landforms, vegetation, climate, and the ways of life in the Southwestern United States and Northern Mexico. During the period from 1952 through 1955 he undertook a study of the Providence Mountains, a range typical of the eastern Mojave Desert, under research grants from the University of California and a contract with the Quartermaster Corps of the United States Army and in collaboration with his colleague, Dr. John F. Gaines.

Desiring to spend his sabbatical year (1956-1957) in the study of a more tropical desert yet one with a culture basically comparable to that of the Mojave, the writer selected the desert regions of South West Africa. The field research for the study was supported chiefly by the Foreign Field Research Program conducted by the Division of Earth Sciences, National Academy of Sciences--National Research Council and financed by the Geography Branch, Office of Naval Research, under Contract Nonr-233(09). The remainder of the expenses were borne out of personal funds including sabbatical pay and from University research grants. The instrumentation necessary for the climatic portion of the study was supplied by the Quartermaster Corps of the United States Army under a no-cost loan agreement.

The writer would have found it extremely difficult to carry on his work without the very friendly attitude of all those with whom he came in contact. The Administration of South West Africa went far beyond the requirements of ordinary cooperation. The Administrator himself, Mnr. D. Viljoen, and the Secretaries for South West Africa, Mr. John Nesor and Mnr. Marais opened many official doors and closed none. With their approval and assistance, permission to visit and even transportation to various native and game reserves were made available. Other government officers, notably:

Jan Meyer, Chief of the Meteorological Office
Dr. O. Wiplinger, Chief of Water Resources
Dr. J. S. Watt, Director of Agriculture
David Krynauw, Chief Archivist
Dr. Henno Martin, Geologist
Bernabe de la Bat, Chief Game Warden
J. V. Joubert, Pasture Research Officer

aided very greatly. Of assistance in the field were many members of the local community, particularly:

Mnr. Fick and Mnr. Viljoen of the South African Railways, Swakopmund
Mr. Ekstien of the Public Works Department, Swakopmund
Mnr. H. A. J. Lintvelt of Farm Onanis, Karibib District
Mr. Lex Courtney-Clarke of Neuheusis, Windhoek District

Herr Hans Kriess, Swakopmund
Herr Attila Port of Farm Valenica, Rehoboth District
Mr. J. J. Hanssen, Farm Tara, Windhoek District
Mr. Dan Minnaar, Editor, the Windhoek Advertiser

Without the friendly cooperation of the above and many others like them, it would have been almost impossible to carry out field work in this remote and difficult area.

Chapter I

INTRODUCTION

The Namib, the coastal desert of Southwestern Africa, extends from the vicinity of Mossamedes in Angola southwards a distance of 1,300 miles to the mouth of the Olifants River in the Cape Province of the Union of South Africa.¹ In width it reaches from the coast inland to the foot of the Great Western Escarpment of southern Africa--a distance of 50 to 90 miles. Eastward it is succeeded by a belt of grass and bush-steppe which in turn yields, north of the tropic, to the thornbush savanna of the Central Plateau. South of the tropic, semi-desert and vegetation continues eastward into the heart of the continent, merging eventually with the semi-deserts of southern Bechuanaland (the Kalahari) and the interior of the Cape Province.

The Namib Desert can be divided geomorphically into two portions: the northern and the southern, with the divide at the Kuiseb River which enters the sea at Walvis Bay. The northern portion consists of a very smooth platform cut into the underlying bedrock and rising very gradually inland to an altitude of about 3,000 feet at a distance of 80 miles from the coast. In some places this platform is overlain by beds of partially consolidated Tertiary gravels. Elsewhere it is trenched by the deep gorges of the several rivers which flow across it from the interior highlands to the sea. Occasional isolated mountains rise above it. But for the most part it is an area of monotonous flatness and distant horizons.

South of the Kuiseb River this platform is overlain by very thick deposits of dune sands actively moved by the wind. This sand sea extends in an unbroken fashion from the Kuiseb River to the Luderitz-Keetmanshoop railway line--a distance of about 200 miles. Actually, the basic geomorphology of the two portions of the Namib is the same, for the sand sea is merely an aeolian deposit veneering the same smooth rocky platform that characterizes the northern Namib.

Inland from the Namib platform lies the Great Western Escarpment of the plateau of southern Africa. In a few places this escarpment is very abrupt, but over most of its length it is bordered by a number of outlying mountains and is itself interrupted by frequent rather deep reentrants. Thus, there is an irregular dissected zone of escarpment averaging some 20 miles in width.

Eastward from the upper edge of the Escarpment stretches a rolling upland surface at an elevation of between 4,000 and 6,000 feet above sea level. In some areas the upland surface is quite complete and still intact; elsewhere it is carved into considerable relief by the dissection of various streams.

Field work was carried on intensively in the central portion of the Namib, from Sandwich Harbour, Walvis Bay and Swakopmund eastward to the foot of the Escarpment.

1. John H. Wellington, *Southern Africa, A Geographical Study*. Cambridge, 1955, pp. 19-120.

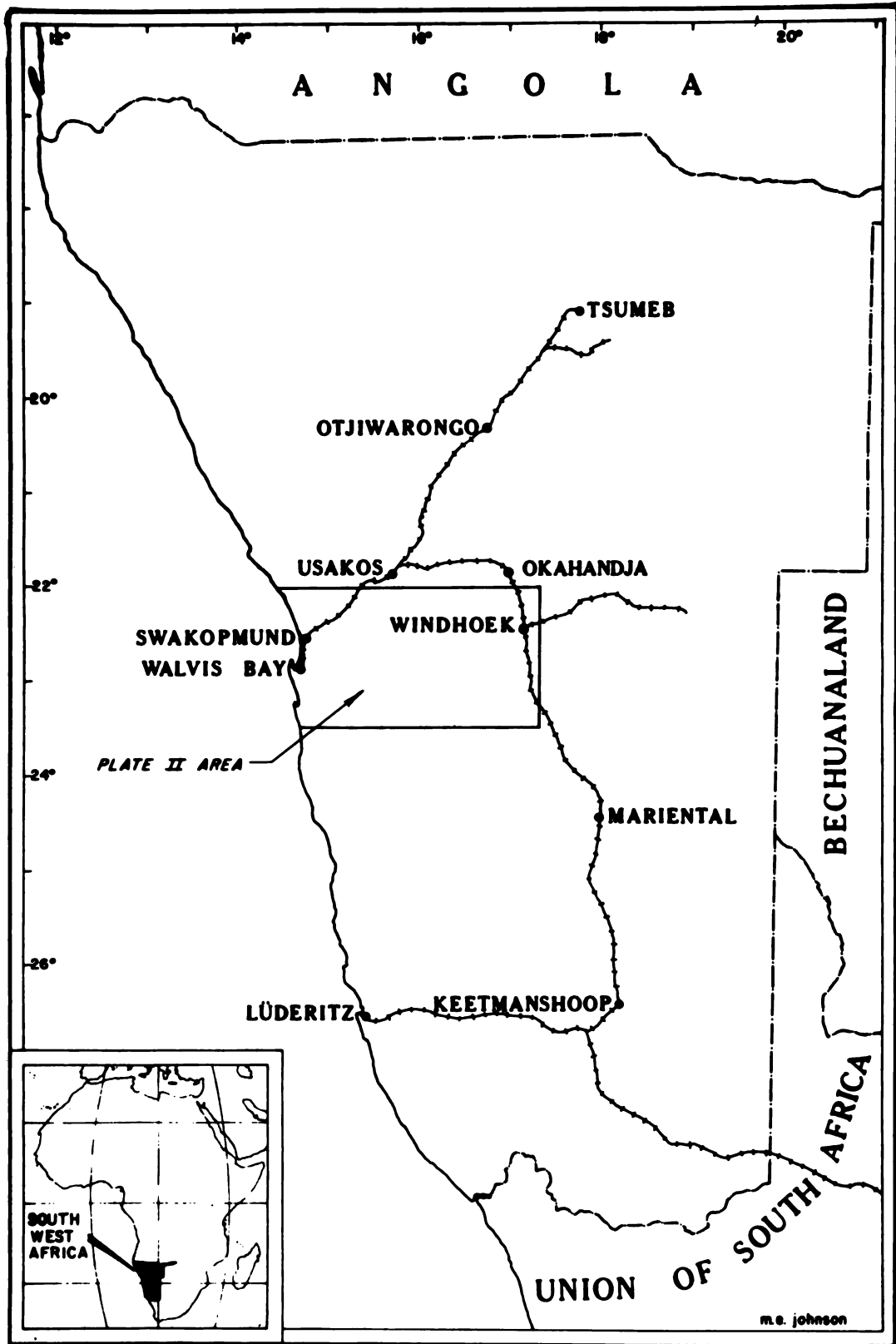
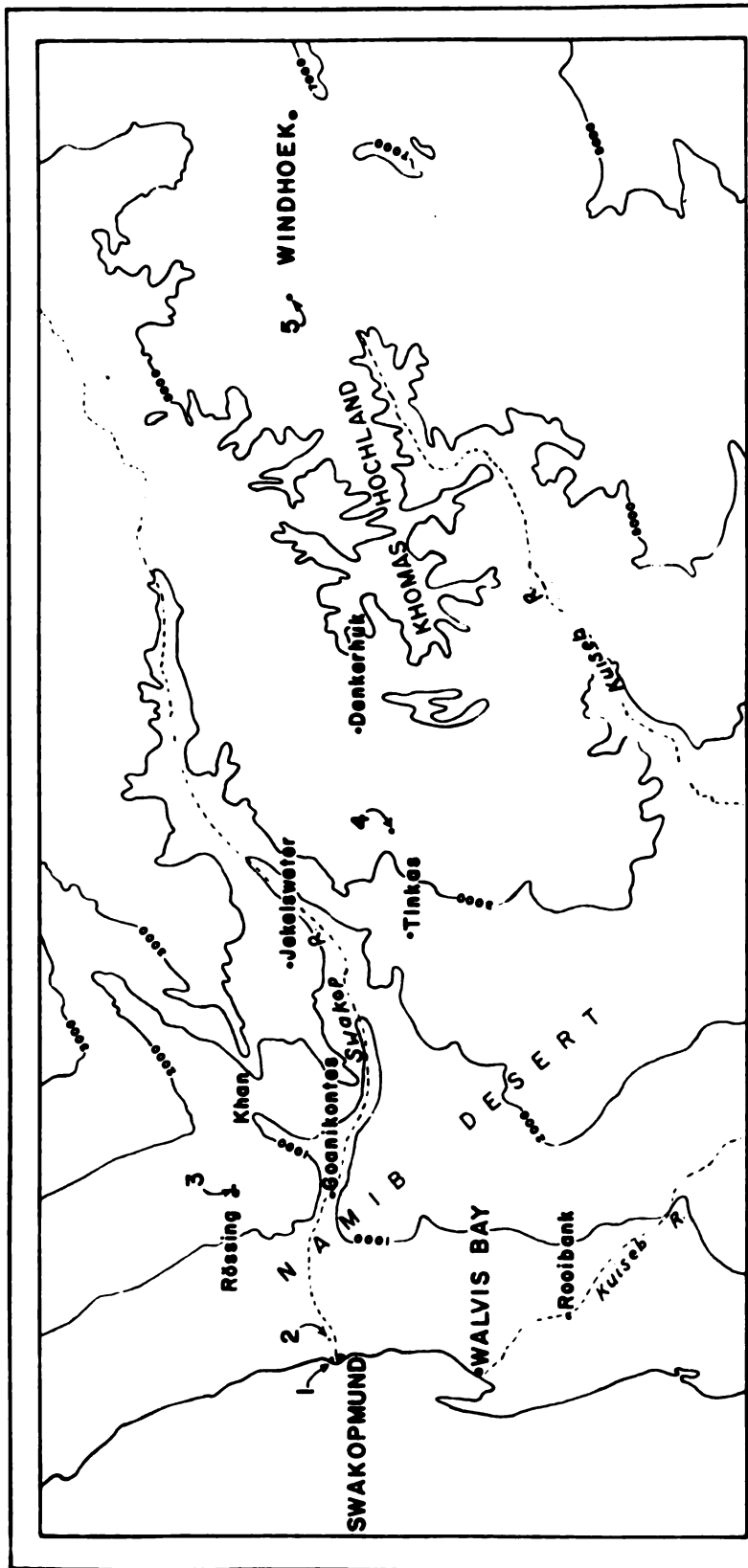


PLATE I



AREA OF DETAILED STUDY SOUTH WEST AFRICA

STATIONS

- 1 SWAKOPMUND LIGHTHOUSE
- 2 SWAKOPMUND AERODROME
- 3 RÖSSING
- 4 LINTVELT'S POORT
- 5 NEUHEUIS



PLATE II
m.e.j.

Within that area (between 22°30' and 23°30' South Latitude) it is possible to study representative samples of both the northern and southern Namib, and to observe the contrasts between coastal and inland situations.

The field investigations were of several sorts. To study as fully as possible the nature of the climate of the areas, five weather stations were established at varying distances inland and records of temperature and humidity were obtained from them during the mid-summer and mid-winter periods. An indication of the nature of the precipitation was available from the extensive collection of records in the Meteorological Office at Windhoek. Random observations of weather were made at all times the writer was in the field, and added greatly to the information obtained by more orderly means.

The geomorphology and vegetation were first observed by reconnaissance, and later examined in detail in a series of carefully selected representative situations.

In the pages that follow, attention is first given to the climate. A discussion of the general climatic controls is followed by detailed analyses of the coastal and interior climatic types in both summer and winter.

When all of the elements of the physical geography are taken into consideration, it becomes apparent that there are three major subdivisions of the Central Namib. On a strictly geomorphic basis (as already indicated) the area can be divided into the zones north and south of the Kuiseb River--the Namib Platform and the Great Sand Dunes respectively. From the climatic viewpoint, the littoral belt is strongly distinctive from the rest of the desert. Each of these three areas are considered here to constitute a separate sub-region, and a separate chapter of this study is devoted to each.

Each of these is in turn broken down into further subdivisions, termed landscape types and unit areas. A unit area is the smallest recognizable unit of the geographical landscape--an area within which each of the geographical elements (slope, exposure, lithology, soil, vegetation, human use, etc.) occur in a homogeneous, uniform manner. In most cases, a single type of unit area is repeated again and again over wide stretches of country, in a dispersed, detached manner. Commonly, two or more types of unit areas occur repeatedly in close juxtaposition, forming parts of a larger entity termed a landscape type. Two or more landscape types, occurring repeatedly, unite to form a sub-region.

Through the central portion of this study, the component unit areas and landscape types of the Central Namib are analyzed in detail.

The latter part of the report describes the general vegetation relationships in the area, the animal life, and attempts to evaluate the future potentialities of the region.

Chapter II

CLIMATE

Causes of the Desert

The existence of an arid zone immediately adjacent to a large water body such as the South Atlantic is deserving of an explanation. Since the desert is caused by an absence of precipitation it is perhaps most logical to approach the explanation by showing why each of the normal forms of precipitation do not occur here and arriving at an explanation by elimination.

Most significant in this area are the mid-latitude frontal disturbances resulting from the interaction between polar maritime air of the high oceanic latitudes, tropical maritime air of the low oceanic latitudes, and the cool continental air mass which develops in winter over the plateaus of southern Africa. These interactions develop as traveling low pressure and high pressure areas move from west to east across the South Atlantic. When the proper combinations occur, rain may fall over the western Cape, Namaqualand and even the southern end of the Namib. The most favorable circumstances are the passage of a strong low in the vicinity of the Cape and the migration of the usual interior high well to the northeast (over Natal and Mozambique).

Such situations can occur only in winter. In summer the migratory lows pass far to the south and no such frontal situation can possibly develop. And at no time do such disturbances effect the areas of the central Namib. The occurrence of these occasional winter rains makes the vegetation of the South quite different from that of the rest of the Namib. In some years these rains do not occur at all and in the most favorable of years occur only on several occasions.

Topographically, the situation seems perfect for orographic precipitation. The Namib platform slopes up to an altitude of 3,000 feet at a distance of 80 miles from the coast and is succeeded by the abrupt rise of the Great Western Escarpment to an altitude of 6,000 feet. But while the prevailing wind is inland and hence would seem very favorable for precipitation, the sea from which it comes is cold and the ground over which it passes is hot and the adiabatic cooling attending the orographic rise is more than offset by the radiational heating from the ground. Thus, orographic precipitation does not develop.

When the wind blows from the opposite direction it descends the Escarpment and the platform and is therefore heated at the adiabatic rate; hence it becomes a drying wind rather than one capable of producing precipitation.

The interior of South West Africa receives its precipitation during the summer in the form of convectional storms. The moisture is derived from the Indian Ocean and has been carried across Mozambique, Southern Rhodesia and Bechuanaland.

Much of it is probably secondary, having been precipitated somewhere en route and re-evaporated. The amount received decreases steadily from east to west as the air gives up its burden of moisture. By the time the summit of the Great Western Escarpment is reached, the amount of humidity in the air available for precipitation is very limited. Thus, even were the situation in the Namib the same as in the interior, the amount of precipitation would be very limited.

Two elements combine to reduce still further the chances of precipitation. The topography and its drying effect upon air from the east have already been described. But of still greater importance is the effect of the inversion. All the summer rain of the interior is produced by convectionality induced by terrestrial heating of the lower elements of the atmosphere. In the Namib a 2,000-foot layer of cold air is interposed between the warming ground and the moisture-bearing air. Thus, convectionality and precipitation are precluded.

Basically then, the coastal area is a desert by default; because it receives rain from none of the normal sources. Rather, it lies under the dominance of subsiding tropical air, the "superior air" of Bergeron: low in moisture, warming adiabatically, and extremely stable, and (as though to ensure it still further against any remote possibility of precipitation) sealed against convectionality by surface temperature inversion.

Thus, we have the anomaly of a virtually rainless area whose air is almost permanently saturated with moisture. Were this layer of moist air thicker, were the ocean off-shore warmer, then conditions potentially productive of precipitation would prevail and the desert would disappear. But the inversion is shallow and the ocean is cold, so we have a cool fog-shrouded, dripping desert.

Major Controls

Several major controls have combined to produce the unusual climate of the coastal portions of South West Africa, among them the subtropical high pressure system, the traveling cyclones and anticyclones, the seasonally alternating pressure of the interior of Africa and the cold current along the coast.

Pressure Systems

Throughout the year the semi-permanent high pressure cell occupying the center of the South Atlantic exerts a great influence on the weather of the area under consideration. Within the cell dry cool air is subsiding from aloft (from altitudes of some 30,000 feet). With descent this air is warmed adiabatically and comes to the surface as dry warm air. Upon reaching the surface the air tends to flow out in all directions with a strong twist to the left due to the rotation of the earth (Coriolis force). The cell shifts only slightly with the seasons;² in summer it is centered about 30° S. ; in winter at about 27°S.

A similar cell is normally developed over the high plateau of southern Africa. During the winter its descending air usually reaches to the surface of the land producing warm, dry, clear air over all the interior of southern Africa. During the

2. Wellington, op. cit., p. 192.

summer, however, surface heating there is strong and the resulting convectionality not only prevents the descending air from reaching the surface but develops a fairly strong low pressure circulation pattern as well. At this season the normal weather map indicates a low pressure cell on the surface although a high pressure zone exists in the upper air.

In contrast with these fixed but dynamic high pressure cells are the traveling cold anticyclones. These originate over the cold water and ice surfaces of high latitudes in the Southern Hemisphere and move eastward. Normally they pass well to the south of Africa, but occasionally during the winter such an air unit may swing northward and merge with the stationary high over the continent. At such times the adiabatic warmth of the normal high is replaced by imported cold air and cold spells ensue.

It might be expected that the air movement in the western part of South West Africa would be controlled largely by the nearby high pressure systems. At sea this is definitely the case. There the winds are almost always from the S. S. E. as would be expected from the position of the South Atlantic high pressure cell. In a sense, these winds are the beginning of the trade winds blowing from the subtropical high pressure zone toward the distant equatorial low pressure area. Since the axis of the subtropical high pressure ridge (connecting the South Atlantic high with the interior African high) is always south of Luderitz and usually south of the Orange River, these winds sweep north-northwestward--along the entire coast of the Territory.³ They are strong and steady, blowing at force 4 to 5 (Beaufort) with an 80 to 85% frequency from the southeasterly quadrant.

Inland the winds are partly under the domination of the high pressure of the interior, resulting in a prevailing easterly wind most of the year. This tends to be the case, however, even in the summer, when the thermal low pressure system has developed over the interior and when one would ordinarily expect winds to be trending in that direction.

In the coastal area the influence of the major control is supplanted entirely by a pair of local influences. A cold sea and a hot land result in the deflection of the southeast wind into a strong southwesterly sea breeze. It is this daily importation of moist, cool sea air that makes the Namib so different from the usual concept of a desert. Its causes and effects will be investigated in greater detail later in this work.

The Benguela Current

The cold Benguela Current exerts a profound effect upon the climate of the coastal area of South West Africa. It originates as a narrow strip of cold water west of the Cape Peninsula in about Latitude 33° South, and broadens rapidly northward until it is about one hundred miles wide at the Orange River⁴ and somewhat wider off Walvis Bay.

-
3. Weather on the Coast of Africa, Vol. 2, Local Information, Part I. Prepared by the Meteorological Services of the Royal Navy and the South African Air Force, 1944, pp. 4, 9.
 4. W. J. Copenhagen, Periodic Mortality of Fish in the Walvis Region: A Phenomenon of the Benguela Current, Union of South Africa, Division of Fisheries, Investigational Report No. 14, 1953.

Its northward movement at a rate of ten to twenty-five miles per day⁵ is caused primarily by the prevailing southerly winds associated with the South Atlantic anticyclone. The relatively low temperatures that might be expected in such a current, moving from high latitude to lower, are made still more anomalous by a very high incidence of upwelling, which brings to the surface "Antarctic Intermediate Water" from great depth⁶ and produces surface water temperatures in the mid-fifties Fahrenheit at latitudes well within the tropic.⁷

The upwelling is continuous neither geographically nor chronologically. Currie⁸ reports that it occurs in pools or "interlocking tongues" of cool and warm

-
5. Current Charts, British Admiralty.
 6. At about Latitude 50° South, the Antarctic Intermediate Current sinks from the surface to a great depth and moves northward. It is this water that upwells in the Benguella Current.
 7. Copenhagen, op. cit., p. 5, gives a series of average surface temperatures to indicate the prevalence of low temperatures along this coast throughout the year, in contrast with temperatures in mid-ocean at the same latitude:

<u>Locality</u>	<u>Feb.</u>	<u>May</u>	<u>Aug.</u>	<u>Nov.</u>
200 miles offshore	68°	66.2°	60.8°	64.4°
Walvis Bay	59	60.8	57.2	59
Luderitz	53.6	--	51.8	50

These figures, largely derived from J. M. Marchant, Report of the Union of South Africa Fisheries and Marine Biology Survey, No. 7 (1929), Special Report No. IV, and also used by J. H. Wellington (op. cit.) as the basis in part for his Table I, p. 135, are most misleading in that they indicate that the water is much warmer at Walvis Bay than farther south--as at Luderitz. This was appreciated by Wellington, who quoted S. P. Jackson (unpublished) on the matter. The Walvis Bay temperatures were apparently taken in the harbor, an area of broad shallows (see U. S. Hydrographic Office chart 2267) where the water becomes noticeably warmed.

In contrast, the temperatures recorded at the seawater intake of the S. S. Frank Lykes during a coastwise run from Cape Town to Walvis Bay on Aug. 19, 1957 were:

<u>Locality</u>	<u>Time</u>	<u>Water Temperature</u>
12 miles off Luderitz	4 a.m.	54°F
8 miles off Spencer Bay	8 a.m.	53
4 miles off Hollams Bird Island	Noon	53
7 miles off Sandwich Harbor	4 p.m.	54

While on its offshore run toward St. Helena Island on August 23-24, 1957, the same ship recorded 56° at a distance of 90 miles from the coast at Walvis Bay, and 63° two hundred miles offshore. The latter figure is in keeping with Copenhagen's offshore average temperature given above.

8. R. Currie, Upwelling in the Benguella Current, Nature, March 21, 1953.

water. Copenhagen⁹ reports that during fogs, and especially during periods of north winds, the flow of the current may slacken, cease or even reverse itself, and that at such times sea temperatures rise appreciably. The latter is undoubtedly due to the cessation of upwelling. But his statement must be weighed carefully--it obviously does not hold true during all times of fog, for the coast is shrouded a good portion of the year.

The cause of upwelling is not definitely known. Wellington¹⁰ gives the simpler and older explanation: that the "fanning out" of water from the Benguela Current westward into the Atlantic draws up water from the deeps for replacement, and then proceeds to summarize the newer theories.¹¹ Since this report is concerned only with the effects of the current, theories relating to its cause are quite beyond the scope of its interests. It is sufficient to say that the Current and the upwelling do exist, and that the water temperatures are far below the normal for the latitude, being in the middle fifties just offshore.

The Sea Breeze

Lying in the vicinity of the tropics the region is subject to very strong insolation heating at all seasons of the year. While this has little effect upon the sea it results in strong terrestrial heating which in turn tends to warm the air above it. Convectionality results and air is drawn in from the adjacent cool sea to replace that which has risen from heating, thus a sea breeze is created.

This is strictly a diurnal phenomenon. At night the insolation ceases, the ground cools by radiation, the air above is chilled, the convection ceases and the sea breeze dies. This situation develops with great regularity at all seasons of the year.

One might expect the air to be drawn in directly from the sea at right angles to the coastline or, in other words, from a westerly direction. However, as has been shown above the prevailing wind direction, determined by the position of the South Atlantic high pressure cell, is from the south-southeast. Thus air is not drawn in directly from the sea; rather this south-southeast wind is deflected landward and, thus, the sea breeze blows from the south-southwest or southwest.

Under normal circumstances the sea breeze blows moderately, usually at force 3 to 4 (Beaufort). It is inclined to be somewhat stronger in the south (as at Luderitz than in the central Namib (as at Walvis Bay). When the wind becomes

-
9. Copenhagen, op. cit., pp. 3-4.
 10. Wellington, op. cit., p. 132.
 11. Particularly that of Defant: "Das Kaltwasserauftriebsgebiet vor der Kuste Sudwestafrikas" in Landerkundliche Forschung: Festschrift zur Vollendung des Sechzigsten Lebensjahres Norbert Krebs, Stuttgart, 1936, pp. 52-66. Copenhagen, op. cit., p. 3, attributes the upwelling to the east wind, pointing out that the upwelling is greatest during May and June--which corresponds to the period of greatest frequency of winds from the East. However, had he taken into consideration how seldom the east wind actually does blow (only several days per month) and that the southwest wind is still the prevailing wind in those months, he would never have been misled into attributing continuous upwelling to so sporadic a cause.

greater, as it does on occasion, it is due to the augmentation of the sea breeze by either an anticyclonic development offshore or a depression over the land.¹²

The sea breeze blows inland across the entire width of the Namib and rises in irregular streams up the face of the Great Western Escarpment to disperse eventually over the uplands of the interior.

Temperature Inversion

This regular importation of air from over the cool sea produces a strong temperature inversion over a wide belt back of the coast. At the coast the lower zone is ordinarily some 2,000 feet thick.¹³ Within it the surface temperature corresponds closely to the temperature of the sea offshore and humidities approach the saturation point. Fogs are common and when not present, a layer of stratus cloud usually exists with its base at less than 1,000 feet.

In its passage inland across the desert this air warms considerably, evaporating the fog and the cloud and lowering the relative humidity. But as far inland as the top of the escarpment the air is still distinctively different from the interior air of Southern Africa.

Above the cooler layers (at about 2,000 feet) the inversion of temperature begins,¹⁴ continuing to 5,000 or 6,000 feet. Above 6,000 feet the air is warm and dry. Mid-morning cross-sections of the air above the coast show temperatures and humidity at the surface to be 59° and 85% respectively; at 3,000 feet 61° and 48%; and at 6,000 feet 66° and 22%.

Precipitation

No area of the world is totally without rainfall, however, and the Namib while extremely low in precipitation does receive some. On the rare occasions when moist air is present aloft and not sealed off from terrestrial heating by the inversion, rain may occur. Such situations usually develop at the beginning and end of summer. Two conditions are necessary for the production of such a situation:

- 1) Temporary absence of the inversion due to large-scale pressure situations that cause a cessation of the sea breeze;
- 2) Presence of modified Indian Ocean air with its attendant moisture.

The chances of the coincidence of these conditions are not great and such rains occur only infrequently.

Because of the shortness of the study, no rainfall observations were taken. Rainfall records are very scarce in the Namib as a whole but fortunately several records have been kept within the area under study here.¹⁵ While all of them are

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12. S. P. Jackson, "A Note on the Climate of Walvis Bay", South African Geographical Journal, Vol. 23, (1941), p. 49.
 13. Jackson, op. cit., p. 52.
 14. Jackson, loc. cit.
 15. Records in the Meteorological Office, Windhoek.

discontinuous and some of them quite short-ranged and covering a period well back in the past, they nonetheless give a fair representation of the general nature of the precipitation amounts and distributions. (See Plate II)

At Swakopmund, a record has been kept discontinuously since 1899. If only the years for which a complete record is available are taken into consideration the average annual rainfall is found to be 0.65 inches. This rainfall is of extremely irregular nature, with long periods of virtual rainlessness punctuated by infrequent years of much heavier rainfall. In one year, 1934, 6.13 inches was received, nearly two inches of it in a single day. If this very abnormal year is omitted from the record the annual average rainfall becomes 0.52 inches.

The rainfall occurs chiefly late in summer, with March receiving an average of 0.18 inches. The winters are virtually rainless with less than 0.01 inch in June. Over the 42 years of the record, 54 thunderstorms occurred. Few have occurred in winter (July and August only one each in 42 years), because of the extremely dry conditions prevailing in the upper air; and few in summer (December one storm and January two), because of the advective inversion which prevents convective development in the upper air. However, when the inversion is absent and enough moisture is present in the upper air, convectionality may result in thunderstorms. Such conditions are most likely to occur in the fall (October--17 storms) and spring (April--12 storms).

Neither hail nor snow has ever been recorded.

At Goanikontes (elevation 787 feet) deep in the gorge of the Swakop river, 20 miles from the coast, a rainfall record was kept for the 8 years, 1918 to 1925. The average (1.35 inches) is considerably greater than that of Swakopmund, although the two records cannot be directly compared owing to a hiatus in the Swakopmund record. It is definitely rainier at Goanikontes, however, as testified by the number of thunderstorms; 71 occurred in the 8 years in contrast to 54 in 42 years at Swakopmund.

Again, the rainfall is extremely variable. The season July, 1921 to June, 1922, received no rain whatever, while 0.9 of an inch fell in 24 hours in September, 1919. Winter and summer are distinctly drier seasons, with no rain having been recorded in July or August or during the summer. March is the rainiest month with a mean of 0.42 inches.

At the Khan mine (elevation 925 feet) in the gorge of the Khan river east of Rosasing and 32 miles from the coast, a rainfall record was kept discontinuously for the 16-year period 1912 to 1927.

If consideration is given only to the years for which complete records are available, the annual average rainfall is 1.71 inches with a maximum in February (0.42 inches) and a minimum in July and August (0.01 inches).

At Jackalswater, on the Namib platform at an elevation of 2,400 feet, about 50 miles from the coast, a discontinuous record exists for the years 1900 through 1912. Considering only the years of complete record, the annual average rainfall is 1.39 inches. The amounts received vary from 3.1 inches to 0.6 inches.

A pronounced rise in precipitation occurs along the foot of the Great Western Escarpment, probably the result of the dispelling of the advective inversion by surface heating, thereby allowing convectional thermals to develop. This is well evidenced by the station Donkerhuk, located in a valley between massive granite outliers of the escarpment, 80 miles from the coast. The station has been operated discontinuously since 1930 in addition to a one-year record in 1914.

The rainfall here is exceedingly irregular. The driest year on record was 1946 when only 1.2 inches fell; on the other hand, in 1934, 29.67 inches was measured. Considering only the years of complete record, the annual average rainfall is 6.8 inches. Omitting the unusual year of 1934 the annual average is 5.8 inches. By far the greater part of the precipitation falls in the summer months, especially February and March. The winter months are virtually rainless. There are no spring or fall maxima. Summer thunderstorms are very frequent with the maximum number coming in January, but they are practically absent from the June and July record. On some occasions the intensity of rainfall may be very great; the maximum measured in the month of February exceeded 3.5 inches in 24 hours. Snow is unknown, but hail has fallen on rare occasions.

A record has been kept intermittently since 1909 at Neuheusis. Considering all years of complete record the annual average rainfall there is 10.6 inches. If the two years of abnormal precipitation (1909 and 1934) are omitted the average is reduced to 8.6 inches. The record for 1934 was 32.55 inches for the calendar year, but 34.65 inches for the July to June season. In 1909 the total accumulation was 25.08 inches for the calendar year and 26.10 inches for the season. On the other hand, only 3.38 inches fell in the calendar year 1911 and 2.95 inches for the season.

Being located farther east than the other stations and being free of the convection-preventing temperature inversion, the summer rains occur at Neuheusis before the more westerly stations. Consequently the three months of January, February and March vie for first place in the rainfall accumulation record. Thunderstorms, sometimes accompanied by hail, occur frequently during the summer period. Snow, on the other hand, is unknown.

Climate of the Coastal Zone

The climate of the Namib coast is the very epitome of the cool coastal deserts of the world. Similar areas are to be found in northern Chile and Baja, California. In the area under study two official stations (Walvis Bay and Swakopmund) provide us with considerable climatic data which has been augmented somewhat by the observations of the writer. ¹⁶

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16. Data given here is derived chiefly from "Weather on the Coast of Africa," Vol. II--Local Information--Part 1, prepared by the Meteorological Services of the Royal Navy and South African Air Force, 1944; from S. P. Jackson, "A Note on the Climate of Walvis Bay," South African Geographical Journal, Vol. XXIII, 1941; from the records of the Weather Bureau of the Department of Transport, Union of South Africa, housed in the Meteorological Office, Windhoek; from the published records of that Bureau; from "Sailing Directions for the Southwest Coast of Africa," U. S. Hydrographic Office publication No. 105, 1951, Appendix 2, p. 280; and from direct field observations, especially at the weather stations operated by the writer at Swakopmund Lighthouse and Swakopmund Aerodrome.

The ameliorating effect of the cool sea to the windward has produced a moderate temperature along the South West African coast. At Walvis Bay the mean temperature for the year is 62 degrees and the range between the mean maximum for the hottest month and the mean minimum for the coldest month is only 29 degrees. (See Table I)

Table I
Walvis Bay Temperatures*
(degrees Fahrenheit)

<u>Month</u>	<u>Avg.</u>	<u>Mean Daily Maximum</u>	<u>Mean Daily Minimum</u>	<u>Mean Absolute Maximum</u>	<u>Mean Absolute Minimum</u>	<u>Extreme Maximum</u>	<u>Extreme Minimum</u>
Jan.	66	73	59	85	52	100	45
Feb.	67	74	60	85	54	97	45
Mar.	66	74	59	86	53	97	45
Apr.	65	75	55	92	49	103	43
May	63	74	52	96	43	104	35
June	61	74	48	94	37	97	35
July	58	70	47	90	36	98	25
Aug.	57	68	46	88	38	99	34
Sept.	57	66	48	85	39	100	32
Oct.	59	67	51	78	43	97	32
Nov.	62	71	54	84	46	95	43
Dec.	65	72	57	83	51	91	45
Year	62	72	53	87	45	104	25

* From "Weather on the Coasts of Africa", p. 58.

Summer Conditions

Summer is surprisingly cool, especially in view of the tropical location of the area.¹⁷ At Walvis Bay the January mean maximum is 73° and the minimum is 59°, giving a range of only 14°. Humidity is high at all times; the means of the official morning observations at Walvis Bay are close to 90 per cent; and the 3 p.m. mean in January is 73 per cent. (See Table II). Conditions at the coast (the Walvis Bay station is separated from the open sea by several miles of mud-flat and lagoon) are even more moderate and humid as exemplified by the writer's observations at Swakopmund Lighthouse. (See Table III).

The instrument at Swakopmund was located in the official weather shelter of the South African Weather Bureau situated at a height of about 40 feet above sea level on the edge of a low bluff overlooking a narrow stretch of beach. It is situated in an unobstructed position just to the windward of the lighthouse itself.

17. The Tropic of Capricorn crosses the coast just south of Sandwich Harbour. Walvis Bay is in Latitude 23° and Swakopmund at 22°40'.

Table IIWalvis Bay--Relative Humidity*
(per cent)

<u>Month</u>	<u>Time</u>	
	<u>0830</u> <u>Per cent</u>	<u>1500</u> <u>Per cent</u>
January	91	73
February	92	73
March	95	74
April	89	66
May	88	68
June	78	64
July	83	65
August	89	73
September	90	69
October	91	72
November	90	71
December	90	72
Year	89	70

* From "Weather on the Coasts of Africa," p. 58.

Table IIISummer ConditionsDecember 16, 1956 - January 14, 1957Mean Humidity
(per cent)

<u>Station</u>	<u>Max.</u>	<u>Min.</u>	<u>Range</u>	<u>Duration, in hours, of</u>				
				<u>100%</u>	<u>90%</u>	<u>30%</u>	<u>20%</u>	<u>10%</u>
Swakopmund Lighthouse	100	90	10	19	23	0	0	0
Swakopmund Aerodrome	100	82	38	13	15	0	0	0

Mean Temperatures
(degrees Farenheit)

<u>Station</u>	<u>Max.</u>	<u>Min.</u>	<u>Range</u>	<u>Daily</u>
Swakopmund Lighthouse	67.1	58.5	8.6	62.8
Swakopmund Aerodrome	68.3	55.3	13.0	61.8

Meteorologically the conditions at Swakopmund Lighthouse during the mid-summer period show a monotonous regularity. The trace for Christmas day, 1956, (reproduced here as Plate III), is representative of the typical mid-summer day.

During the first half of the day, from midnight until noon, the humidity remained consistently at 100%. During the same period the temperatures fluctuated only between 58° and 56°--dipping a bit in the early morning hours and recovering slightly during the late forenoon. The temperature curve crossed 60° at about one p.m., at which time the humidity for the first time dropped below the saturation point. During most of this period, however, there was no fog at the surface, but a very low stratus cover persisted--at times touching the top of the lighthouse.

The one o'clock rise in temperature and concurrent drop in humidity was associated with the occasional breaking through of the sun as the cloud cover was momentarily dispelled. These conditions prevailed through the remainder of the afternoon. As shown by the thermograph trace there were occasional returns of the cloud cover and resultant near-saturation of the air, but not for a long enough time to cause a depression of the thermometer.

At 6:00 p.m., the humidity went once more to 100% and the stratus cover aloft was resumed. These conditions prevailed until the end of the day. During the evening a gradual cooling off occurred, with the temperature dropping from its maximum of 63° at 5:00 p.m., to 60° at 9:00, which continued through the remainder of the evening.

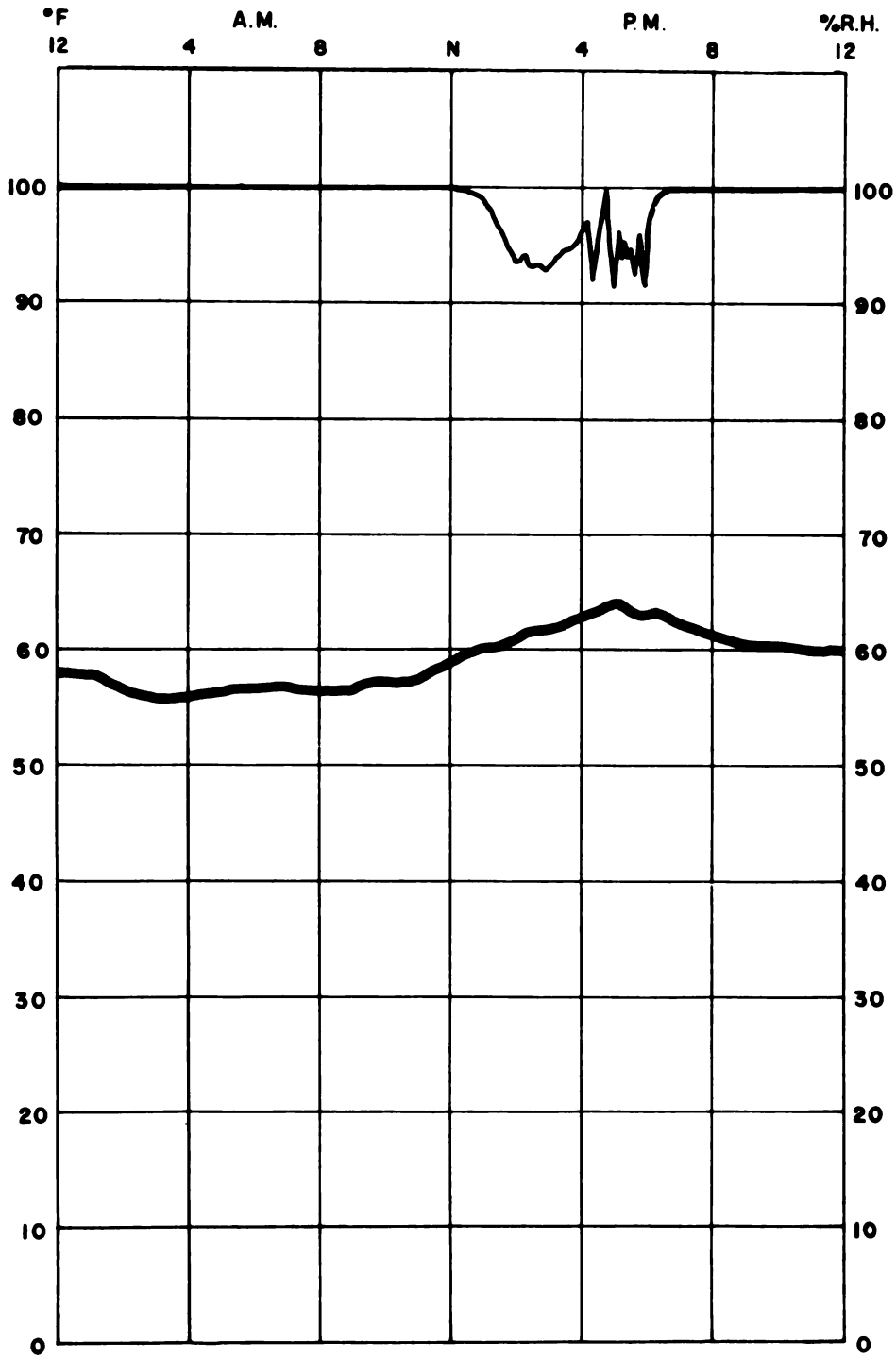
A perusal of Table III will indicate that during this period the humidity is normally at 100% for 19 hours per day and is in excess of 90% for 23 hours. The mean minimum is 90%.

As indicated in the same table, the summer days have a range of 8.6°, from a maximum of 67.1° to a minimum of 58.5°. In all respects the climate of Swakopmund is controlled by the presence of the neighboring sea and exhibits the most extreme characteristics of oceanity.

The weather shelter at Swakopmund Aerodrome, about 3 miles from the coast and at an altitude of about 250 feet, was situated on a broad flat gravel terrace, about 200 yards from its seaward edge.

A study of the hygrothermograph trace for Christmas day (Plate IV) shows a similarity to the nearby Swakopmund Lighthouse curve, but with considerably greater variations in both humidity and temperature. The humidity left the saturation point about three hours earlier than at the lighthouse, and the minimum humidity reached was 77% in contrast to 92% at the lighthouse. That the sea breeze does not blow steadily and regularly is shown by the extremely serrate nature of the trace during all of the time that it is below 100%. Each new surge of sea breeze brings in fresh, moisture-laden air which causes a sudden rise in relative humidity. When the breeze drops, sudden warming of the air by terrestrial radiation causes the rapid reduction of the relative humidity. The temperature element of the instrument is more sluggish and does not respond to these rapid changes, and its sheltered positions within the weather screen, probably also tends to smooth out the curve.

As at the lighthouse, 100% humidity was reached in the late afternoon and continued until midnight.



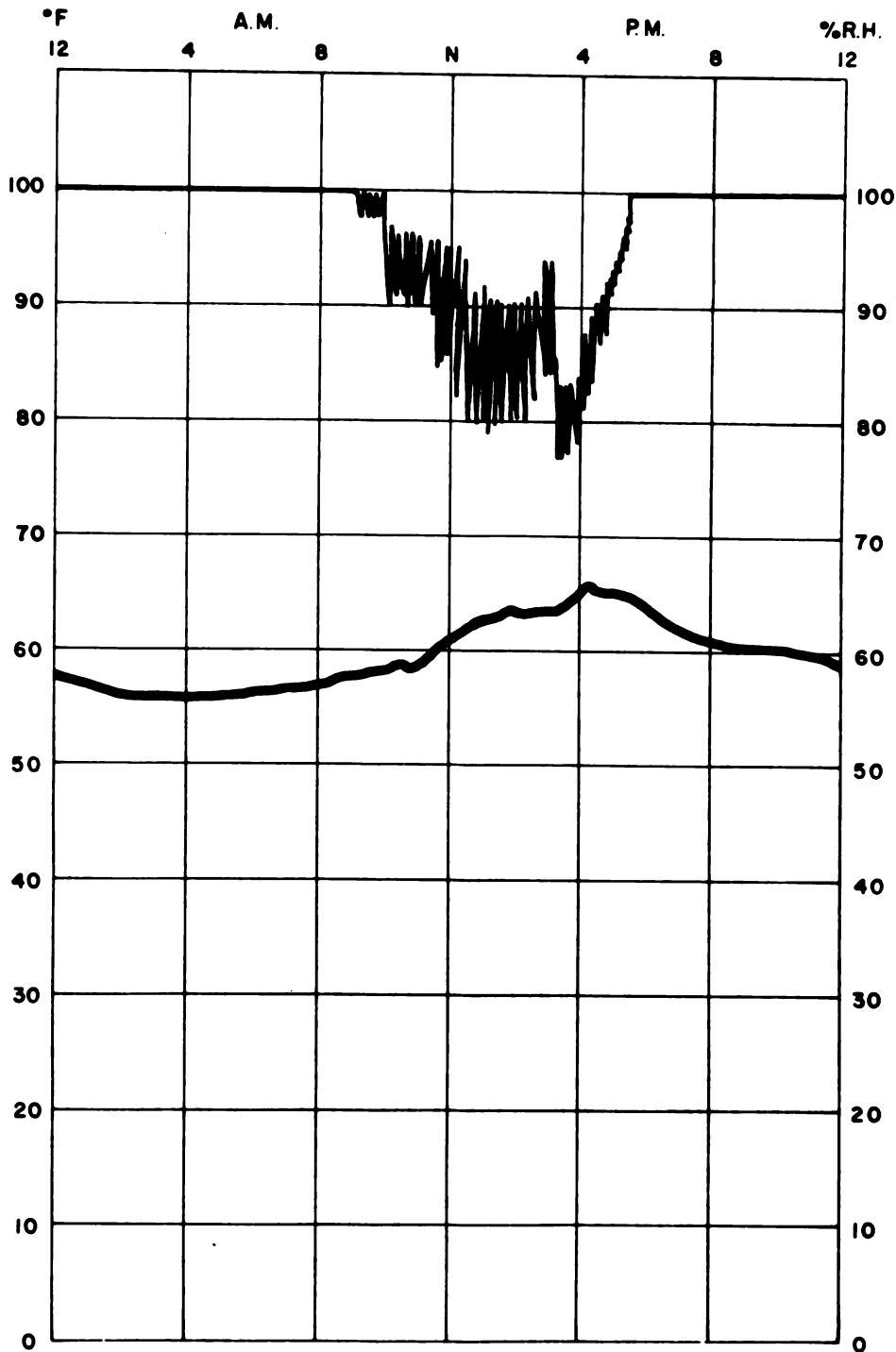
SWAKOPMUND LIGHTHOUSE

HYGROTHERMOGRAPH TRACE

DECEMBER 25, 1956

temperature 
humidity 

PLATE III



SWAKOPMUND AERODROME

HYGROTHERMOGRAPH TRACE

DECEMBER 25, 1956

temperature ———
 humidity ———

PLATE IV

The minimum temperature here was approximately the same as that at the coast, but during the daytime, the air warmed to a temperature approximately 2 degrees higher than that at the coast. This is not quite in keeping with the situation as shown in Table III where it can be seen that the mean minimum temperature is over 3 degrees lower than the lighthouse recording.

In general it could be said that the Aerodrome, only 3 miles from the lighthouse, exhibits much greater continentality than the seaside station. On the average (as shown in Table III) it has only 13 hours per day of 100% humidity--has a diurnal humidity range nearly four times as great as that of the coast and, from personal observation, has a much greater incidence of sunshine.

The uniformity of the temperatures at Swakopmund Lighthouse is well shown by the fact that in January, 90 per cent of the daily maximum temperatures are under 60 and 70°, and only 3 per cent over 70°.

At Walvis Bay, conditions are more like those of Swakopmund Aerodrome, being modified somewhat by the stretch of land to the windward.

At all of the points along the coast, the same daily regime is current during the mid-summer. Morning arrives grey, damp, and calm, or with a gentle wafting of air from the north; (See Table IV) the sky is covered with low stratus often at heights of only a few hundred feet. As the sun climbs higher, it gradually warms and evaporates the top of the cloud layer and, eventually by mid-morning, the sun begins to break through. The relative humidity drops somewhat as the surface air warms. At about the same time the sea breeze begins to blow, gently at first, but with increasing vigor, until by noon it is SW force 3 (Beaufort). During the early afternoon it increases to force 4 or 5, at which strength it continues to blow until near sunset. (See Table V).

At first, the soil and sand are held in place by the dampness of the preceding night, but eventually they dry out, released fragments begin to blow and soon clouds of dust fill the air. Visibility is reduced to less than a mile, small ripples of sand blow across the roads, and collect behind every obstacle, houses, fences, poles and bushes. The local Hottentot tribesmen call the sea breeze the "Soo-ooop-wa" imitating the noise it makes in the sand dunes. The sea breeze is constantly in the minds of the local people. A real estate advertisement in the Windhoek Advertiser for a house at Walvis Bay stated, "The building is sheltered from the southwest winds."¹⁸ In a news item concerning the overlooking of an entry on the agenda of a meeting of the Walvis Bay Town Council, the local correspondent noted "The strong southwest gale of the afternoon had probably blown the idea completely away."¹⁹

It is usually clear during the late morning and most of the afternoon. Towards dusk the wind slackens and dies after dark, the low stratus comes in overhead and the humidity increases again.

On occasions during the summer the South Atlantic anticyclone retreats from the coast and the usual sea breeze is supplanted by northwesterly winds of force 2 or 3. While this gives relief from the dusty southwest wind it brings heavily overcast

18. Windhoek Advertiser, Edition 3670.

19. Windhoek Advertiser, Edition 3656.

Table IVSurface Winds--8:30 A.M.December - FebruaryWalvis Bay*

<u>Velocity</u> <u>(Knots)</u>	<u>No</u> <u>Direction</u>	<u>Per cent Frequency From:</u>							
		<u>N</u>	<u>NE</u>	<u>E</u>	<u>SE</u>	<u>S</u>	<u>SW</u>	<u>W</u>	<u>NW</u>
0 - 2	60	-	-	-	-	-	-	-	-
3 - 13	-	19	5	1	1	4	3	1	6

Swakopmund

0 - 2	43	-	-	-	-	-	-	-	-
3 - 13	-	21	4	0	1	2	5	5	18

* From "Weather on the Coasts of Africa," pp. 17, 18.

Table VSurface Winds--3 P.M.December - February*

<u>Velocity</u> <u>(Knots)</u>	<u>No</u> <u>Direction</u>	<u>Per cent Frequency From:</u>							
		<u>N</u>	<u>NE</u>	<u>E</u>	<u>SE</u>	<u>S</u>	<u>SW</u>	<u>W</u>	<u>NW</u>
<u>Walvis Bay</u>									
0 - 2	4								
3 - 13	-	1	0	0	0	1	34	21	8
14 - 27	-	0	0	0	0	3	22	1	1
28 - 40	-	0	0	0	0	1	1	0	0
<u>Swakopmund</u>									
0 - 2	9								
3 - 13	-	1	0	0	0	3	48	23	12
14 - 27	-	0	0	0	0	0	2	0	0

* From "Weather on the Coasts of Africa," pp. 17, 18.

skies often with a light misty drizzle. This precipitation is not enough to record, but it does moisten the upper inch or so of the ground and produces very miserable living conditions. Such conditions have been noted on 14% of the observations in January, as shown by Table V.

Winter Conditions

In most ways the winter along the coastal belt of the Namib is quite similar to the summer. Cloudiness is somewhat less, humidity somewhat lower and the sea breeze less pronounced--but it still remains an area of moistness and of moderate temperatures.

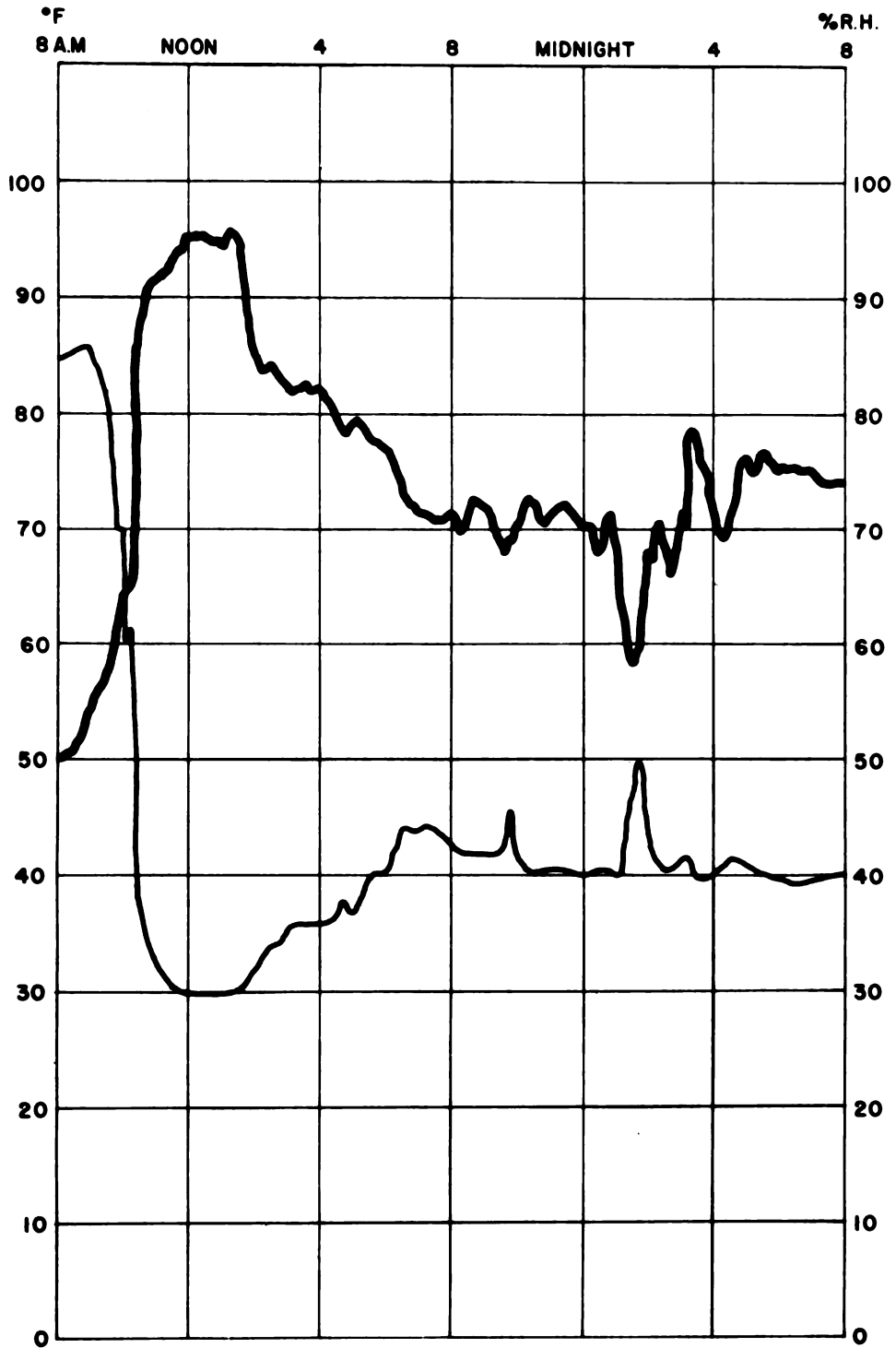
East Wind. An exception to these general rules occurs, however, on the days when the Berg ("Mountain") or East Wind blows. The cause of this hot, dry, seaward blowing wind is in some dispute, but there is no doubt whatever as to its existence; for it is well-known along the whole of the western coast of Africa. It brings extremely high temperature (with the result that the highest temperature of the year usually occurs during the winter) and extremely dry air. A typical example of an East Wind hygrothermograph trace is shown in Plate V.²⁰

The East Wind stirs up great quantities of dust from off the desert floor and blows it not only to the coast but for great distances seaward. At times it interferes with pilotage at Walvis Bay and is considered a great nuisance by the housewives of that port and of Swakopmund. On the other hand, its lower humidity permits a very welcome drying out of everything--clothing, house furnishings and the very houses themselves. By some, it is referred to as "The Doctor," but is generally more cursed for its dustiness than blessed for its desiccating effects.²¹

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20. No East Winds occurred during the period that the writer had instruments operating in the coastal area. The trace reproduced here is from a hygrothermograph operated at Swakopmund as part of the International Geophysical Year program of the South African government, and which was made available through the thoughtfulness of Mr. Jan Meyer, Chief of the Meteorological Office, Windhoek.
21. A rather vivid description of a siege of East Wind weather at Walvis Bay is given in the following extract from a personal letter from a teen-age girl, Miss Brenda Bramwell, a resident of the port, to the author's daughter:

"Tuesday, 12 August, 1958--It is noon and the sand is blowing like crazy and it's hot as Hades. When we come to work in the morning it is soaking wet, and about 9:30 the East Wind comes up and you can't see the houses opposite for dust. It's a horribly dry wind that makes you cough and cough, and one just about chokes on the dust. The nice part about it is that from 3:30 in the afternoon there is no wind whatsoever, and it is terrific out. And it is terrific all evening."

Another apt description is that of the Rev. Frank Haythornthwaite in his book "All the Way to Abenab." On page 19, he states: "This hot wind is like a blast from a furnace, dry and scorching. Even one's clothes become hot to the touch. With it come, not only sand, but thousands of flies of all varieties, including a particularly disgusting small, black, long, shiny one that stinks horribly when you kill it, and, if there are a lot of them, even when you don't." It is quite probably that these flies originate in the flats of the Kuiseb River to the eastward of the town.



SWAKOPMUND

HYGROTHERMOGRAPH TRACE

JUNE 9-10, 1957

temperature —
humidity —

PLATE V

The older, simpler and, to the writer, more acceptable explanation of this phenomenon places it in the same category as the familiar Santa Ana wind of Southern California. It holds that on rare occasions the sub-tropical high pressure system of the interior plateaus of southern Africa becomes stronger than normal and in conjunction with migratory low pressure areas on the coast the pressure gradient becomes sufficient to cause an out-pouring of air over the edge of the plateau and down the escarpment into the Namib Desert. This air is dry to begin with and, after undergoing compressional heating in the descent of the escarpment, becomes a strong outblast of moderately warm very dry air.

On the other hand, the writer of "Weather on the Coasts of Africa" states directly that there is no proof that this situation exists and proposes another explanation: namely, that the hot dry air of the "Berg Wind" is merely the "superior air" always present above the level of the temperature inversion which has been able to reach the surface because of the absence of the usual layer of cool sea air. It seems likely to the writer that either or both of these explanations may be correct.

When the East Winds are blowing the temperature may rise to 90° or even 100° and has on occasion reached 104° at Walvis Bay and 115° at Port Nolloth (just across the Orange River in the Cape Province). Ordinarily, the East Wind dies at night and may or may not be renewed on the following day. On most occasions the night is quite normal and the minimum temperatures prevalent at that season are usually reached. This is perhaps a result of strong terrestrial radiation into the dry air above. On some occasions, however, the wind does continue to blow into the evening and the minimum temperature may be raised as much as 20° at Walvis Bay. In spite of the attention that has been given to this wind, it is actually of very infrequent occurrence. A perusal of Table VI will show that winds from the northeast and east occur on only 2% of the afternoon observations taken during the winter period (June through August) at Walvis Bay and 3% of those observed at Swakopmund.

Normal Conditions. The normal conditions of weather in the coastal area in winter are not very greatly different from those of summer. A comparison of Plates III and VI will disclose basic similarities in the weather of these two days half a year apart. Careful scrutiny will reveal that more variation prevails both in humidity and temperature during the winter period, but basically the patterns are the same. The June 20 trace indicates a daily range of 13°, contrasted with 9° on Christmas Day. This higher range is due in part to nocturnal cooling as indicated by the continuing depression in temperature from midnight until 6 a. m., and in part to the stronger diurnal heating as evidenced by the abrupt rise from sunup (8:15) to noon.

The period of unsaturated air was longer, occurring earlier (8 a. m. rather than 1 p. m.) and lasting longer (9 hours vs. 6 hours), and being drier (a minimum of 88% instead of 92%). It will be noted that this period was not unbroken--that shortly after noon, a two-hour period of saturation occurred.

As during the summer, the existence of 100% humidity does not necessarily imply fog. In fact, it very often is relatively clear at the same time that the air is saturated. At such times, however, fog is present just overhead--often shrouding the top of the lighthouse and the top of the several towers in the town. This is the reversal of the situation in the interior desert in which summer rain often falls when the surface humidity is far below the saturation point.

Table VI

Surface Winds--3 P.M.June - August

<u>Velocity (Knots)</u>	<u>No Direction</u>	<u>Per cent Frequency From:</u>							
		<u>N</u>	<u>NE</u>	<u>E</u>	<u>SE</u>	<u>S</u>	<u>SW</u>	<u>W</u>	<u>NW</u>
<u>Walvis Bay</u>									
0 - 2	8	-	-	-	-	-	-	-	-
3 - 13	-	3	1	1	0	7	33	8	9
14 - 27	-	0	0	0	0	11	17	0	0
28 - 40	-	0	0	0	0	1	1	0	0
<u>Swakopmund</u>									
0 - 2	17	-	-	-	-	-	-	-	-
3 - 13	-	1	2	1	1	22	43	9	2
14 - 27	-	0	0	0	0	0	2	0	0

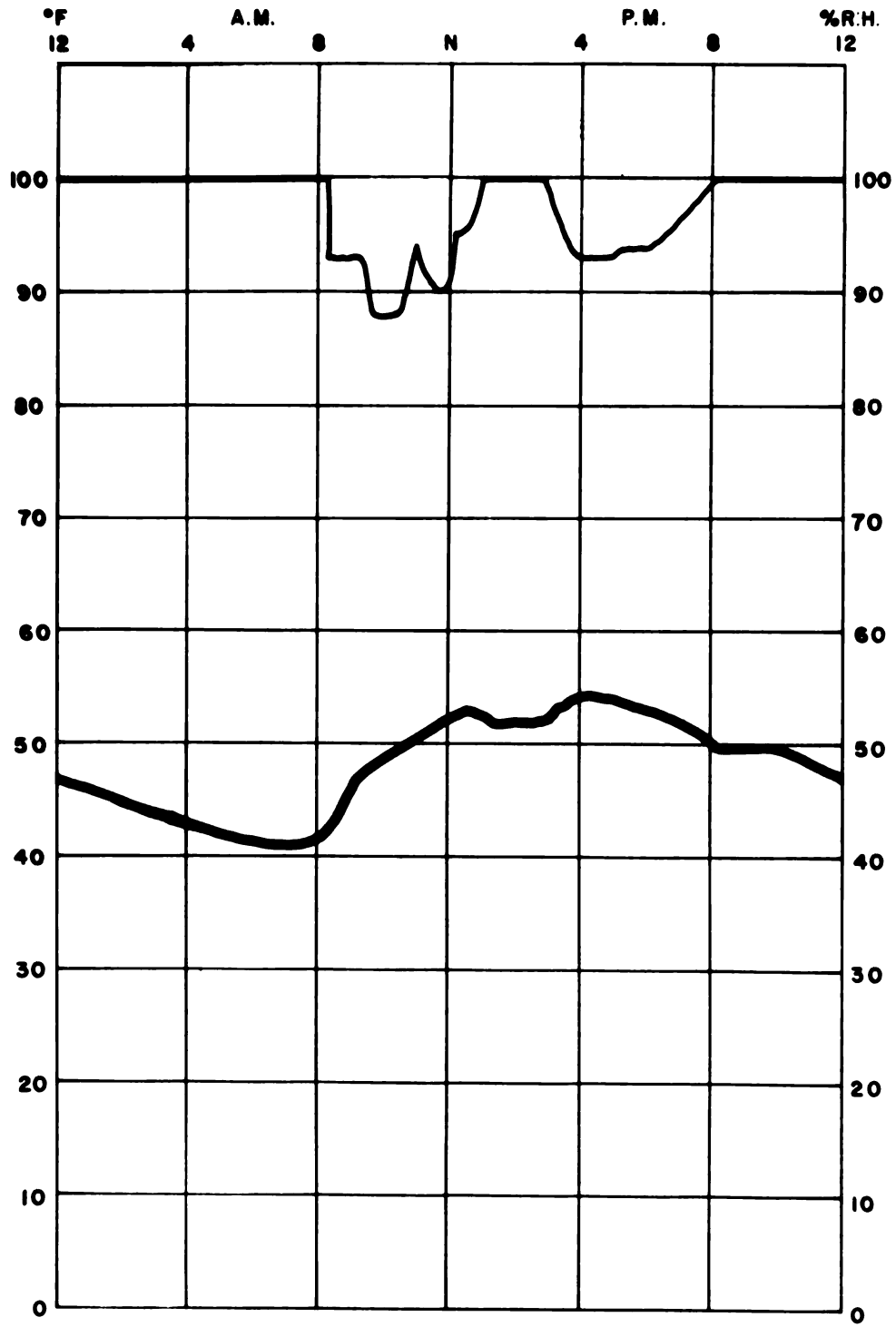
In general, however, it can be stated definitely that Swakopmund Lighthouse "enjoys" a climate characterized year around by extremely high humidity, cool temperatures and a very narrow range of both humidity and temperature. A comparison of Tables III and VII will show that the winter mean is about 11° below the summer mean, but that the minimum temperatures never really become cold, nor the maximum high. This definitely is one of the more equable climates of the world.

Conditions are very similar at Walvis Bay, as is to be realized when the July and January figures in Table I are compared.

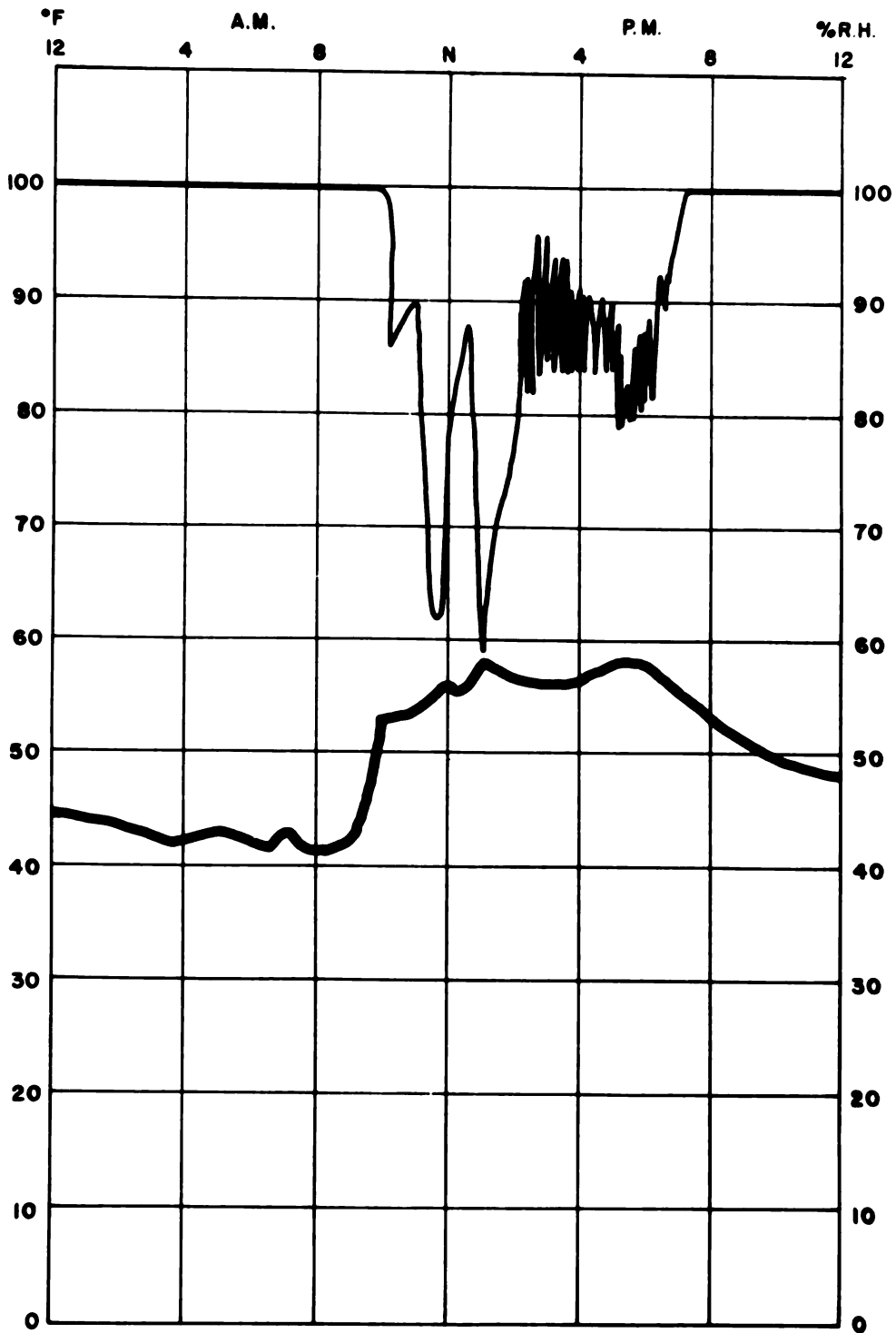
In the same way, a comparison of Tables III and VII will reveal that while the winter is slightly drier with shorter periods of saturation, and a greater range, an extremely humid climate prevails at both seasons.

At the Aerodrome, three miles inland (Plate VII, the period of air saturation was actually longer than at the coast; that this is normally the case is shown by the figures in Table VII. This is not due (as might be anticipated) to the greater nocturnal cooling inland for the temperatures of the two stations during the hours of darkness are surprisingly comparable. Rather it is believed by the writer to be the result of orographic rise of air up the slope, thus placing the station within the layer of fog previously mentioned as blanketing the upper portion of the lighthouse.

On the other hand, clearing brings much greater heating at the Aerodrome. The temperature on the 20th of June rose 3° higher at the Aerodrome than at the coast, and thereby produced considerably lower relative humidity (60% at the Aerodrome in contrast to 88% at the lighthouse). That this is representative of the normal situation is evident from a study of Table VII.



SWAKOPMUND LIGHTHOUSE
HYGROTHERMOGRAPH TRACE **JUNE 20, 1957**
temperature ———
humidity ———
PLATE VI



SWAKOPMUND AERODROME

HYGROTHERMOGRAPH TRACE

JUNE 20, 1957

temperature ———
humidity ———

PLATE VII

Table VIIWinter ConditionsJune 17 - July 1, 1957*Mean Humidity
(per cent)

<u>Station</u>	<u>Max.</u>	<u>Min.</u>	<u>Range</u>	<u>100%</u>	<u>Duration, in Hours, of</u>				
					<u>90%</u>	<u>30%</u>	<u>20%</u>	<u>10%</u>	
Swakopmund Lighthouse	100	77	23	8	17	0	0	0	
Swakopmund Aerodrome	100	49	51	11	14	0	0	0	

Mean Temperatures
(degrees Fahrenheit)

	<u>Max.</u>	<u>Min.</u>	<u>Range</u>	<u>Daily</u>
Swakopmund Lighthouse	57.4	46.1	11.3	51.7
Swakopmund Aerodrome	60.5	44.2	16.3	52.3

* From "Weather on the Coasts of Africa," pp. 17-18.

Table VIIISurface Winds--8:30 A.M.June - August*

<u>Velocity</u> <u>(Knots)</u>	<u>No</u> <u>Direction</u>	<u>Per cent Frequency From:</u>							
		<u>N</u>	<u>NE</u>	<u>E</u>	<u>SE</u>	<u>S</u>	<u>SW</u>	<u>W</u>	<u>NW</u>
<u>Walvis Bay</u>									
0 - 2	70	-	-	-	-	-	-	-	-
3 - 13	-	3	5	7	5	3	1	0	1
14 - 27	-	0	0	2	0	0	0	0	0
28 - 40	-	0	0	2	0	0	0	0	0
<u>Swakopmund</u>									
0 - 2	62	-	-	-	-	-	-	-	-
3 - 13	-	6	13	7	3	1	2	1	2
14 - 27	-	0	2	2	0	0	0	0	0

* From "Weather on the Coasts of Africa," pp. 17-18.

Minor differences between winter and summer are detectable in the wind patterns of the coastal belt. The gentle air movements from north and northwest which are significant in the early summer mornings (Table V) are lacking in the winter (Table VIII), being replaced by a greater incidence of northeast and east breezes and a higher percentage of calm. High winds non-existent during the summer occur occasionally in the winter.

But in general the winds are much the same at both seasons. The early mornings are predominantly calm; and in both seasons the southwest and south winds prevail at about the same frequency and the same velocity during the afternoons (See Tables V and VI). In regard to wind, then, as well as temperature and humidity, there is a strong repetitive nature to the weather at all times of the year.

As far as cloudiness is concerned the winters are invariably brighter and more cheerful than the summers (Table IX). On the average mid-summer morning 80% of the sky is overcast at Walvis Bay at 8:30 a. m., whereas at the same time on a mid-winter morning there is only 40% cloud cover. At noon, too, the cloudiness is much reduced in winter.

Table IX

Cloudiness*
(Per cent of sky cover)

Walvis Bay

	<u>8:30 a. m.</u>	<u>12 noon</u>
Summer		
Dec. - Feb.	80	30
Winter		
June - Aug.	40	20
Year	70	20

* From "Weather on the Coasts of Africa," p. 58.

In all ways the climate of Walvis Bay, Swakopmund and the rest of the South West African littoral is very mild. There is but little diurnal change in temperature under ordinary circumstances and extraordinary ones occur but rarely. Freezing conditions are all but unknown. Snow never falls, high winds are infrequent, and storms are unusual. In fact, abrupt changes in the weather are the exception rather than the rule. A more moderate, equable climate is hard to find in the world. Yet, at the same time a more unpleasant one is difficult to picture.

Climate of the Inner Namib

The inland portions of the Namib display a gradual transition from the extremely marine conditions obtaining at Swakopmund and Walvis Bay (as described above) to a condition of relatively strong continentality along the inner edge of the desert at the foot of the Great Western Escarpment. Nowhere, however, does one find the extremes

of either temperature or humidity that characterize the interior deserts of the world, whether they be subtropical high-pressure deserts, such as the Sahara, or mid-latitude deserts as represented by the Mojave. Rather, the Namib is almost everywhere a desert of moderation in regard to both temperature and humidity. The exceptional cases occur in particularly sheltered spots, such as the deep gorges of the Kuiseb or Swakop Rivers or the valleys on the leeward side of the Brandberg. Even here, however, conditions do not rival those of the Sahara.

Two weather stations operated by the writer give a fairly representative picture of the inland part of the Namib. Both of these were intentionally situated on the upland area--the Namib peneplain itself--where they were freely exposed to the inland sweep of the sea breeze. One was situated at Rössing, the other at Lintvelt's Poort (Numbers 3 and 4 on Plate II).

Rössing is a railway siding in the midst of an undulating gravel plain which is broken by low (50 foot) rocky ridges. It is at an altitude of 1,394 feet above sea level, and is 26 miles airline from the coast at Swakopmund. The large monadnock of Rössing Mountain, three miles to the west, rises about a thousand feet above its surroundings but does not obstruct the flow of sea air to Rössing since the sea breeze normally has a strong southerly component.

Lintvelt's Poort is a gap in a chain of granite kopjes, or small hills, which lie in front of the main portion of the Great Western Escarpment of Southern Africa. To the westward of the Poort lies the undulating expanse of the Tinkas Flats--the inner edge of the Namib platform. The station is situated at an elevation of 3,750 feet about seventy-six miles from the coast at Walvis Bay. The instrument shelter was in an unobstructed position about 100 feet from the foot of a kopje slope to the south and several hundred feet from the foot of a kopje to the north, and just south of a track leading from Farm Onanis by way of the Tinkas waterhole and the Langer Heinrich Mountain to Swakopmund. (See Figure 1)

Summer Conditions

The Christmas Day hygrothermograph trace for Rössing (Plate VIII) shows strikingly greater variation in both temperature and humidity than were recorded at Swakopmund (Plates III and IV). Surprisingly, however, the air was saturated with moisture for fourteen hours at Rössing--from midnight until 9:00 a.m., and from 7:00 p.m., until the following midnight. While this is similar to the Swakopmund conditions the writer believes that it is genetically quite different. The fog at Swakopmund is unquestionably advective sea fog, blown in from the nearby ocean. That at Rössing, on the other hand, appears to be radiation fog resulting from pronounced nocturnal cooling. It will be observed that the Christmas Eve temperature was considerably below that at the coast. A perusal of Table X (in contrast with Table III) will indicate that this is normally the case. Sea air wafted in across the coast is warmed greatly during the daytime which results in clearing of the atmosphere, lowering of the humidity and raising of the temperature. As night comes on and the sea breeze dies, the temperatures drop rapidly in the clear air and strong ground fogs develop. At the coast, thick layers of very low stratus blanket the air and prevent strong nocturnal dropping of the temperature; at Rössing, on the other hand, the clear air permits rapid radiational cooling and the thermal range is much greater.

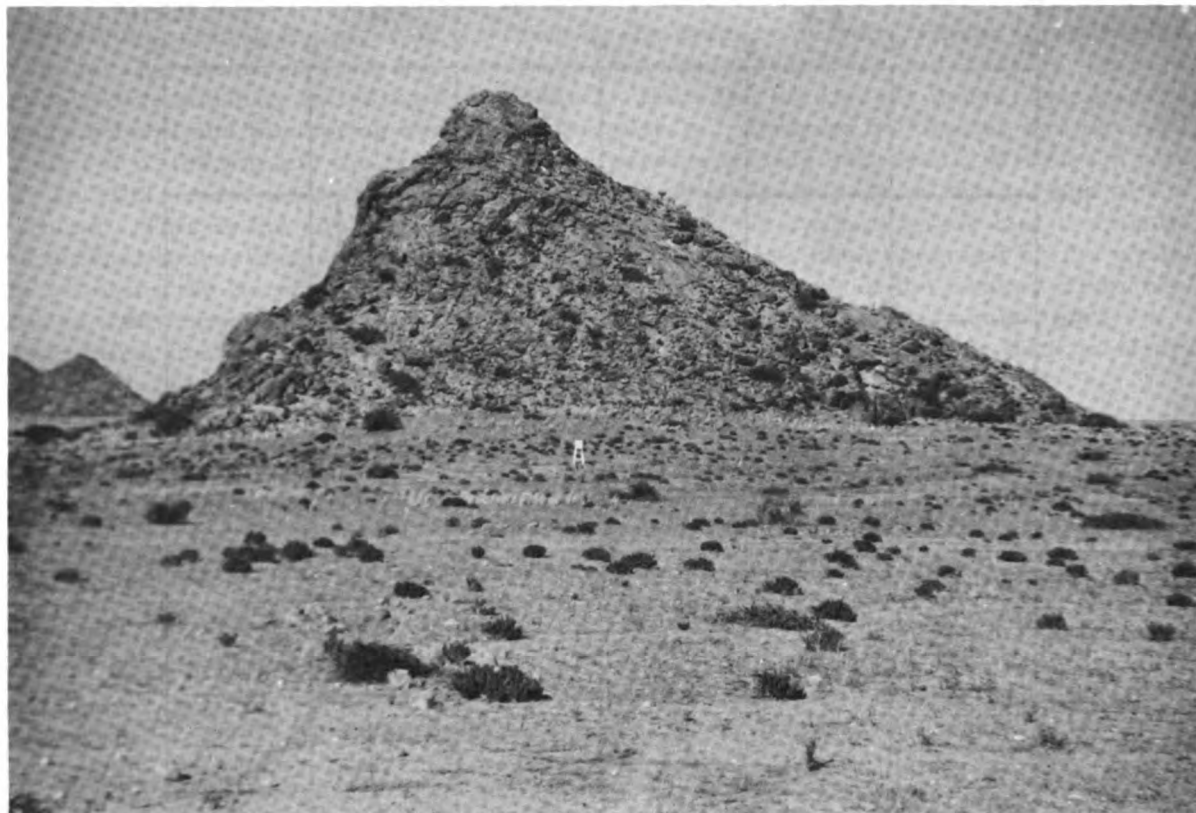


Figure 1. The Lintvelt's Poort weather station was situated in a gap in a chain of granite hills at the inner edge of the Namib, amidst a very open bush-steppe vegetation.

Table X

Summer Conditions

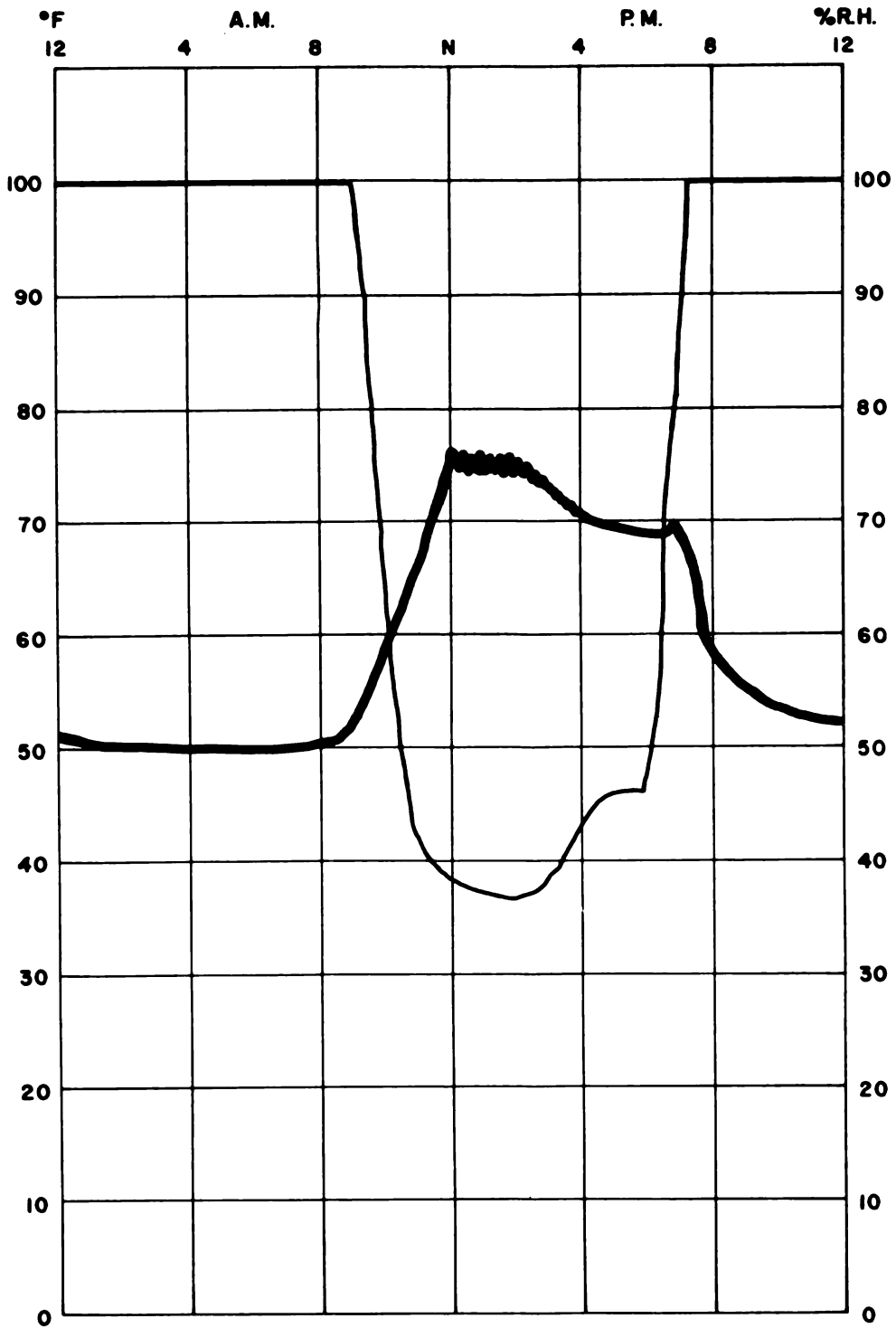
December 15, 1956 - January 14, 1957

Relative Humidity
(Means, in per cent)

<u>Station</u>	<u>Max.</u>	<u>Min.</u>	<u>Range</u>	<u>100%</u>	<u>Duration, in Hours, of</u>			
					<u>90%</u>	<u>30%</u>	<u>20%</u>	<u>10%</u>
Rossing	100	37	63	11	12	.5	0	0
Lintvelt's Poort	67	21	46	0.2	0.6	9.5	3	.5

Temperatures
(Means in degrees Fahrenheit)

	<u>Max.</u>	<u>Min.</u>	<u>Range</u>	<u>Daily</u>
Rossing	79.0	53.4	25.6	66.2
Lintvelt's Poort	84.8	57.5	27.3	71.1



RÖSSING

HYGROTHERMOGRAPH TRACE

DECEMBER 25, 1956

temperature ———
 humidity ———

PLATE VIII

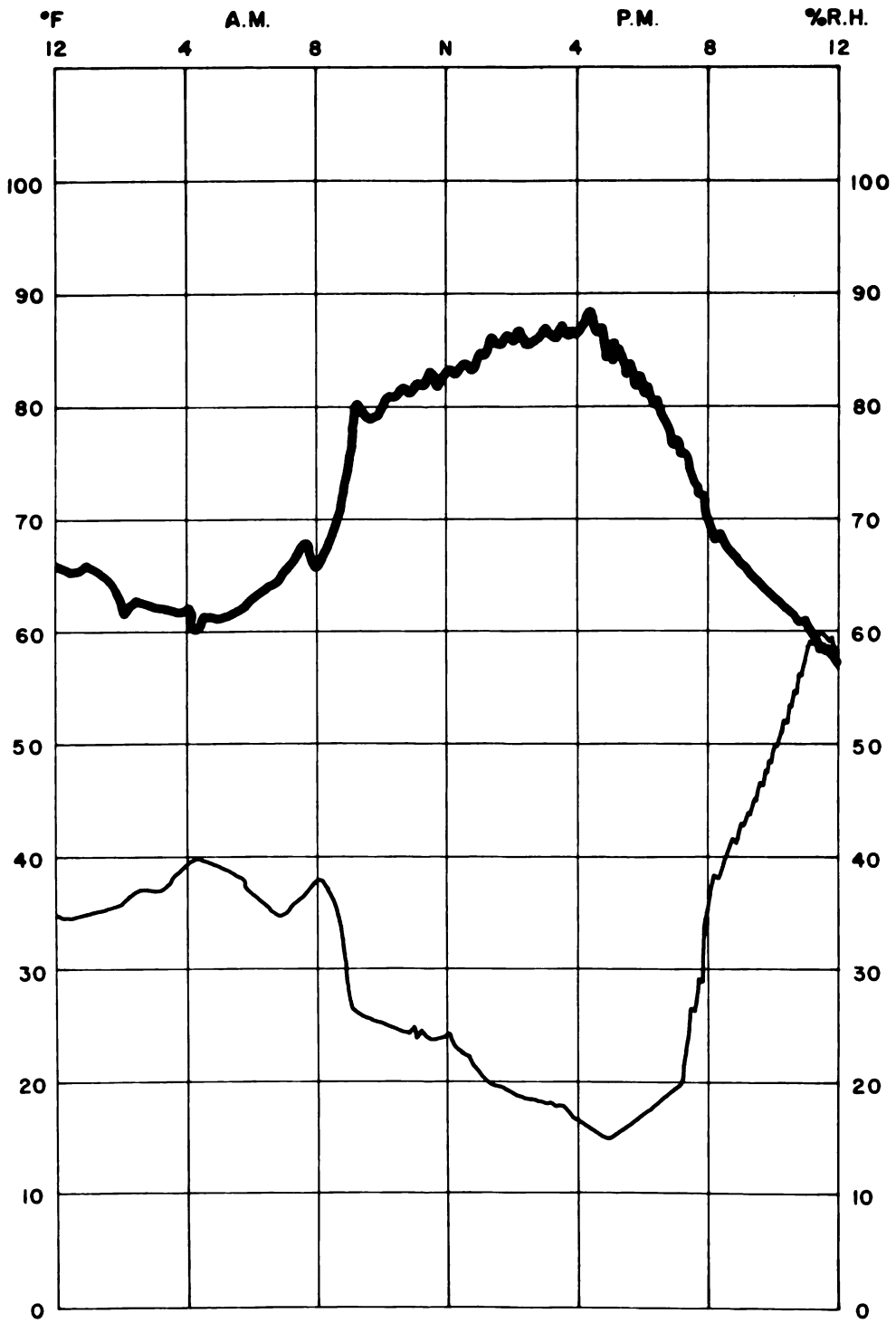
The two belts of fog can also be clearly noticed in driving down from the interior to the coast during the night or the dawn on the main road from Usakos to Swakopmund. One usually encounters the fog somewhere between Trekkopjes and Rössing (between twenty-five and fifty miles from the coast). Here the fog is very dense, lying at the ground level and blanketing everything completely. Seaward of Rössing one normally runs out of the fog and the stars may even become visible overhead. Within ten miles or so of the coast a low stratus cover appears overhead but not on the surface of the ground. This is the advective fog, evaporated at the surface by the last remnants of diurnal terrestrial warming. Similar conditions have been observed by the writer in crossing the Namib in other places: along the south bank of the Swakop River between the Witpoort and Swakopmund; on the great Tumas Flats southeast of Walvis Bay; along the Kuiseb River south of Walvis Bay and on the direct line Usakos-Henty's Bay road.

The rise in temperature at Rössing starts a little before the fog clears away and before the humidity drops below 100%. This is due to the penetration of the shorter wave lengths of insolation through the thinning fog blanket and their rapid absorption and re-radiation by the ground. Thus, the temperature curve turns upward at 8:30 a. m.,²² while the humidity curves do not drop until 9:00 a. m. The temperature curve rises steadily and rapidly through the morning, but is abruptly truncated at noon by the arrival of the sea breeze with its cooling influence. The maximum temperature for Christmas Day was about 76°, some three degrees lower than the mean maximum for this period. In the same way the minimum temperature recorded for Christmas Day was 50°, some three degrees lower than the mean maximum for the period.

The sea air blowing inland across the Namib Platform warms considerably by the time it reaches Lintvelt's Poort. The mean maximum temperatures (Table X) normally reach the middle 80's and even the strong nocturnal cooling does not depress them much below the temperatures prevailing at Swakopmund Lighthouse. The relative humidities are much lower than in the coastal area. The absolute humidity, too, is lower, probably as the result of the large loss of moisture by condensation in the form of dew in the radiation fog belt. Hence, even when the temperature drops to 58° as it did in the late evening of Christmas Day, (Plate IX) the humidity barely reaches 60%, whereas with the same temperature at Swakopmund Lighthouse, 100% humidity was reached. The inland area, then, has a much higher diurnal temperature and higher daily range than the coast, as well as a much lower humidity throughout the twenty-four-hour period.

In the inner portion of the Namib, as at Lintvelt's Poort, the summer days are normally cloud-free and fog is rare. However, the thunderstorms which characterize the later summer in the high interior to the eastward, manage to progress this far westward on some occasions and bring short, sharp showers to the area.

22. Times given are South African Standard Time, based on the 30°E. meridian, which passes near Durban, on the opposite side of the continent. Since the longitude of the Namib area is about 15°E., local time is about one hour behind Standard Time; hence a reading stated here as 8:30 a. m., actually is equivalent to 7:30 a. m. local time.



LINTVELT'S POORT

HYGROTHERMOGRAPH TRACE DECEMBER 25, 1956

temperature **—**
 humidity **—**

PLATE IX

A remarkable description of such a rain storm is contained in Dr. Henno Martin's story of his two and one-half year exile in the Namib during World War II:²³

"Christmas was approaching and we didn't feel very Christmasy, but then we received a wonderful present. On December 18th, white billowing clouds appeared in the sky, and on the following day two showers fell on the south plateau. And in the afternoon of the 20th a shining, white monster with a dark belly appeared behind the Goagos Mountains. We dropped everything and sat on the plateau, trying to hypnotize the clouds, told each other what we could see, and discussed each new stage of development.

"Then the first flashes of lightning lit the sky and a gray veil was drawn across the Khomas Hochland. After that everything went very quickly. A chain of ragged clouds swept over the sky, the precursors of the coming storm. The thunder was louder now and we counted the time between the flash of lightning and the subsequent roll--forty-five seconds: about ten miles. And before long it was only ten seconds. Then the last of the sun on the Goagos Mountains disappeared and the furthestmost peaks were hidden in rain. Ridge after ridge was blotted out by the slanting curtain of the storm. There was no doubt about it: the rain was coming!

"A roaring and drumming like the sound of great breakers came up from the gorges as the storm lashed out on thousands of rocky ridges. The rain was spinning on the plateau now and a cold wind hit our faces. And then a higher note in the roaring of the storm announced the rain as it swept forward over the gloomy gorges. Yet quite close mountains and plains were still in bright sunshine.

"With long, bounding strides we ran from the plateau. We were hardly under the rock face when a blinding, hissing, stone-splitting fork of light dazzled us for seconds and the first great drops fell on our heads. We laughed and danced with delight--the first rain for nine months! . . . There was a rushing sound like a waterfall now and slanting gray clouds of rain sluiced from heaven to earth. Suddenly each small rock rib wore a kind of milky, transparent aureole as the rain fell on its hot surface, glanced off and evaporated into fine steam. Every detail stood out as though sketched with light chalk. The smell of wet earth was intoxicating. . . . Then a new sound was added to the symphony of falling water. Brown streams tearing the earth were gurgling in every gully now and from a high rock face poured a small waterfall.

"The downpour was already subsiding and gradually resolved itself into individual silver droplets. For a few moments a brilliant rainbow hung in the sky and across the dripping rock face and then it was all over.

"The whole downpour had lasted perhaps seven minutes, but we measured about half an inch of rainwater in a tiny canister though the outer edge of the storm had only just reached us. . . .

"The next day the west wind arrived early and the clouds remained over the uplands."

23. Martin, Henno, "The Sheltering Desert," London (1957), pp. 119-120.

Such storms occur infrequently. Their development has two prerequisites: (1) the disappearance of the normal advective temperature inversion over the Namib; and (2) the presence of marine Indian Ocean air aloft in an abnormally moist condition. Some years pass with no precipitation in the area at all due to the failure of these two prerequisites to appear concurrently. Furthermore, the presence of these conditions may give much rain to the desert as a whole and yet completely miss a given spot--as with all convective storms, the rain is greatly localized.

The advective inversion produces a most remarkable optical effect--probably one of the most extreme developments of mirages in the world. These seem to be classifiable into three groups based upon three separate causes:

1) The simple shimmering of the air resulting from distortion of the light rays in the heated air of minor thermal convective currents arising from the sun-heated surface.

2) Distortion of light rays along a surface of discontinuity where a thin (few inches to a score of yards) layer of air heated by terrestrial radiation contacts cool advective air from the ocean.

3) Distortion of light rays along a surface of discontinuity on the upper side of the advective layer where it contacts warmer air aloft. This warmer air may be either the superior air descending from high altitudes or surface-heated air displaced upward as a distinct stratum.

Of these the first produces what is often termed "scintillation." Objects in the distance seem to quiver and ripple so much as to be scarcely distinguishable. The phenomenon is common all over the world and has long been observed and understood.²⁴

The second type is very common in the Namib. The air blowing in from the sea is cold. During the summer days the strong insolation warms the surface of the ground, which in turn warms a thin layer of air above it. The contact between this heated air and the unheated sea air above is often very sharp and refraction occurs on that surface. A vanishing line is produced whereby protruding surface features seem to float above water, often well up into the air.²⁵

The third case is the most baffling and disconcerting of the group. It often results in the inversion of the image in the air well above its actual position. It has been observed by the writer only from a high level (the summit of the Rooikop, a pronounced granite knob amidst flat plains) looking westward at Walvis Bay where ships in the roadstead and the lighthouse at Pelican Point were seen upside down and well out of their vertical position; actually they should have been invisible, for the high coastal dunes intervening between them and the summit of the knob should have interrupted the line of sight.²⁶

24. Isaac Newton, "Opticks," Fourth Edition, p. 110. Well described in M. Minnaert, "The Nature of Light and Color in the Open Air," New York, 1954, p. 52.

25. Minnaert, op. cit., pp. 45-51.

26. Optics described in Minnaert, op. cit., pp. 56-58.

Any combination of these three is likely to occur over the interior Namib during a summer day. The most common occurrences are between mid-morning and mid-afternoon: earlier the heating is not sufficiently great to produce a plane of discontinuity; later the air becomes mixed due to both convectional currents and sea breeze turbulence. They are most common in the seaward half of the desert; further inland the advective layer is not likely to be so distinct.

The effect of these optical aberrations upon the traveler in these wastes is most disconcerting. All landmarks are lost to view. "Pools of water" appear at distances of little more than a hundred yards. On one occasion the writer saw a two-foot bush from a distance of over a mile, appearing first as a water tank, later as a tall tree, and eventually as a floating object that could have been a captive balloon. Only by driving within a couple of hundred yards could it be identified. On another occasion the writer's daughter, idly staring at a distant mountain, was suddenly terrified to see a gigantic animal appear on its crest. The "distant mountain" was actually a hillock only a few hundred yards distant, and the "gigantic animal" was a mere springbok (small antelope), the apparent distance and shape of the hillock having been completely destroyed by the mirage. Under such circumstances it becomes almost impossible for a traveler to maintain his sense of direction. If the route to be traversed is along a track which has been used previously, then it is simply a matter of following the wheel tracks. But if a fork occurs in a road, then the traveler is faced with the problem of deciding which fork is to be followed. And when one attempts to negotiate a routeless area the problem becomes really critical. Nor is the sun of any assistance, for during the summer (the period when the mirages are at their worst) the sun is nearly overhead during mid-day and neither it nor its shadows are of assistance. At such times one has to rely upon that usually-most-unreliable of indicators--the wind. Since it nearly always blows from the southwest the wind is a most reliable indicator of direction, a traveler often steers by it through the middle part of the day until, with the cooling of the surface in the late afternoon, the mirages disappear and he can trust his eyes once more.

Winter Conditions

June 23rd was a typical mid-winter day at Rössing (Plate X). From midnight until morning the humidity was 100% and the temperature descended irregularly from 50° to 40°. At 8:30 a.m., just after sunrise, an abrupt change occurred: the humidity dropped spectacularly, reaching a minimum of 38% at 1:00 p.m., and the temperature soared to a height of 62° at the same time. During the late afternoon, slow cooling occurred, followed by a rapid drop into the middle 40's in the early evening, and accompanied by a concurrent rise in humidity to 100% by 6:00 p.m. As in summer, it is radiation rather than advective fog which dominates at Rössing. That it is very thin is evidenced by the fact that the temperature trace rose rapidly immediately after sunrise and that radiational cooling took place between midnight and dawn--neither of which would have occurred had there been a thin cover of fog or low stratus as commonly prevails in the advective cases.

In most ways this trace is very similar to that produced at the same station during the summer period. Minor variations do occur, however. The sea breezes do not penetrate so far inland during the winter period; thus, there was no serration of the trace during the mid-day hours. The temperature trace was, however, characterized by some serration during the pre-dawn hours when minor breezes associated with air drainage from Rössing Mountain to the westward produced brief periods



RÖSSING

HYGROTHERMOGRAPH TRACE

JUNE 23, 1957

temperature —
 humidity —

PLATE X

of warming followed by brief periods of cooling. But even this warming did not bring the humidity below the 100% mark.

In short, Rössing normally shows a remarkable combination of characteristics of oceanic and continental conditions (Table XI). It has the high nocturnal humidity of the coastal regions but it shows pronounced diurnal warming and dropping of humidity which is more characteristic of inland stations. It is fully representative of the transitional zone of the middle Namib Desert.

Table XI

Winter Conditions

July 17 - July 1, 1957

Relative Humidity
(Means, in per cent)

<u>Station</u>	<u>Max.</u>	<u>Min.</u>	<u>Range</u>	<u>100%</u>	<u>Duration, in Hours, of</u>			
					<u>90%</u>	<u>30%</u>	<u>20%</u>	<u>10%</u>
Rössing	89	27	62	6	8	3	1	0
Lintvelt's Poort	42	12	30	0	0	18	11	3

Temperatures

(Means, in degrees Fahrenheit)

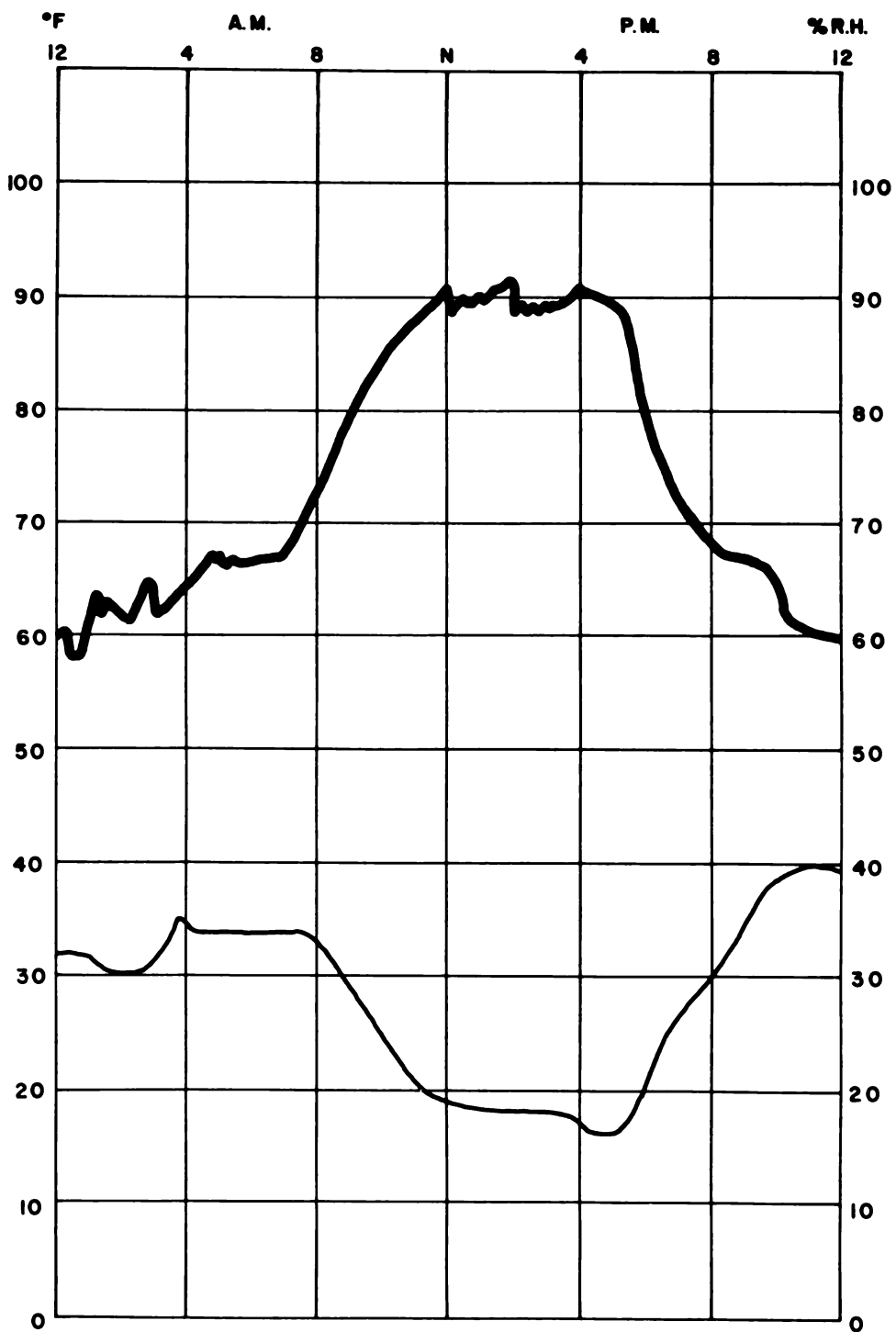
	<u>Max.</u>	<u>Min.</u>	<u>Range</u>	<u>Daily</u>
Rössing	69.8	41.5	28.3	55.6
Lintvelt's Poort	70.8	42.4	28.4	56.6

The trace for June 16th at Rössing (Plate XI) presents a considerably different picture. During this period a minor outflow of air from the interior occurred, representing a weak form of Berg or East Wind condition. At Rössing the results were:

- 1) A much higher maximum temperature (91° in contrast with 62° on the 23rd)
- 2) A higher minimum temperature (57° contrasted with 40° on the 23rd)
- 3) Much lower relative humidity (maximum, 42% contrasted with 100%; minimum, 19% contrasted with 38%).

Obviously on this day all of the effects of the nearby ocean were removed and the station enjoyed a typically continental climate. These conditions, however, did not exist at the coast, for the trace for Swakopmund for the same day is thoroughly normal.

June 20 provides a typical hygrothermograph trace (Plate XII) for the station at Lintvelt's Poort. Thermometrically the night hours showed a serrate trace, the result of local winds upsetting the inversion that developed from terrestrial radiational



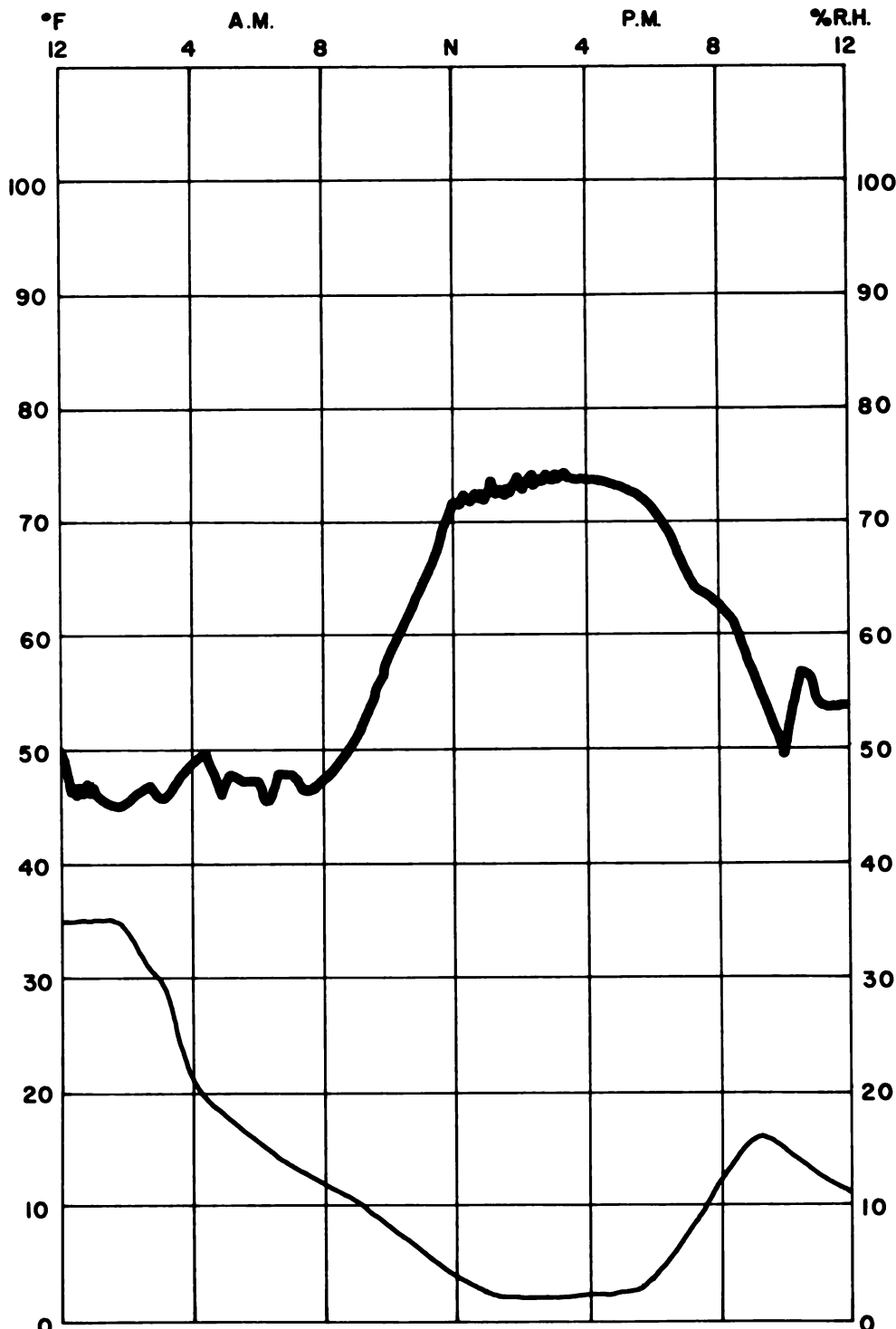
RÖSSING

HYGROTHERMOGRAPH TRACE

JUNE 16, 1957

temperature —
 humidity —

PLATE XI



LINTVELT'S POORT

HYGROTHERMOGRAPH TRACE JUNE 20, 1957

temperature —
humidity —

PLATE XII

cooling. The breezes were probably associated with air drainage from the adjacent kopjes and the flow of air westward through the Poort from the basin and its adjacent slopes to the eastward. Temperatures averaged about 50° with a minimum of 45°.

At sunup (about 8:15 a.m.) an abrupt rise commenced. About noon a leveling off in the middle 70's occurred. A gradual drop began at 4:00 p.m., becoming a sharp descent after sundown (6:00 p.m.) and truly nocturnal conditions were resumed after 10:00 p.m.

Humidity was low throughout the day. The highest was at midnight and then reached only 35%. At mid-day it reached a minimum of 2%. At no time during the winter is the humidity high for long periods. (Table XI) On occasions (averaging perhaps a dozen days per winter), however, sea air penetrates this far inland and strong radiational cooling produces early-morning fog. Once started, this may recur for several days in succession.

In short, the conditions in the Inner Namib in winter are characterized by cool to cold, brilliantly clear nights and pleasantly warm, very sunny, dry, clear days. The area is totally rainless during the winter period and while freezing of standing water occurs, frost is unknown because of the exceptional dryness of the air. Snow is unknown.

Chapter III

THE COASTAL NAMIB

(Sub-Region I)

The central Namib Desert can be easily broken into three segments, each clearly distinguished from the other: the Coastal Namib; the Dune Namib; and the Namib Platform.

The first is set apart from the other two on the basis of its distinctive climate. The other two are clearly distinguishable by their landforms. Actually, on a strictly landform basis, the Coastal Namib is not distinctive, being merely a seaward extension of the other two. But this is not a paper limiting itself to the geomorphography of the area, and the strikingly different climate of the coastal area is ample reason for setting it apart as a separate geographic region.

The west coast of southern Africa is one of the cruelest shorelines imaginable. It is waterless, lifeless, bleak and barren.

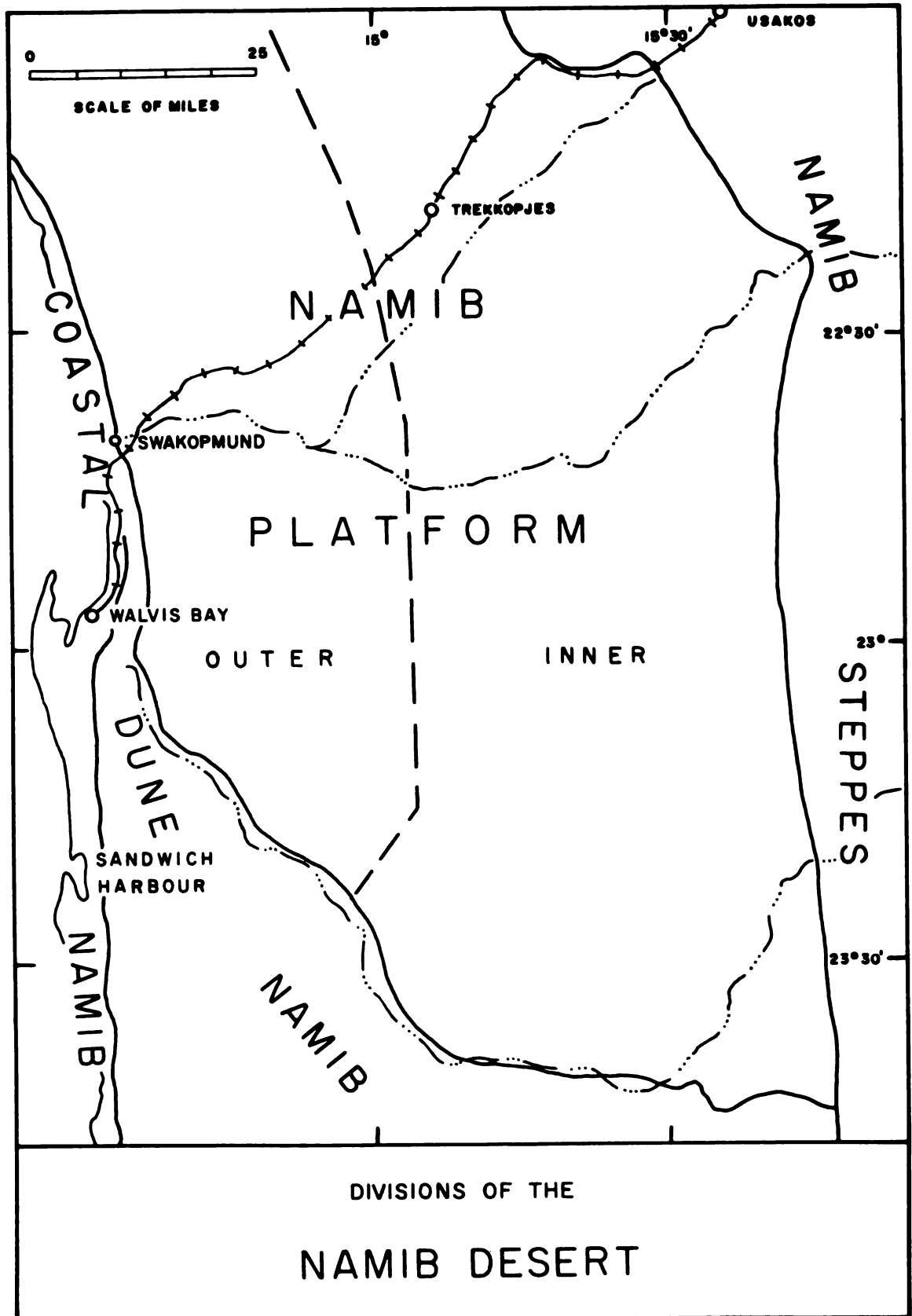
It is a land of contrast and paradox, where appearances are deceiving and where the truth is often a lie. One cannot believe one's eyes--for this is the very home of the mirage. Rain almost never falls, yet it is more humid than most other places. There is nothing to eat--yet the surface reveals myriads of track: of beetles and ants and lizards; of jackals, springbok and gemsbok; of crows, ravens and ostriches. Here the hottest days come in mid-winter, rain seldom falls but floods are violent, fog endlessly shrouds a parched land, and sterile sands conceal diamond-bearing gravels.

Subdivisions of the Coastal Namib

The coastal belt of the Namib Desert (Sub-Region I) is composed of several physically distinctive landscape types:

- I - A The Guano Islands
- I - B The Coastal Headlands
- I - C The Lagoon Coasts

In the pages that follow, each of these is discussed individually, and sometimes further sub-divided into unit areas. (See Plate XIII)



The Guano Islands

(Landscape Type I - A)

Lying just off the coast of the central Namib Desert are two small islands which, together with a dozen or more similar bits of land farther south, are commonly known as the "Guano Islands."²⁷ The two within the area under study are Hollams Bird Island, six miles offshore in Latitude 24°39' South, and Mercury Island, in the entrance to Spencer Bay, in Latitude 25°43' South.

Both are small rocky knobs rising abruptly from the sea, and undergoing considerable attack by the waves. Surf breaks violently against them at all times. Hollams is a single outcropping of bedrock, forty feet high and about three-fourths of a mile in circumference. Its north side is moderately sloping, at about 20°, becoming vertical only in the last few feet above the sea; its south side is very steep. Reefs with depths of less than fifty feet extend three miles to the southwest, and four miles to the north; but the whole mass is separated from the mainland by a deep channel. Mercury Island, 800 yards north-south by 300 yards east-west, rises as a bare rock pyramid to a height of 125 feet. There are no shoals or extensive reefs about the island, indicating the lack of any extensive wave-cut platform.

The islands are virtually soilless and practically devoid of vegetation.

Hollams is one of the chief breeding islands²⁷ of the Cape Sea Lion (*Arctocephalus pusillus*), which come ashore here in great numbers to bear and rear their young. The islands have no other mammalian inhabitants, but this lack is more than offset by the vast numbers of seabirds who feed on the plentiful marine life of the adjacent waters and use the islands as roosting places and rookeries. These include pelicans, cormorants ("duikers"), gulls, gannets, strandloppers, penguins and myriads of smaller birds.

Through most of the year, the islands are uninhabited, but from approximately April through August a group of men (largely Cape Coloureds) are brought to the islands to collect the guano deposited on the rocks during the past year by the birds. It is deposited so thickly that, before the hand scraping commences, the islands have a strikingly white appearance from offshore. The complete aridity prevents the droppings from being washed off by rainwater. On Hollams, the guano is collected in sacks and barrow loads and taken to the north end, where a pair of high "sheers" have been built overhanging the water. From them the guano is loaded into lighters and taken to the ships, which anchor in fifteen fathoms a half-mile or more to the

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27. No detailed studies of these islands were made by the writer. Information given here has been obtained from conversations with captains of fishing boats which work in the area, by scanning the islands with binoculars while passing them to the seaward, from studies of the coast charts (Hydrographic Office Charts No. 2205 and 2317), and from the "Sailing Directions for the Southwest Coast of Africa," Hydrographic Office Publication No. 105, Washington, 1951, pp. 223, 224. A popular description of the islands is contained in Lawrence Green's travel book, "At Daybreak For the Isles" Timmins (Cape Town) 1950.
28. Roberts, Austin "Mammals of South Africa," p. 213.

northward. On Mercury, the guano is loaded from the rocks into the lighters, which take it to the ships anchored some five hundred yards east of the northern end of the island, in about 6 fathoms of water. The loading is usually done near the north-eastern point; there the seas are somewhat less heavy. Both islands have a few small, rather crude buildings for the housing of the guano gatherers.

The Coastal Headlands

(Landscape Type I - B)

At a few places along the coast of the central Namib, bare rock outcrops occur, making strong contrast with the great sand dunes or sweeping gravel flats that characterize most of the coast line. These rocky forelands fall into two groups; those south of Sandwich,²⁹ and Cape Cross, north of Swakopmund.

Southern Headlands

South of Sandwich Harbour, the coastal belt is composed chiefly of huge sand dunes. The headlands, probably composed of more resistant rock than occurs elsewhere, stand out as high rocky masses. Because they extend well into the sea, they are sand free, while the rest of the country is engulfed in a vast sea of sand. Off-shore here, the prevailing wind is south-south-east,³⁰ almost precisely parallel to the coast. Near the shore, it turns slightly inland. Thus, the sea of sand, migrating endlessly northward up the coast, is held back from the headlands, which are continually being swept clean by the wind. Only during the periods of the East Wind, which comes occasionally during the winter, is there a threat of an invasion by sand, and the promontories are soon swept clean again when conditions return to normal.

Four erosional agents have been responsible for the shaping of the headland landforms:

- 1) Gravity has resulted in the accumulation of minor talus veneers and fans, and aided in the downward movement of materials in an inconspicuous manner.
- 2) The wind has had a minor role by sandblasting certain exposed surfaces, and has removed large quantities of disintegrational weathering products.

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29. No detailed studies were made in these areas. All lie within the Sperrgebiet, to which entry is strictly prohibited, and are places quite inaccessible by the means at the writer's disposal. Information herein was obtained largely from:
 - a. Inspection of the area from the seaward by binoculars.
 - b. Kodachromes taken from the air at low altitudes by Herr W. Schenck, pilot for South West Airlines, Windhoek, who has flown several contract missions into the area.
 - c. Discussion with Walvis Bay fishing boat captains, who often fish off this area.
 - d. "Sailing Directions for the Southwest Coast of Africa," Hydrographic Office Publication No. 105, Washington, 1951, pp. 222-225.
 30. "Pilot Chart of the South Atlantic Ocean," Hydrographic Office Chart No. 2600, issued quarterly. Washington, D. C.

3) Marine erosion is active at tide level, producing cliffs, caves, coves and submarine benches. On abrupt sections of the coast, the huge rollers cast themselves directly against the cliffs; spray is cast scores of feet up the cliffs, and runs back, acting as a minor agent of fluvial erosion. In many places the attack at the base keeps cliffs vertical, and the erosion of the cliffs above is by gravitational dropping of blocks, sometimes creating little balconies which are pre-empted by the sea birds as nesting sites. The force of the rollers is tremendous when exerted against a major obstacle, and the cliff bases are shattered thereby.

4) Fluvial action, even in this arid land, is still the major force shaping the landforms beyond the reach of the waves. Thus, everywhere there are gullies, rills, ravines and steep valleys.

In general, this is a sand-free area of bare rock, with massive sea-cliffs, steep slopes, angular topography, and short, steep, narrow gullies. The area appears quite devoid of major vegetation, although detailed studies would no doubt reveal a few xerophytic shrubs and some dwarf succulents. The area lies within the Sperrgebiet--the prohibited diamond area of South West Africa. Consequently, it is uninhabited, and is visited only rarely by a police patrol hunting for diamond poachers or for shipwrecked fishermen.

Cape Cross

Cape Cross lies in Latitude 21°47' south approximately 70 miles north of Swakopmund. It is a headland with low, black rocky cliffs connected to the mainland by a double tombolo enclosing a large salt flat. From the seaward it appears as an island.³¹ The Cape extends well out into the ocean and to the northward of it lies a broad bay fairly well sheltered against the southwest rollers.

Cape Cross is said³² to be the only place in the world where fur seals breed on the mainland. This is perhaps a holdover from the earlier geologic period when the Cape was an island separated from the mainland and the seals have not yet changed their instinctive habit to conform with the new geomorphic situation. These animals, Arctocephalus pusillus, have been coming ashore in such great numbers for so long a time that the rocks of the headlands are literally worn smooth from the rubbing of their bodies against them. They are magnificent animals; the males grow up to eight feet in length and weigh up to 800 pounds. Their protruding bristles fairly well conceal the soft wooly lighter color under-fur. Their massive heads resemble that of a bear (hence the Latin generic name). All their flippers clearly show five "fingers" and "toes."

They come ashore twice a year³³--in the winter to shed their fur and in summer to breed. The females normally bear two pups and remain in the colony for months following delivery. Curiously, the females come ashore in the summer, deliver the young, and immediately remate. The period of gestation is apparently twelve months.

31. Hydrographic Office Publication No. 105, pp. 218-219.

32. Lawrence Green, "Lords of the Last Frontier," p. 312. Austin Roberts in his "Mammals of South Africa" p. 213, says "these animals seem never to land on mainland" and then mentions Cape Cross as one of the breeding areas. Apparently he was unaware that Cape Cross is attached to the mainland.

33. Roberts, op. cit., p. 213.

Under a franchise from the Administration about 4,000 seals are killed annually at Cape Cross. The victims are generally young pups which are killed by clubbing on the forehead in order to avoid damaging the fur. The carcasses yield oil and are eventually used for bone-meal.

To the early navigators³⁴ along this coast, Cape Cross was noted for its white appearance from the seaward. This was the result of a vast accumulation of guano on the headland and on several black hillocks of Kaoko lavas which rise as islands in the midst of the adjacent pans. The mining of the guano began, by a British company, before the German time and continued for many years. In the decade 1895-1904, it is said that 100,000 tons of guano were removed.³⁵ A settlement, including a large dining hall, storehouse and dwellings, was erected on the shore of the bay. This was apparently still in existence in 1918, since the buildings are shown on the map from the Surveyor General's office of that year. The settlement had to be supplied entirely from the outside--even in regard to water, although it is said that a salt water distillation plant was finally established.

The Lagoon Coasts

(Landscape Type I - C)

At many places along the coast of the central Namib, minor indentations have been converted into lagoons through the construction of spits across their entrances by waves and littoral currents; elsewhere long sand barrier beaches have formed, fronting long stretches of coast.

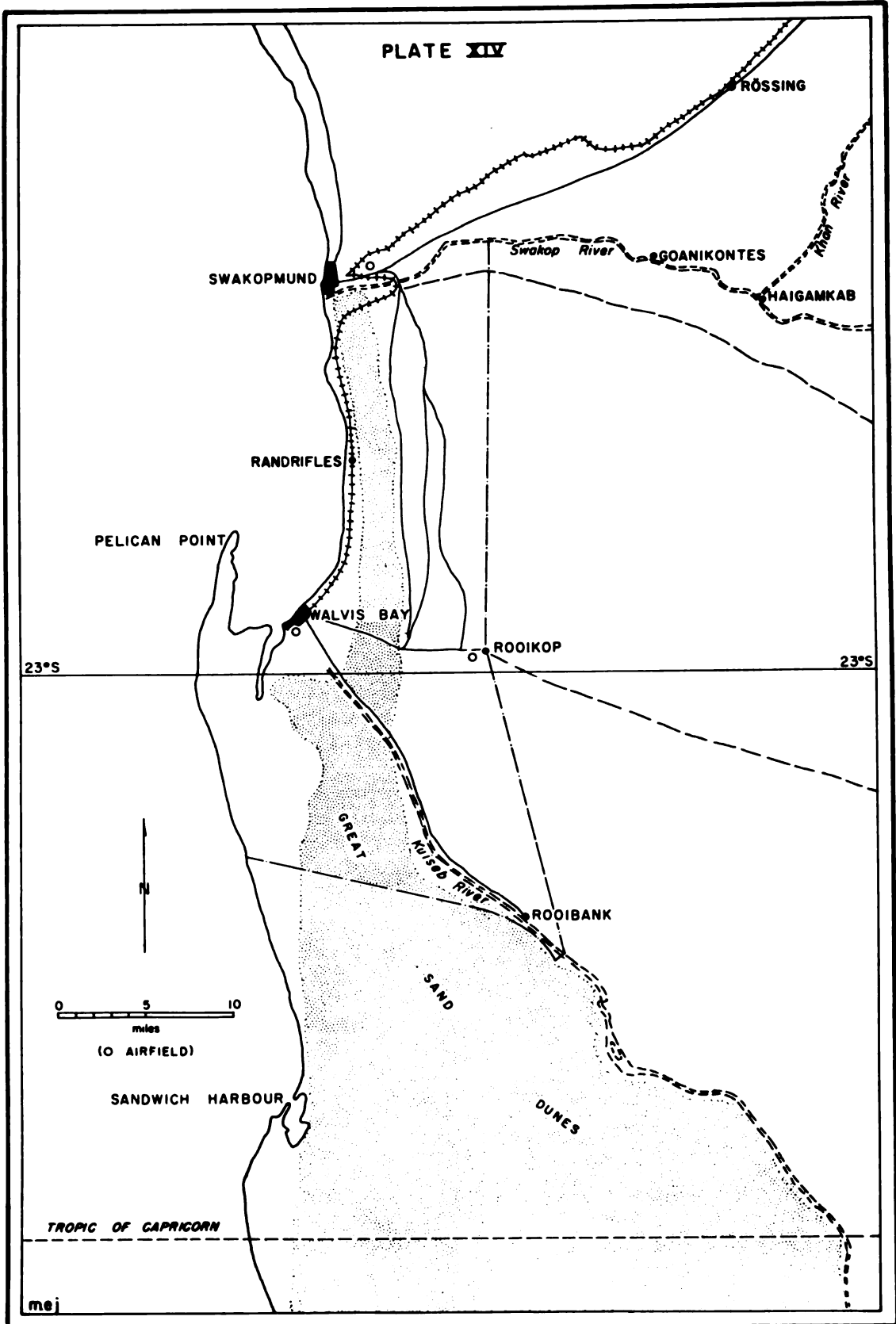
The chief examples of this type of coast are:

- 1) From Hollams Bird Island (24°30' South) to Conception Bay (23°50' South);
- 2) Sandwich Harbour (23°40' South to 23°58');
- 3) Discontinuously to the northward of Swakopmund.

The process is only partially complete at Walvis Bay. (See Plate XIV).

In the pages that follow, these lagoons are treated as an entity in regards climate; are divided into their component parts for the descriptions of landforms, vegetation, soils, and animal life; and are finally considered as a unit again for the discussion of the human occupance.

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34. The name of the Cape is derived from the marker set up here in 1485 by Diego Cão, the Portuguese navigator. It stood here for 407 years until "rediscovered" by the Germans and removed by the cruiser Falke to the Naval Museum at Kiel whence it was later transferred to Berlin. A replica replete with German eagles set up in the same spot immediately afterwards still stands.
 35. T. W. Gevers, "The Morphology of Western Damaraland and the Adjoining Namib Desert of South West Africa," *South African Geographical Journal*, vol. 19 (1936) p. 76; also Gevers and J. P. van der Westhuysen, "Occurrence of Salt in the Swakopmund Area, South West Africa," *Transactions, Geological Society of South Africa*, vol. 34 (1931), pp. 61-80.



Climate

The climate of the Lagoon areas is basically the same as that of Walvis Bay and Swakopmund, as described previously. However, there are some minor but observable differences resulting chiefly from the distance from the sea and the nature of the intervening terrain. In all regards, the precipitation characteristics described above for the coastal portion of the Middle Namib apply here. The rainfall probably averages less than one-half inch per annum throughout the Coastal Lagoon area.

Being immediately adjacent to the coast, and swept almost continually by winds from off the sea, the thermal environment is extremely marine. Diurnal ranges are very low, as are the seasonal. It can be expected the temperatures on these more exposed coasts will be a little lower than the official reading at Swakopmund, since the water off that place must be warmed somewhat by the outflow of warmed water from Walvis Bay, just as the official temperature at Walvis Bay is noticeably higher than that of Swakopmund. The difference will only be a matter of a few degrees, however.

Despite the narrowness of the area, there is frequently a very noticeable thermal difference between the eastern and western edges. Measurements made on a typical spring day (November 3, 1956) at Sandwich Harbor showed a difference of 9° in the 2 p.m. temperatures between the foreshore (56°) and the inner edge of the salt marshes (65°) two miles to the east; while on the 230-foot-high summit of the sand dune overlooking the marshes, the temperature was only 2° higher (58°) than at the shore. In short, the salt marshes effectively warmed the lower strata of the air, but not the upper.

On calm nights (which are prevalent in the area) it seems probable that the situation is reversed, and that the coldest temperatures are to be found along the dune foot at the inner edge of the marshes, and the warmest next to the surf breaking on the outer beaches, and on the summits of the dunes.

On calm days (which are an exception), the temperatures along the inner edge of the marshes become very much warmer; and quite comparable temperatures occur on the top of the adjacent dunes. The temperature difference at such times between the outer beaches and the inner marsh border probably becomes as much as fifteen to eighteen degrees.

Briefly, it can be said that on some 340 days of the year, conditions over the Lagoon coast of the Middle Namib are exceedingly damp. At some time on every one of these days, the humidity reaches 100%, and on many of them, it remains there all day.

As a result, fog is common and often persistent. But like the temperatures, there are many minor variations, and these become very important since they control the visibility.

Most days dawn slowly, with gray fog shrouding all of the area. There is no sunrise--only a gradual graying, an enlightening of the darkness of the night. The air is calm or blowing lightly from the north, and is very damp. The few objects that can be seen seem out of proportion. One is more conscious of his whereabouts from sounds around him--the dull boom of the surf or the crying of sea birds on the invisible banks.

But by nine or thereabouts, the fog "lifts": actually there is no "lifting"; the air stays still, while the droplets in its lower levels are evaporated. Short wave-lengths of insolation energy have penetrated the fog blanket, and been absorbed by the soil of the marsh and the sand of the dunes. Long wave-lengths, radiated in turn by these now-warmer bodies, heat the air above, and the fog particles go rapidly from the liquid into the gaseous state.

And so, suddenly, one can look for miles up and down the marshes underneath the fog; but the ceiling is at 25 or 50 or 100 feet. And there is still no visible sunlight.

About this time, the sea breeze usually begins to blow, or really, to waft; but there is neither an increase nor a decrease in the fog. Sometime later, usually about ten or eleven, the sun becomes visible intermittently as a pale gray disc, and soon thereafter, following several premature "bursts," it comes out to stay.

The fog has now succumbed to evaporative attacks from both above and below, and has gone for the day. But banks of it will persist just offshore, where there is no ground heating to aid in dissipating it; and from them, detached fragments will scud by all day, just overhead at altitudes of 100 to 1,000 feet.

With late afternoon, the insolation heating gradually decreases, the evaporative attack on the top of the offshore fog bank lessens, and the fog-edge begins to creep shoreward. Minute by minute the top rises higher, progressively cutting off more and more rays of the lowering sun from the forward edge of the bank, and the front surges beachward. The rising bank rapidly throws the whole marsh into shadow, and moments later the fog comes sweeping in. And just as there was no sunrise, so there will be no sunset; the sun disappears behind banks of fog, and, much later, darkness comes on imperceptibly.

But while the fog rolls in, it does not come in at sea level. Rather the warmth of lagoon and salt marsh combined keep the air warm, and hence clear, to a height of a score or a half-hundred feet above the surface. And once again one can look for miles up and down the marshes under the gray roof of the fog.

Now a peculiar phenomenon occurs. The shallow water of the lagoon edges and the pools of the marshes are warm from a day of sun. Above them, under the shroud of fog, the air chills rapidly. The surface of the water gives off moisture at a much faster rate than the air above can absorb it--and so the pool "steams," as the vapor is condensed into droplets, forming little waftings of fog. These blow away eastward, rising gradually and joining the thick gray mass above.

Eventually, as night approaches, the stored heat of earth and pool is exhausted. There is nothing to warm the lower levels and hold the fog aloft, and so it settles down to smother everything. The breeze continues for a time, then gradually diminishes till, by midnight, all is calm and thickly enshrouded in gray vapor.

The fog blankets all, and thus retards the dissipation of heat from the earth into space during the night. Hence, the nights, while damp and dismal, are not really cold.

Unit Areas of the Lagoon Coasts

Along the lagoon coasts of the central Namib Desert, several types of unit areas can be recognized:

- 1) foreshores,
- 2) backshores and beach ridges,
- 3) pans,
- 4) salt marshes,
- 5) mudflats and
- 6) the Kuiseb delta.

Treatment of the Great Sand Dunes, which come to the sea along a large extent of this coast, will be deferred until the next chapter, which deals entirely with them.

The Foreshore--(Unit Area I - C - 1). The foreshore consists of the seaward side of the spit or barrier beach, it is present along the entire length of the area under consideration here.

In most cases this strip is rather narrow, and quite steep, for this is a coast which is usually rather steep-to, along which there is a strong current, and where the action of huge rollers is most violent.

The usual width is somewhere in the vicinity of 200 feet, measured from the crest of the beach to the low water line. In grosser outline, the beach is quite straight; in detail, it is often seen to be composed of an endless array of cusps, so common on steeper, coarser beaches everywhere. The beach is rather steep inside the low water line, and outside of the breaker zone; but the bottom under the breaker zone appears to be much flatter, at a level just below low tide, forming a narrow bench. This is well shown in the following table.³⁶

Table XII

Representative Foreshore Profile

<u>Distance From Shore (Yards)</u>	<u>Depth (Feet)</u>	<u>Increase In Depth In Last Hundred Yards (Feet)</u>
100	6	6
200	12	6
300	28	16
400	55	27
500	72	17
600	78	6
700	82	6
800	86	4
900	90	4
1000	101	11

Above the low water mark, the beach rises at a gradient ranging from 6% to 18%, with the average being somewhere about 12%. The beach is composed of gray-white to yellow-gray fine sand, containing quartz grains, considerable amounts of finely broken shell, and much micaceous mud.

It is apparent that the beach material is migrating steadily and quite rapidly northward. The rollers break obliquely from the south-southwest and hence carry materials in typical zigzag fashion up and down the beach, but progressively to the northward. In addition, material is kept suspended by the turbulent water across the entire beach--i.e., within the breaker zone, and for some hundred yards further seaward, as can be clearly seen by the roily appearance of the water. Since the whole body of the water is moving northward as the littoral current, this suspended matter is drifted in that direction.

The effect has been to gradually extend each of the spits, resulting in the closing of the harbors, and the action seems to be progressing from south to north along the whole coastline. The harbors south of Sandwich were bar-closed before the beginning of the historical period. Sandwich Harbour, on the other hand, was open to navigation³⁷ until 1889. Today it is definitely closed to all navigation, but is not usable for land traffic.³⁸

Walvis Bay is still in an earlier phase of the development. Here the bay is still open-mouthed, allowing access to all types of shipping, as will be described later. That there is only one current along the coast is well shown by the spit

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37. The harbour was open to sailing vessels when the Grundel (exploring the coast northward from Cape Town for the Dutch East India Company) landed there on May 1, 1670 (Vedder, "South West Africa in the Early Times," p. 9). Seven years later, the Bode, sailing under the same auspices, visited the same spot (Vedder, op. cit., pp. 12-14). In the latter case the description of the area is quite complete, and no mention of having to cross bar and marshes to reach the dunes is made, and it can be assumed that the bay was open and the ship able to anchor in its protected waters. Sandwich was an important harbor during the heyday of American whaling, in the early nineteenth century. Vedder (op. cit., p. 467), mentions that the smuggling of ammunition to the warring native tribes of the interior took place through Sandwich in the early 1880s. Green ("Lords of the Last Frontier," p. 301) states that H.M.S. Sylvia anchored at Sandwich in 26 feet of water in 1880, and that it was the site of a German customs station in the last days of the nineteenth century. Wagner (Geological Survey Memoir #7, 1916, p. 19) states that from studies of old charts, the bay was open prior to 1880; that between 1880 and 1889 the spit grew across and finally closed the bay in the latter year; and that it has been repeatedly breached since that time.
38. In October 1956, the bar was traversed by jeep at low water; but in May, 1957, there was a channel eight or ten feet deep and considerable sea water was entering the lagoon. At the time of the first phase of the guano operations here, some thirty years ago, the product was shipped out over the bar in lighters; but this was shortly given up. (Oral discussion with Mnr. Crees, commercial surf fisherman from Walvis Bay, and Hans von Braus, coloured, resident at Sandwich Harbour since 1930).

development here: the northward-moving sands have accumulated to form six-mile long Pelican Point; but there is no vestige of a counterpart on the other side of the bay.³⁹

That the point is still being extended is shown by the position of the lighthouse. Constructed as near to the end of the point as was feasible, it is shown on the chart⁴⁰ of 1928 as being 1100 yards from the tip, and in 1953, the U. S. Hydrographic Office warned⁴¹ shipping that the point was extending to the northeast far beyond the position shown on the chart.

The foreshore is completely devoid of vegetation, aside from the seaweed cast up by the waves and such microorganisms as may live in the sand. On the other hand it is particularly rich in avifauna, both in total population and in numbers of species. This is, of course, a reflection of the remarkable abundance of fish in the Benguela Current. Most conspicuous are the flamingos, standing on long, spindly legs in the surf-edge. At times they line the coast in great numbers--it can be stated conservatively that in October, 1956, there was a flamingo for every ten feet of the thirty miles of shoreline from Pelican Point to Sandwich Harbor; and from a distance their white plumage looked like a second line of surf breaking on the beach. Almost equally numerous are the huge snowy-white pelicans, with their monstrous beaks. Small strandlopers run in and out of the surf, probing with their long thin beaks for small organisms in the sand. Overhead fly flocks of cormorants, duikers, gannets, mews, sea gulls and various other small sea birds. Infrequently in the north and much more commonly south of Sandwich, one comes on individuals, and sometimes groups of penguins, walking up and down the beach.

Jackals live in the dunes behind the beach, and prey on the flamingos, pulling them down at night as the birds sleep standing on one leg at the water's edge. Jackal tracks are everywhere in the soft beach sand, as are the bony, leggy carcasses of the birds they have destroyed. Occasionally one sees the larger tracks of hyenas, scavenging for dead fish, dead seals, and the like.

Occasionally, from the sea, seals come ashore to bask in the sun, although they much prefer the rocky islets and headlands to the sandy beaches.

Beach Ridge and Backshore--(Unit Area I - C - 2). Between the lagoon or salt marsh and the open ocean lies the sand spit or barrier beach. Its seaward side is the foreshore, just described. The backshore--toward the marsh or lagoon--and the hummocky ridges of the center are described here.

By wave action alone, the altitude of the top of the beach would not exceed that of the highest storm tide, and the crest would be fairly smooth. But here, where the southwesterly winds are fairly strong, the sand, dried out following the recession of the tide, is picked up and carried about by the wind. Most of the movement is at a very low height, only an inch or so above the surface, and the grains move only very

39. See U. S. Hydrographic Office Chart No. 2267.

40. Ibid.

41. U. S. Hydrographic Office, Notice to Mariners, Feb. 21, 1953.

short distance at a time. But the net movement is great, and so, eventually, accumulations of wind-blown sand develop.

Any obstacle may cause a sand accumulation; but most common are certain small bushes, notably Aerva leubnitziae⁴² and Mesembryanthemum salicornioides. The former is one of the Amarantaceae; and is characterized by the longitudinal furrowing of its soft, jointed stems, and the obscure, unimpressive flowers on the ends of the stems. The leaves are very rudimentary; most of their work has been taken over by the chlorophyll lodged in the dark green stems. The plant commonly forms thick cushion-like masses, half buried in the sand.

Mesembryanthemum salicornioides (Aizoaceae) is a very succulent, sprawling mat of interlocking stems and branchlets. Its swollen stems are constricted every half-inch or so, making the stems look like a miniature string of sausages.

These plants form small dunes similar to the "elephant head dunes" of San Gorgonio Pass, California.⁴³ In this case, the dunes, each with a mat of vegetation to windward, accumulate to a height of six feet. Between them are blow-ways (deflation areas) where the concentration of the wind produces greater velocity than elsewhere. There is no coarsening of the surface materials in these blow-ways-- principally because there is no coarse material present in the first place.

Where the orientation of the coast is favorable, much greater accumulations of sand occur. There the larger dunes may rise thirty or forty feet above the highest level of the sea. The elephant-head dune is absent; rather, the sand is just heaped in patternless arrangements of dunes.

In these areas, the Aerva and the Mesembryanthemum are joined by two grasses: Aristida sabulicola and Eragrostis spinosa, and two other bushes (Salsola aphylla and S. zeyheri). The Aristida is a tall (five to six feet), coarse, almost shrubby perennial grass with long creeping rhizomes. The branches occur in tufts at the nodes, and the leaves are very coarse and spiny. Eragrostis spinosa is, at first glance often mistaken for a shrub, so "ungrasslike" is its appearance. It forms very hard, spiny masses up to two feet in height. Only when viewed closely, or when seen in bloom, will it be recognized as a grass.

Salsola aphylla, a strong halophyte, is so salty to taste that it has acquired names with the same meaning in the three languages: "brakbossie" in Afrikaans; "brackbusch" in German; and "saltbush" in English. Its leaves are very reduced in

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42. This plant was formerly called Arthroa leubnitziae (as in Dinter, K., "Deutsche-Sudwest-Africa, Flora, Forst and Landwirtschaftliche Fragmente," Leipzig, 1909, p. 1), but is listed by Phillips (Phillips, E. P. "Genera of the South African Flowering Plants," Botanical Survey of South Africa, Memoir No. 15, 1951, Pretoria, p. 278) as Aerva. Phillips states: "The species on which Schintz based the genus Arthroa is a typical desert species. In floral structure it does not differ from Aerva."
43. Russell, R. J., "The Land Forms of San Gorgonio Pass," University of California Publications in Geography, 6, Berkeley, 1932, pp. 107-113.

size; they grow closely together on the ends of the twigs, overlapping each other in a shingled fashion, and, with their somewhat shiny, silvery surfaces, are easily mistaken at first glance for either catkins or seed-pods. Salsola zeyheri is generally similar in appearance, but a thick covering of felty hairs over the surface of its much larger leaves gives it a grayish appearance. Both plants are sprawling, scraggling plants, always in imminent danger either of burial by sand or of being undermined totally by wind erosion. While small above ground, they have large-diametered roots, usually gnarled and twisted, and often exposed by the wind on the southwestern side of dunes.

The backshore is drab and uninteresting, suffering poorly by contrast with the thundering foreshore a hundred feet or a hundred yards away. The quiet waters of the lagoon lap against it in some places, often so stagnant that they smell badly. Elsewhere a mudflat is the contact, and in still other places the beach sand is encroaching on the salt marsh. Here the sand is finer than on the foreshore, and much softer, lacking the compaction by the surf. In addition to the present beach ridge situated adjacent to the existing shore line, older beach ridges also exist further inland. Rising from the inner shore of a pan, mud-flat or lagoon, they are lacking in a foreshore as described above, but in all other ways fit the description just given.

Despite its immediate proximity to the foreshore with its dense avifauna, the typical beach ridge and dune area has only a modest animal population. It is occasionally visited by the gulls, who fly there to devour a choice morsel away from their rivals, but the flamingos, pelicans, penguins, duikers, and strandlopers seldom leave the sands wetted by the latest wave. Amid the dunes one occasionally sees the burrow of the jackal, and the small holes of the little mouse, Gerbillus swakopensis, who feeds on seeds and other vegetable matter. One even finds his tracks occasionally amidst those of the sea birds where he has ventured forth to look for food in the piles of sea-wrack left at high tide. Among the higher dunes away from the shore, one sometimes comes on the feet-and-tail spoor of some unidentified lizard. And, not infrequently, one comes upon a scorpion, probably Opisththalmus wahlbergi littoralis.

The Pans--(Unit Area I - C - 3). Back of the ridges and dunes of the barrier beach is a discontinuous chain of basins, representing minor to major indentations of the original coastline separated from the ocean by the construction of the spit-barrier combination. In some places, they are still water-filled, making long narrow lagoons; elsewhere they have been partly filled with mud, now exposed twice daily by the receding tide. And in many places, they have been completely filled, forming pans.

A pan is merely a southern African version of a playa or dry lake. It has the same thick accumulation of muds and silts, perhaps interbedded with some pure salt, and with some sand lenses. Most of the African pans occupy the bottoms of desert basins, as do the American playas. In the present case, the term is stretched slightly to include these coastal forms, but the net effect is the same, although the origin is slightly different.

The pans have an almost perfectly flat surface of mud and sand. Usually it is dry, and even inclined to dustiness, but following spring or perigee tides, it may get well moistened through seepage and capillarity, whereupon it becomes plastic and sticky. Being a nearly rainless area, the tide is the chief control, although,

obviously, a heavy rain has the same result. Usually, the moisture seeps from below, and the actual inundation of a pan in this coastal area is very rare. On the other hand, ground water is usually present at depths ranging from less than a foot to seldom more than five feet; it is usually very briny.

The pans may be divided, genetically, into two major groups: those of the Kuiseb river delta, east and south of Walvis Bay, where the river has had a major role in their origin; and those of the rest of the coast.⁴⁴

In the latter case, the pans represent filled lagoons, where fine muds and soluble minerals have been deposited in sluggish or stagnant waters, and where soluble salts have been precipitated by solar evaporation. Since streams do not flow along many parts of this coast, the material is derived from other sources:

- 1) fine material blown by the wind into the lagoon
- 2) materials carried by the littoral current, and deposited when the lagoon was still open, or when the bar is occasionally breached
- 3) soluble salts from percolating ground waters
- 4) the dissolved mineral content of sea water, entering the pan either on the surface or by seepage through the bar.

In some cases, the pan at some time since its filling has been covered with a layer of some different type of material, most of which has since been blown away, leaving only an occasional hummock as a residual remnant. Remains of roots of bushes formerly growing in this higher stratum are occasionally encountered. Such removed strata have no deep significance; it is probably rather common to have a mass of dune sand detach itself from the beach ridge and drift slowly inland, across the intervening pans, and on into the back country. Probably it is chiefly the moistening of the surface by capillarity from the water table which keeps the present material from being deflated as well.

Aside from microorganisms not studied by the writer, vegetation is completely lacking on the pans. Only animals in transit across the pans are to be seen; none make their homes there, or hunt there regularly.

Salt Marshes--(Unit Area I - C - 4). Large areas of the lagoons behind the spit-barrier beach are partially filled with mud and vegetation, making a salt marsh.

The salt marsh is a result of a combination of marine deposition with the accumulation of organic matter. Micaceous muds are swept through the break in the barrier beach or are blown over the beach by the wind, and settling out in the quiet waters of the lagoon, make a foundation for vegetation growth. Plants grow and die, and their decaying remnants are added to the accumulating muds. Some arenaceous

44. Two of these, north of Swakopmund, have been studied in detail by Gevers (loc. cit.), to whose reports the reader is referred for more complete details. The Kuiseb pans will be discussed in detail later in this work.

material is added by the erosion of the edge of the adjacent dunes by minor waves and currents in the lagoon, and the shells of mollusks, crustaceans, etc., add a hard calcareous element. Thus the composition of the salt marsh and its underlying foundation ranges from slick black mud of purely organic nature through arenaceous muds and argillaceous sands to pure sand and beds of shell.

The patterns of the salt marsh are complex and intricate. For the most part, the salt marshes lie in the more remote parts of the lagoon, away from the opening into the sea. Within themselves, a seemingly senseless intricacy of channels and pools characterizes the landscape. The channels meander in an exaggerated fashion, and receive tributaries which meander in the same manner. The channels are two-way streams: during the recession of the tide, they drain water from the marshes; during the rise of tide, they return it. At high tide, they overflow their banks slightly, so that the whole marsh is covered with a thin sheet of water. The streams in the channels transport considerable fine sediment, which is entrapped by the vegetation as the water overflows the bank; thus a low natural levee is slowly constructed, and along it more luxuriant vegetation exists than in the lower inter-stream areas. Gradually the rising banks cut off the interiors, and low areas of stagnant pools form there, in which less and poorer vegetation grows. In addition, the materials of the channel edge are coarser and have stronger internal drainage than the thick, heavy muds of the interior pools.

The relief of the marsh is governed by the range of the tide--since it is essential that the marsh be flooded regularly. Thus the channels are kept open to a depth of a couple of feet at low tide, while the marsh surface is built up to the level of higher high water. The mean range of the tide along this coast is about 3 feet, hence the extreme relief of the marsh--from bed of channel to surface of marsh--is about 5 feet.

About the outer edge of the marsh, currents and waves of the lagoon have built up minor spits and bars, made of sand and shell fragments.

From under the sand dunes, there is usually a slow seepage of fresh water into the lagoon; the inlet through the beach is small and the flow of water in from the ocean is not very great. Thus in course of time, the water in the more remote parts of the lagoon has become brackish rather than saline, and as a result, there is a flourishing vegetation in the salt marshes.

All the plants are thick-leaved, thick-stemmed succulents, with recumbent to sprawling habits, typical of salt marshes the world over. No attempt has been made to identify the individual species botanically.

Many birds occur over the marsh and lagoons and in the pools and channels. The more important larger birds are the flamingos and the pelicans. The penguins are quite tame and when frightened disappear below the surface of the lagoon.

Other than the avifauna there are few animals in the marsh. The regular flooding discourages mice, rats and snakes. The only larger animals are a few domestic donkeys and goats.

On rare occasions gemsbok and springbok come to graze on the marshes. Where they come from is a mystery, for the Great Sand Dunes stretch lifeless for thirty miles to the eastward. They may merely be occasional stray bands searching

for feed. More likely they are bands who have lost their way during the sandstorms of the East Wind, and have drifted, tail to the blast, down wind into the Dunes. Then, the gale over, they smell the lush scent of the marshes on the sea breeze, and go there to feed.

The Mud Flats--(Unit Area I - C - 5). Large areas back of the barrier beach or spits are occupied by mud-flats, which are covered by water at high tide and exposed during low tide. In some instances, the flat is covered only during perigee and spring tides, and continuously bare otherwise. The flats have very low relief, and are monotonous in the extreme. They are usually cut by an open network of shallow channels.

The group of birds which frequents the salt marshes, as described above, also frequently visits the mud flats. In addition, some jackals and hyenas occasionally hunt thereon. But unlike the salt marshes, the mud flats are virtually without vegetation.

The flats of Sandwich Harbour and Walvis Bay are pockmarked everywhere by low, ring-shaped mounds, each surrounding a small, ring-shaped depression in the center of which is a low, dome-shaped mound. Their outer diameters range from one to ten feet; their heights from six inches to a foot. These are explosion craters, from which eruptions of hydrogen sulphide gas have occurred.

These submarine explosions occur annually, especially during the summer, along the entire coast from the Sperrgebiet northward to Cape Cross. They are especially notorious at Walvis Bay and Swakopmund--chiefly because these are the only inhabited places of consequence in the area.

Descriptions of the phenomenon are sometimes quite dramatic. One itinerant journalist states:⁴⁵

"Occasionally the sea bed rumbles and emits a belch of poison gas." Actually the gas is not poisonous in the usual sense and the "rumbling of the sea bed" is probably only the sound of the gas escaping from the water. That the phenomenon is not new is indicated by the fact that nearly every visitor to the port from the earliest times has reported it.⁴⁶ For example, W. B. deWitt describes⁴⁷ the dead fish resulting from such an eruption in January 1882. The U. S. Hydrographic Office warned⁴⁸ that the use of the Bay water will at times ruin ship distillation plants and that the water will take the paint off of anchors.

Any fishing captain of the Walvis Bay waterfront can vividly describe an eruption. At first the sea takes on a milky color, eventually turning to khaki and finally to a coffee brown. Dead fish will be seen floating and small bubbles begin to rise. Living fish will be seen gasping as though for air. At such times the temperature of the water is warmer than usual. At the height of an eruption, large bubbles rise from

45. Negley Farson "Behind God's Back" p. 52.

46. McKiernan's failure to mention it (1875) is easily explained by the fact that he stayed at the port in August and September.

47. S.W.A. Annual, 1948, p. 137.

48. U. S. Hydrographic Office publication No. 105, p. 221.

the bottom and sometimes there are immense "blubs" large enough to rock a rowboat; the stench of hydrogen sulphide becomes very strong.

The gas drifts landward on the sea breeze turning the paint on houses black, tarnishing the silverware in bureau drawers and producing a sulphide patine on bronze objects.

Great shoals of dead fish appear and drift shoreward to accumulate in banks along the high tide line. The sea birds spurn these for food and crews of natives have to be put to work at Walvis Bay and Swakopmund removing them since they create a real health hazard.

Most laymen believe the eruption to be due to volcanic activity under the harbor.⁴⁹ It is far more likely that the cause is bio-chemical rather than geological. Detailed work by Copenhagen⁵⁰ led him to theorize that the following sequence of conditions and events brought about the "eruption":

- 1) The bottom muds in and off Walvis Bay contain vast quantities of sulphate-reducing bacteria which produce hydrogen sulphide.
- 2) This results in an azoic area of sulphide diatomaceous ooze.
- 3) The Benguela current is ordinarily cold and rich in plankton and hence rich in surface fish.
- 4) The invasion of subtropical Atlantic water into the Benguela current results in high salinity, high temperature, and the resultant death of the plankton.
- 5) The plankton sinks into the azoic zone, is attacked by anaerobic sulphate-reducing bacteria which produce hydrogen sulphide.
- 6) Bottom water if displaced will kill fish through its lack of oxygen.
- 7) These conditions are often accompanied by the sudden appearance of poisonous plankton in the surface water, especially the dinoflagellates in great quantities, making the sea red or brown.
- 8) The fish may be poisoned by the gas, by the bottom water, by the plankton, or by all three.

The writer does not wish to take issue with Copenhagen, for it seems quite reasonable that such situations do develop in the deeper water and within the Bay itself. However, a further explanation must be sought for the gas-created explosion craters found everywhere over the mud flats at Walvis Bay and Sandwich Harbour. These seem to indicate a source for the gas within the mud layers and which would seem therefore not to be connected with any recent or short-term sequence of events. It would seem

49. This myth is perpetuated by the United States Hydrographic Office, *loc. cit.*

50. W. J. Copenhagen, "Periodic Mortality of Fish in the Walvis Region," 1953.

that the gas is produced at considerable depth from biochemical reactions involving materials deposited at some time well back in the past.

The coincidence between the occurrence of the eruptions and the beginning of the rainy season in the interior has led to the belief that the arrival of flood waters as underflow in the river bed imposes pressure on buried strata and displaces gases which have been generating there over the preceding ten months or so. This likely explanation must be discounted because the eruptions not infrequently occur before the arrival of the first rain in the uplands.

It is the writer's belief that as yet no completely satisfactory explanation for the gas eruptions has been provided.

The Kuiseb Delta--(Unit Area I - C - 6). The southern half of coastal South-West Africa is a riverless land. From the Orange River on the southern boundary northward for over four hundred miles, no stream whatsoever, either on the surface or as an underflow, succeeds in reaching the sea. It is only at Walvis Bay that the Kuiseb, one of the larger streams of the Territory, succeeds in accomplishing this feat.

The Kuiseb rises in the western part of the Khomas Hochland, at an elevation of some 6000 feet, and flows southwest and west in a rock-walled gorge for a hundred miles into the Namib Desert. Across the desert it forms the northern border of the Great Sand Dunes, separating the Middle Namib from the Northern Namib. Sixty miles from the coast, it turns northwestward; from there on, its valley gradually loses its gorge-like character until finally, fifteen miles from the coast, it opens out as a broad plain bordered only by shifting sand dunes.

Judging from the present bedrock exposures, it would appear that there was formerly a fairly deep indentation in the coastline at the present site of the Kuiseb delta. Bedrock outcrops at Bird Rock, near Rand Rifles, and east of the longitude of Rooibank--but there is none in the broad flats between those places and Walvis Bay. It appears that not long ago this was a bay.

The Kuiseb seldom flows on the surface. But when it does, it flows with a violence that is surprising. Since World War I, the river has reached the sea only in 1917, 1923, 1931, 1934, 1942, 1950 and 1953; but each time it has done so with great flooding. Coming from a land of steep slopes eroded in mica schist, and as a result of violent downpours, it carries a mighty volume of mud. Over the centuries, this has been deposited in the bay at the mouth, and has filled most of that former embayment with micaceous clay and mud.

In its lower course, below Rooibank, the stream finds its channel much impeded by sand dunes. Here, the strong sea breeze daily blows the sand from the Great Sand Dunes and from the coastal beach ridges northeastward. Small migrating dunes, some of them barchans, drift slowly across the clayey surface of these river muds until, north of the river bed, they join the portion of the Great Sand Dunes which extends north to Swakopmund.

Were it not for these sand hills, the flooding river could spread out over the delta in a thin sheet and discharge to the sea. But the dunes block its flow, and its gradient here is too low to allow the stream to scour them away. The result is an

impounding of the river waters and the formation of temporary lakes in the delta region. One of these lakes, crossed by the road to Swakopmund, was full of water for three months in 1942, and wrought havoc with transportation in the area.

Thus the area is one in which two major geomorphic forces are at work: the wind, blowing sand northeastward nearly every day of the year; and the river, flooding the countryside once a decade, impeded by the dunes, and depositing its muds in the lake-beds. The landscape shows it clearly: a broad, smooth platform of mud and clay, over which ride the migrating sand dunes.

The vegetation is relatively scanty over most of the area. The muds and clays in particular are quite devoid of it. Only an occasional stunted Salsopa aphylla bush is to be seen. Along a couple of stream beds, notably the one passing Traut's "Green Valley" garden, Tamarix austroafricana is plentiful--a sad looking excuse for a tree, with dusty, blue-green, needle-like⁵¹ foliage covered with little crystals of salt, and scraggly branches twisted in all directions. It is a plant very tolerant of brackish water, and hence does moderately well along these lower river courses.

In the bed of some of the old lakes, a rather dense growth of Nicotiana glauca⁵² sprang up in the mud as the water dried away, and even today, several years later, the dried stalks still stand.

Since the area lies so close to the Walvis Bay settlement, its animal life has no doubt been greatly altered by man and his domestic animals--notably the "Kaffir dogs" of the natives. No special study of this phase of the area was made.

Human Occupance of the Lagoon Coasts

Although this is one of the least inhabited and most desolate coasts in the world, it is not totally without population, and a full accounting of its inhabitants would be quite lengthy.

Everything has militated against the occupance of the coastal belt south of the Kuiseb River--the aridity of the climate, the uselessness of the soil, the impermanence of its surfaces (sand dunes, mud flats, sandy beaches), and the total absence of resources--and curiously the presence of one resource (diamonds), which has resulted in the total depopulation of the area.

The Sperrgebiet

From the southern end of the Sandwich Lagoon to the harbor of Luderitz, a distance of over two hundred miles, the coast is absolutely uninhabited. No European, coloured or native, lives or travels over its endless sea of sand or along the rocky beaches. This is the Sperrgebiet, the Prohibited Area.

51. This is not a needle-leaved tree, despite the appearance of its leaves from a distance. It is the sole southern African genus of the Tamaricaceae.

52. This is an exotic plant imported from Peru, and growing in disturbed soils throughout the Territory, just as it does in California.

In order to enforce their monopoly on diamond extraction, and hence to control by limitation of supply the diamond market of the world, the Consolidated Diamond Mines have received from the Administration of South West Africa a concession entitling them to exclusive occupation, prospecting and mining in this tremendous tract of the Namib. Since the operations in the southern Namib, at Oranjemund, yield all the gems required, the area of the Middle Namib is held in reserve for the future, and all entry into the area is prohibited. Permission to enter is seldom given, and the borders are rigidly patrolled to prevent poachers from entering. On the east, patrol is both on the ground and in the air; on the west, patrol planes scan the coast occasionally for evidences of illegal entry.

Actually, there is little to do. Diamond poaching is quite a hopeless preoccupation. The surf is an excellent guard--while one might be able to land safely through it, it would make return to the sea a virtual impossibility. And once ashore, the poacher would be faced with the task of finding the likely site, and removing tons of overburden to get at the placers before running out of supplies or being spotted by the patrols. Yet it is still attempted occasionally. In most cases the diamond seekers look upon the C.D.M. patrol as rescuers rather than captors, and are glad to get out of the desolate wastes alive, even though they face a stiff jail sentence.

Guano

Furthermore, there is a resource from the birds that is only partly exploited at present. As mentioned above, guano accumulations on the offshore islands are of considerable commercial importance. Great quantities of guano could accumulate in the lagoon areas of the mainland, were it not for the fact that the birds roost chiefly on small sandbars awash at high tide.

In 1932 a German, Adolf Winter, constructed a platform 1,700 square yards in area about 2,000 feet offshore 4.5 miles north of Walvis Bay Wharf. It has a wooden deck about 15 feet above high water, supported by iron legs which rest on the bedrock bottom of that locality. For the first year or two of its existence, it was ignored by the birds, but today great masses of cormorants, gulls, pelicans, flamingos, and smaller birds roost and nest thereon. A crop of approximately a thousand tons of guano is removed from it each February and March by a crew of 50 or more natives working under three or four white supervisors. The entire platform is covered to a depth of three to six inches with white droppings. The guano is broken up with hammers and shoveled by hand into 200 lb. sacks. Picked up on handcarts, the bags are wheeled to a chute and slid down into a lighter. A wire cable connects the platform to the shore and the lighter is attached to it. A winch aboard the lighter powered by four natives cranks the loaded vessel to shore, where it is unloaded by hand onto a trailer and truck backed down into the waves over a temporary roadway of iron plates. The guano is stored in the open at the nearby railway siding of Cables, when it is transported at the end of the season by the special "White Train" to Walvis Bay for shipment by sea to the Union. In 1957, 2830 tons of the fertilizer, valued at £63,677 were produced in and shipped from South-West Africa,⁵³ a good share of it from this platform.

53. Office of the Inspector of Mines, quoted in the Windhoek Advertiser, edition 3962, Feb. 14, 1958.

Today, vast quantities of guano are lost to commerce along the South West African Coast because the birds roost in small sand bars awash at high tide. The construction of other platforms and places of major concentration of birds will probably prove economically worthwhile if the problems of transportation of the product could be overcome.

A guano company formerly operated at Sandwich,⁵⁴ collecting the droppings from some artificial islets since destroyed by the waves and currents of the lagoon. At the same time, great problems were encountered in the transport of the product to Walvis Bay. At first the guano was run out of the inlet and through the breakers to the ships offshore by means of lighters. But when the inlet silted in, it became necessary to haul it overland to Walvis Bay in caterpillar-drawn carriers. A wooden road was laid at a few particularly bad places--remnants of it can still be seen. On the stretch around the dunes north of Sandwich, there was always danger of the outfit being swamped by the waves of a rising tide. The company is said to have gone out of business because the lagoon closed completely and the birds left the stagnating water. The author suspects that transport difficulties were an element in the situation.

Green states⁵⁵ that the Germans formerly operated a meat canning factory at Sandwich. This is believed to be a mistake--there has never been a source for meat, and anyone driving animals to the coast from the interior would make for Swakopmund or Walvis Bay, but never for Sandwich. The others are termini of natural routes, but to cross the Great Sand Dunes with a herd--never!⁵⁶ On the other hand, a whaling factory was once operated here (Hans von Braus still has one of the old kettles for boiling down the blubber), and this may be what Green is referring to.

Salt Extraction

Along the coast north of Swakopmund, several pans are being commercially exploited for salt. The table below gives the 1957 production figures for the entire Territory, nearly all of which was produced in this area.⁵⁷

54. Green, Lawrence, op. cit. pp. 302-3; personal conversations with Hans von Braus of Sandwich Harbour.

55. Green, loc. cit.

56. In the narrative of the Bode voyage (1677), the chronicler (as quoted in Vedder, op. cit., p. 13) states that the natives at Sandwich brought 12 to 16 cows down to the shore. It seems probable that these animals were grazed on the nearby marshes, much as donkeys and goats are today.

57. Office of the Inspector of Mines, quoted in the Windhoek "Advertiser," Edition 3962, Feb. 14, 1958.

Table XIIIProduction of Salt in South West Africa, 1957
(Tons)

<u>Type</u>	<u>Production</u> (tons)	<u>Exports</u> (tons)	<u>Value</u> (£)
Coarse	64,063	65,746	197,889
Rock	6,959	5,890	17,745
Fine	446	106	777
Snoek	1,523	1,524	6,366

Although many claims for salt have been "pegged" in the coastal Namib, most of the actual salt production is in the hands of several large companies. Two basic methods are employed in the extraction of the salt: mining and evaporation. The former is for the production of rock salt, which occurs in fairly thick strata at various levels beneath the pan surface--each strata representing a period of evaporation of sea water from the pan. After the over-burden of clay has been removed, blocks of the rock salt are dislodged and removed intact. Much of this salt is sold within the Territory for cattle licks.

However, the bulk of the salt is produced by digging elongated basins to a depth a little below the local water table; salt water seeps into them and evaporates filling them in time (usually in two weeks to a month) with pinkish white salt crystals. These are shoveled out into heaps and drying in the midday sun eventually become shimmering white.

The evaporated salt is shipped out to Walvis Bay, over the coastal salt road described below, in large gasoline and diesel powered trucks. All supplies for the workers including water are brought in on the return trip. All of the manual labor in connection with the operation is done by natives under the control of a white boss.

Many of the pans, however, are almost completely unused by man. Their sole potentiality for the future seems to lie in the possibility of extracting rock salt from below the surface. It would probably be worthwhile in the not-distant future to make a few shallow drill holes to investigate the possibility of the presence of rock salt there.

Subsistence Agriculture

Today, Sandwich supports only one family. Hans von Braus, son of a German father and a woman from the Otjimbingwe Native Reserve, has lived at Sandwich since 1930. He was in the employ of the guano company, and has remained on since, with his wife (who died in 1956) and a dozen or more children.

They live a lonely life. There are no people for thirty miles to the north, and for 220 to the south. It is impossible to go inland. His werf (farm) is situated under the Great Sand Dunes at the eastern end of the lagoon, its location having been

determined by some preexisting buildings of the guano company, whose site was in turn selected by the presence of water there. In his garden, behind windbreaks to protect against the seabreeze, he raises a good crop of vegetables and some flowers. On the salt marshes he grazes goats for meat and milk and donkeys for meat and transport. On the other beach, and to a lesser extent in the lagoon, he makes good catches of fish. It is strictly a subsistence existence, but he and his large family live fairly well, though frugally.

Farming

In a couple of places attempts are being made to farm little patches of land on the Kuiseb Delta. One of these, beside the main Swakopmund-Walvis Bay road near the inner edge of the delta, is Traut's "Green Valley" farm. A second is located several miles southeast of the south end of the lagoon, and east of the track to Sandwich. Irrigation water is obtained from wells and a small yield of vegetables and flowers find a ready market in the stores and hotels of Walvis Bay.

Fishing

Commercial fishing is carried on in a small way on the foreshore at Sandwich. A half-dozen coloureds in the employ of Mnr. Cress of Walvis Bay, handline in the surf for steenbras and other large fish. Their catch is hauled overland to Walvis Bay for local sale. The fishermen utilize a small house erected by the guano company near the von Braus werf, but part of the time they camp on the open beach. The group also has a pair of small boats equipped with motors which they use for crossing the lagoon to the bar. The occupancy by this party can scarcely be considered permanent: the personnel changes rapidly, and the whole operation is suspended from time to time.

Recreation

From Walvis Bay northward to Cape Cross the coast is frequented particularly during summer by a goodly number of sports fishermen and their families partly from Swakopmund and Walvis Bay, and from the towns and farms of the interior, as well. Many come and go the same day; others camp for a night or two; and an increasing number are raising structures varying from the flimsiest of shacks to very respectable cottages. At no place do these agglomerate to such an extent as to warrant being called a "beach colony" or "town" but there is a concentration of several scores of them at Henties Bay (latitude 22° 08' S.), just south of the Omaruru River. The recent construction of a new direct-line road along the twenty-second parallel from Usakos to the coast is causing a rapid expansion of this particular area. Two decades ago this was a completely desolate, seldom-visited area. The Territory's road improvement program of the last decade has done much to bring about the recreational use of this desert coast.

None of the beach camps are provided with a water supply--but the underflow of the Omaruru River is potable just back of the coast and some water is drawn from it today. It is possible that with proper pumping facilities the Henties Bay group could be provided with a running water supply. It seems very likely that during the next decade the summer population along this coast will increase very rapidly and such improvements are bound to come.

Another minor concentration of cottages occurs in the vicinity of Wlotzka's Bakon (latitude 22° 26' S.). At both of these concentrations recreational activity occurs at points where minor projections of the coast break up the incessant pounding of the surf somewhat, making for better fishing and even the possibility of some swimming.

The Game Reserve

North of the Sperrgebiet, the lagoonal coast lies within Game Reserve #3 of the Territory of South West Africa. This Game Reserve has fine potentialities although at present nothing is being done to develop it, or even to enforce existing laws concerning game reserves. The Sandwich lagoon is the mecca of thousands upon thousands of sea birds, which should be protected. Until a decade ago, Sandwich was seldom visited, but with the appearance of the Land Rover and the jeep, the area has suddenly become accessible. Consequently, today it is not uncommon to run into a group of Walvis Bay or even Windhoek "sportsmen" at Sandwich, fishing, and incidentally shooting at anything that moves. The days of the big game hunting are fast drawing to a close in South West, and the sea birds, particularly the larger ones, will be next on the list. The supply of birds seems inexhaustible but so also did the supply of lions and rhinos a few decades ago, and of springbok, gemsbok, and zebra within the present decade. Unfortunately, the supply of birds is not nearly as inexhaustible as the supply of hunters, and if things change as much in the next decade as they did in the past one, the waterfowl situation at Sandwich may become acute.

Of course, the fisheries' interests cry out that the sea birds destroy great numbers of commercial fish; that fact is indisputable. But to destroy, or to allow the destruction of, the sea bird race would scarcely be justified at present, and who knows what ramifications might develop from so upsetting the balance of nature?

Walvis Bay

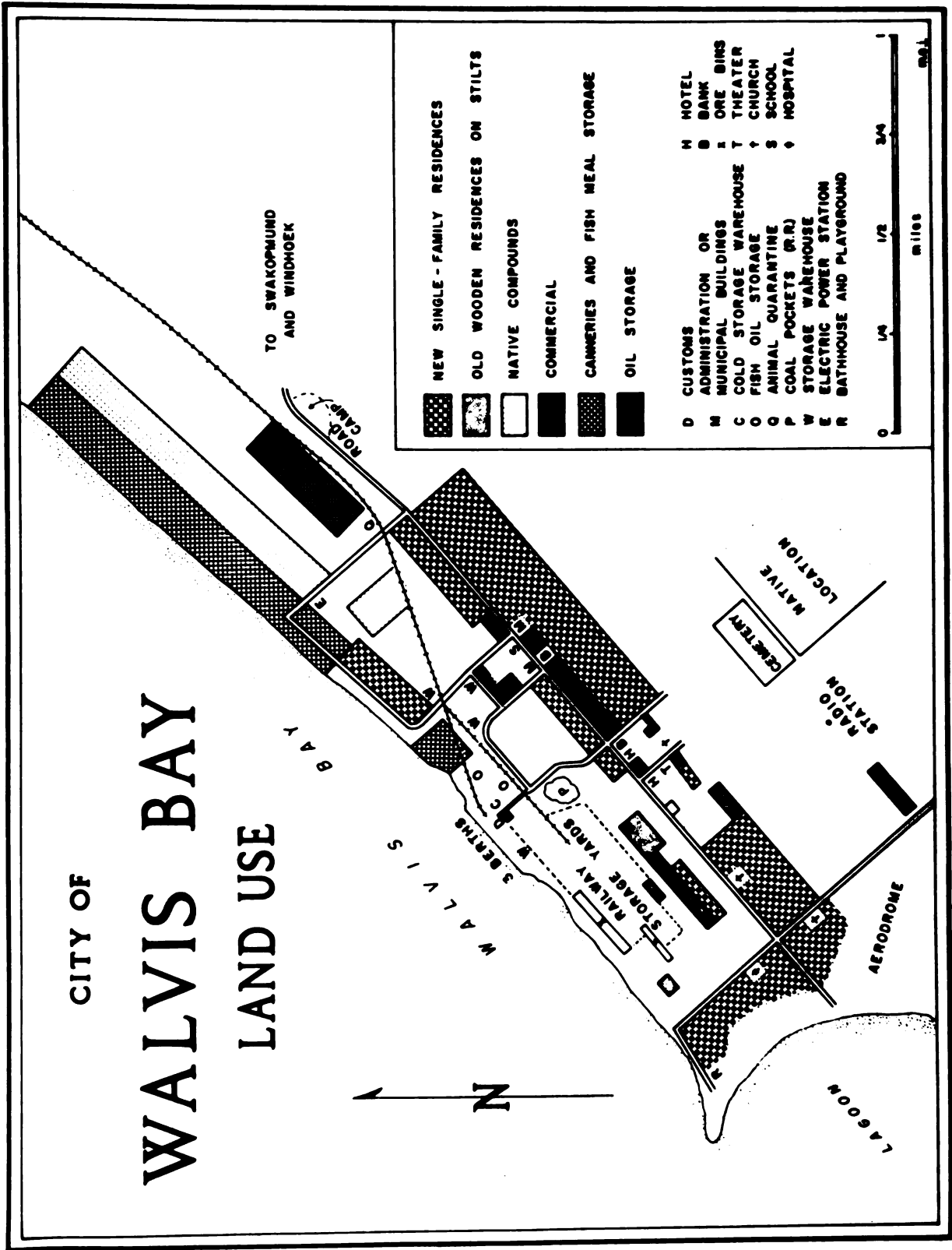
(Landscape Type I - D)

Few places in the world have a more dismal and unprepossessing appearance than Walvis Bay, South-West Africa's chief port. Built on a low mud flat in danger of periodic inundation, annoyed by seasonal eruptions of hydrogen sulphide gas from beneath the harbor, in a windy, dusty, foggy yet rainless environment, it certainly offers little in the way of attractiveness. Yet it is a fast-growing, prosperous city. (See Plate XV)

Site

The settlement is located on the deltal mud flats of the Kuiseb River at an elevation just barely above high water. Being on the delta, it is vulnerable to the floods of the river. All of the older houses were built on stilts; and on several occasions boats have been used in the streets for days, and even for weeks. To prevent this in the future, an earth dike has been built around the town, which it is hoped will divert the river when the next flood comes. Because of its low level, some parts of the town even in dry times are subject to seepage, probably from the sea as much as from the river.⁵⁸ This offers something of a threat in case of a river flood.

58. A good example is to be seen just southeast of the coal platforms of the railway, where seep water perennially stands at the surface.



The soil on which Walvis Bay is built is simply the silt, clay and sand of the delta. It is high in salts, some of which are deliquescent, which means that the soil is always dank and slimy. Even on a dry day, when the surface appears dry, the soil one centimeter down is still stickily wet. The constant dampness results in rapid rotting of timbers which touch it, in the rusting of iron which penetrates it, and even in the deterioration of cement or stucco. The salinity makes the growth of almost any plant impossible.

Drift Sand

The town is plagued by drifting sand and dust. The prevailing southwest wind rises nearly every morning about 10, and blows at twelve to twenty miles per hour till dark. In the early morning the sand is damp from the nocturnal dew, and does not blow; but it eventually dried out, and by noon the air is filled with particles that sting the cheeks, irritate the eyes and grit between the teeth. The supply of such material was formerly limitless, blowing in from the barrier beaches and dunes of the coast and the northern end of the Great Sand Dunes. It was actually possible to note the day by day progress of individual small dunes as they migrated right through the town. The construction of houses on stilts offered relatively little obstruction to such drift; but any solid object at ground level created a captive dune in its lee.⁵⁹

During the past decade, the Public Works Department of the South West Africa Administration in cooperation with the local municipality has done much to stop this sand movement. Working on the principle of the snow fence of colder climes, a municipal sand dune has been created to the windward of town. A fence was constructed across the path of the prevailing wind, and the eddy behind it traps nearly all the sand that would otherwise blow through town. The fence is constructed simply of posts driven lightly into the soil; when the sand accumulation reaches their tops, they are merely wiggled loose and pulled straight up, one at a time, by a pair of stalwart Ovambos. The sand falls into the holes, and the fence resumes operation at a higher level.

This artificial dune, now over 15 feet high, has been notably successful: the drift of sand from outside has been largely stopped. But there is still enough moving within the town to be evident: even at the post office little drifts collect on the pavement⁶⁰ each afternoon and are swept off the following morning; the approach to the Anglican rectory is over a sizeable dune between that building and the Church; board fences are soon buried from their leeward sides; and brave souls trying to raise a few flowers on imported soil surround the plot with high walls and still have to remove the new accumulation at least once a week.

59. The problems of living under such circumstances are well described, with a fine sense of humor, in a most readable book "All the Way to Abenab" by the local Anglican minister, the Rev. Frank Haythornthwaite, published by Faber and Faber, London, 1956.

60. "Pavement" in South Africa is the equivalent of "sidewalk" in the United States.

Water Supply

In the early days, Walvis Bay was totally without water. McKiernan reported in 1874⁶¹ "The only disease known at the Bay is intoxication. Drinking water is brought from Cape Town, and they will give you a bottle of English ale worth 25 cents sooner than a drink of water."

A distillation plant was set up in 1898, and continued in operation for several decades.⁶² Eventually, owing to the need for boiler water for the locomotives, the South African railways dug wells at Rooibank, an oasis on the Kuiseb River, and built twenty-three miles of pipeline to bring water from there to the town. Surplus water was provided to the townspeople, but the use by the railways held first priority. Within the last decade, the matter of water supply has been taken over by the South-West Africa Administration in cooperation with the Municipality of Walvis Bay. Tube wells yielding a good flow have been sunk in the river bed at Rooibank, from which water is lifted by pumps into pressure and storage reservoirs. It is an up-to-date, high-grade system, yielding a reliable supply of potable water⁶³ to the town; and it can take care of a considerable expansion in the size of the town.⁶⁴

Other Public Utilities

In contrast to the modern system of water supply, the sewerage arrangements are relatively primitive. Water is "laid on" (i. e., running water) in the homes, most of which have flush toilets. But the terrain is so flat and low that an integrated system of water-borne sewerage would be very difficult and costly.⁶⁵ As a result, the town has recourse to the system of cesspool pumping. All day every day one can see the black Municipal "honey wagon" trucks, with their black cylindrical tanks (looking much like an oil truck), their heavy hoses, and their little pumps on the rear, pumping waste matter from cesspools and hauling it away through the streets.

The town is amply supplied with 220-volt electricity from a large diesel-powered plant, situated in the northeastern part of the town.

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61. McKiernan, Gerald, "Narrative and Journal in South West Africa, 1874-1879" Van Riebeeck Society Publication No. 35, 1954, Dr. P. Serton, Editor, p. 35.
62. Green, Lawrence G. "Lords of the Last Frontier," Timmins, Cape Town, 1952, p. 293.
63. The mineral content of tap water in Walvis Bay has ranged from 860 p.p.m. (September 25, 1948) to 628 p.p.m. (August 9, 1956). Information from O. Wiplinger, "Water Supplies, Central Areas, South West Africa," Water Supply Brochure No. 1, 1957. (Issued to delegates of the SARCCUS Conference at Windhoek), p. 8.
64. Increase in the growth of Walvis Bay is well indicated by the water consumption figures (from Wiplinger, loc. cit.):
- | | |
|---------|---------------------------|
| 1951-52 | 0.20 million cubic meters |
| 1956-57 | 0.55 " " " |
65. Nonetheless, the Municipality has begun the construction of such a system. "Walvis Bay is nearing the completion of their (sewerage) scheme. Tenders (bids) are now being called for the construction of the purification work." Windhoek "Advertiser," edition 3968, March 7, 1958.

A powerful commercial short wave radio station with a high mast, much used by shipping, is in the south part of town between the aerodrome and the Location (native quarter).

Harbor

Walvis Bay is the only harbor on the coast of South West Africa where a full-sized ocean-going freighter can come alongside a wharf.⁶⁶ Furthermore, it affords good protection against all winds except those from the northwest, and there are virtually no winds from that quarter.⁶⁷

The bay shoals gradually shoreward from depths of over ten fathoms near the entrance.⁶⁸ The twenty-eight foot curve is about 1.8 miles offshore, and the eighteen foot line is about one mile from the wharves. It has always been thus, for McKiernan stated⁶⁹ in 1874:

"...large vessels cannot anchor nearer than a mile from the shore in that part of the Bay opposite to which the stores have been erected."

To overcome this difficulty, a channel has been dredged to a depth of twenty-nine feet, with a width near the entrance of about 150 yards, and widening inshore to about 250 yards. It terminates in a turning basin 2150 feet long and 750 feet wide, with depths throughout of between 29 and 30 feet. The channel is marked by frequent buoys, those on the port hand entering being painted black, and those on the starboard, white. This channel leads almost directly south, at an angle of some 60° with the shoreline and the depth curves, to the wharves on the southeast side of the bay.

The tides do not pose much of a problem to the port. The mean range is only 3.5 feet, and the range of the spring tides only 4.6 feet.⁷⁰ Since the bay is so wide and open, there is no troublesome tidal current.

Pilotage in the channel and up to the docks is compulsory. The pilot boards the ship from one of the two tugs of the South African Railway and Harbors Administration at the outer end of the channel.

The main wharf or quay is of concrete, 1500 feet long by 500 feet wide. The depth alongside is 29 to 30 feet. Ships tie up here parallel to the shore; the ship comes in under its own power, is turned broadside to the wharf, and is warped in with its own cables and winches, the lines having been brought ashore by a small launch. A tug helps with the warping by nosing against the outer side of the ship, amidships. In leaving, the ship is pulled out stern first by a tug and her own engines,

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66. At Luderitzbucht, the depths alongside the wharves are seven and eight feet, and vessels must anchor off, loading and discharging cargo by lighter. "Sailing Directions for the South West Coast of Africa," U. S. Hydrographic Office Publication No. 105, 1951, p. 228.
67. Only 4% of the winds come from the northwest at Walvis Bay. *Ibid*, Appendix II, p. 280.
68. Vide: U. S. Hydrographic Office Chart No. 2267.
69. McKiernan, *op. cit.*, p. 33.
70. Hydrographic Office, *op. cit.*, p. 221.

the bow being held relatively fast to the wharf until the ship is at right angles to the dock. It is then released, and pivots through another 120° with the aid of the two tugs and her own engines till it is pointed out of the channel--at which time the two tugs cast off and she proceeds under her own power. One tug follows to pick up the pilot.

Wharfage

The wharf is fitted with 9 traveling electric cranes of four to ten tons capacity each. The wharf is served by a railway line (actually two parallel and interconnected lines on the wharf itself) and goods can be unloaded or loaded directly from ship to car or vice versa. Since the lines run lengthwise of the wharf, and thus parallel to the ships, some awkwardness is encountered; for goods from the farther end to the southwest have to be carried past all the other ships to exit. The rail lines are connected to the South West African system--which is, in turn, part of the South African system.

Cargo is worked chiefly on palettes and in nets by use of the shore cranes; ship's booms are not commonly used. Loading of bulk ore is sometimes done by means of a belt conveyor, located at the southwestern end of the quay. Single shipments of manganese ore range from four to nine thousand tons. Fish oil may be taken aboard tankers by pipelines from storage tanks nearby; and ships may be re-watered or bunkered with fuel oil and diesel oil by pipelines on the wharf. Vessels at anchor can be re-watered and refueled by lighter.

The wharf usually accommodates three ocean-going freighters or, occasionally, two freighters and two coasters. On rare occasions, more are accommodated by tying up two abeam each other, and either sending cargo to and from the outer one above the decks of the inner by shore crane, or by working cargo onto a lighter tied up on the outside by means of the freighter's own booms.

During recent years the traffic of the port has increased tremendously,⁷¹ often resulting in serious harbor congestion. The Railways and Harbours Administration of the Union government, under whose jurisdiction the port falls, has recently undertaken the extension of the present facilities.

Along the shore southwest of the wharf there is nothing today. Old piers shown on some maps⁷² are non-existent, only a few of their pilings still being visible. In the first unit of the port expansion (for which contracts have already been awarded), the quay is to be extended into this empty area for a distance of 1300 feet and ten more cranes are to be installed. The second unit calls for a further extension of 1800 feet in the same direction, and the construction of a tanker berth alongside the approach channel a quarter-mile seaward, connected with the mainland by an overhead catwalk pipeline. The first unit is due for completion in 1960; no date has been set for the second.⁷³

71. A memorandum submitted by the Walvis Bay Chamber of Commerce to the Ministry of Transport, December, 1957, stated that the volume of cargo handled has more than doubled since 1948.

72. A. Gordon-Brown, (editor), "Year Book and Guide to Southern Africa," Union Castle Mail Steamship Company, 1957, p. 584; and U. S. Hydrographic Office Chart No. 2267.

73. Statement of the General Manager of the Railways and Harbours Administration, quoted in Windhoek "Advertiser," edition 3966, Feb. 26, 1958.

At present some of the harbor congestion could be overcome by more efficient operations on the dock. The use of more mechanized equipment in place of the native laborer would be advantageous: some fork-lift trucks are in use, but more would speed up the handling of goods on the quay, and even in the holds. A realignment of the rail lines, to get trains off the dock without having to pass any ship other than the one concerned, would help. Perhaps more helpful than anything else would be the institution of two or three shifts so that operations could go on around the clock. Today only one shift works and there are, unbelievably, nine cranes and only nine crane operators in the port. If an operator is unable to work because of illness, the crane remains idle.

Except where pipeline or conveyor belt are used, loading involves an inordinate amount of hand labor. The labor is entirely Ovambo, recruited under contract from the extremely primitive northern part of South West Africa. They are a happy race of high intelligence, but under the conditions existing at Walvis Bay--where they get no training, where any initiative is stifled by the practice of working them as a herd rather than as individuals--they are extremely inefficient.

Storage

Some commodities are stored in a large warehouse in the southern part of the wharf. Ores are stored in a huge open shed with a cement floor, southwest of the end of the wharf and in two cement-lined open pits to the southeast of the shed. Much of the coarser type of ore is merely dumped on the ground in the open alongside the spur railway lines south of the wharf in the midst of a huge tract of empty land. Fish meal awaiting shipment is merely stacked in the open on any vacant land available all over the northern part of town. As shipping space becomes available, it is trucked to the wharf.

The oil storage area is at the extreme northeast end of the town. There the Shell installation can store six million gallons⁷⁴ of petrol (gasoline), paraffin (kerosene) and diesel fuels, in fourteen tanks over an area of 15 acres, and the Vacuum Oil Company can handle two million gallons of petrol, one and one-half million gallons of diesel oil, 368,000 gallons of power paraffin, and an equivalent amount of illuminating paraffin.⁷⁵

Dock Area

Southeast of the mid-point of the wharf is the exit road, through the Customs Gate⁷⁶ towards the town. At the gate on the left is the great gray bulk of the cold

74. British Imperial gallons; Windhoek "Advertiser," editions 3674 and 3745.

75. Windhoek "Advertiser," edition 3811.

76. In theory, the wharf is an area under the control of the Customs--and the gate is a symbol of that control. Actually, no one is ever on duty at the gate, and the area is not fenced. Hence it is possible to drive a truck out via the rail line to the northeast through the yard of the Walvis Bay Canning Company, and to walk out in a couple of other ways, including through the storage warehouse itself. At most times there are no more than two Customs guards on the entire length of the wharf. That there is not more smuggling and theft is due to the inherent honesty of South-Westerners, rather than to any stringent control.

storage warehouse, with its own power plant at the northeast end. Behind it to the east are several large fish oil bulk storage tanks, looking just like petroleum storage tanks. On the right at the gate is a line of low, dirty-walled, disheveled buildings housing the Customs and Port offices, the South African Railways and Harbors Police, and the shipping agents, Sturrock and Woker. The street is unpaved and full of pot-holes. There are patches of visible sidewalk, more buried under inches of sand and dust, and fragments of boardwalk. It is a dismal sight in the best weather and, with the gray fog lying overhead, it is most depressing.

Passengers arriving aboard freighters are landed directly onto the quay when their ship ties up. The mail ships of the Union Castle line, which make a brief stop of only a few hours, anchor in the bay and passengers are handled by lighter. In 1954-55, 1,152 passengers embarked at Walvis Bay and 1,328 landed.⁷⁷

Two hundred and fifth yards northeast of the wharf there is a marine railway accommodating boats up to 750 tons and measuring less than 172 feet by 30 feet. It was built originally for the killer boats of the whaling fleet, but is no longer used by them and is open to public use.

Fisheries and Canneries

Northeastward from the wharf, several canneries are lined up along the shore, each with its wharf for fishing vessels with seven to ten feet of water alongside (the one nearest to the wharf--the Walvis Bay Canning Company--has twelve feet at its dock). Each dock is equipped with a steam crane and a suction pump system for raising the catch of fish out of the boat.

Whaling. Walvis Bay has a long record as a whaling and fishing port. Whalers were at Walvis Bay before the first recorded "discovery" of the harbor.⁷⁸

In the present century the port became the base of operation for the Norwegian Antarctic whaling fleet. At first the whales were towed in to a factory here to be boiled down for their oil. In 1930, 300 whales were brought in in this fashion. With the development of the floating factory ship, this activity was transferred to the high seas, but the 14 killer boats of the fleet were overhauled here annually during the winter season while the factory ship returned to Norway. After World War II the whole operation was transferred to Cape Town and Walvis Bay was totally abandoned by the whalers.

Pilchards. Within the present decade the fishing industry has developed from virtually nothing to a major economic activity. Two fish are of prime importance: the pilchard and the snoek.

77. Windhoek Advertiser, edition 3671.

78. Pieter Pienaar, coming ashore from the ship Meermin in 1793 found huts in the Swakop river mouth apparently built by whalers, English or American, Vide: Vedder, op. cit., p. 17.

The pilchard (Sardinops ocellata) looks like a large-scale Norwegian sardine and is closely related to the herring. A similar species (Sardinella auritz) is being taken in great quantities off the Angola coast. Both are filter-feeders of migratory habits and little is known about the range of their movements. There are two main classes of pilchard boats at Walvis Bay: lamparas and purse-seiners. The first has its cabin aft and the nets have to be thrown by hand. The latter has the cabin forward, enabling the crew to pile the net up in the stern from whence it is run out as the ship cruises. Needless to say, more and more of the fishermen are turning to purse-seiners, since they require a smaller crew. There are approximately 100 pilchard fishing boats based at Walvis Bay. Most of them are wooden, powered with diesel engines, and are privately owned. The bulk of the fishermen are non-Europeans, particularly Cape Coloureds; most of them live aboard their boats.

The pilchard season runs from early March to mid-November and fishing is prohibited during the remaining period. Further conservation measures enforced by the South West Africa Administration include:⁷⁹

- 1) Regulation of the size and of the mesh dimension of nets.
- 2) Maximum capacity restriction per plant. Four plants are restricted to 30 tons per hour, and 47,875 tons per year and two others to 20 tons per hour and 31,250 per year.
- 3) A ceiling is placed on catches--250,000 tons per year per cannery.
- 4) A maximum of 25 boats per cannery is enforced (unless the cannery had more boats than that before the regulation was passed).
- 5) The carrying out of an extensive scientific fisheries research program under government sponsorship with one boat (Namib II) permanently based at Walvis Bay.

When fishing is good remarkable catches are sometimes made, often right within the Bay itself. Catches from 50 - 80 tons have been made in a single trip lasting only a few hours. In 1955, the boat "Happiness" landed 336 tons in six days.⁸⁰ At a price of four pounds per ton this is a good return.

Pilchards well lubricated with sea water are sucked by vacuum through hoses and pipes from the ship to the highly mechanized factories where they are prepared and canned under careful sanitary and scientific controls. In the canneries the labor is largely contract Ovambo, the minor bosses are Cape Coloureds or Bastards from South-West Africa, and the management and technical help is European.

The unused remains of the pilchards (heads, tails and entrails) are converted into fish oil and fish meal in highly efficient mechanized plants attached to the canneries. The total output of the canneries⁸¹ for 1951 and 1953 are shown in Table XIV.

79. Keun, I. J., "The Fabulous Fishing Industry," South West Africa Annual, 1955, pp. 15-21.

80. Windhoek Advertiser, Edition 3685.

81. Keun, op. cit., p. 19.

Table XIV
Output of Fisheries Products
Walvis Bay
 (Weight in pounds)

	<u>1951</u>	<u>1953</u>
Canned	5,225,880	21,619,287
Oil	16,000,000	21,444,460
Meal	<u>74,644,000</u>	<u>125,067,440</u>
 Total	 95,869,880	 168,131,187

Snoek. The other fish of importance is the snoek, a close relative of the barracuda. Each year 20 or 30 snoeking cutters come round from Cape Town to engage in the activity. Over a million of these fish, weighing an average of six pounds apiece, are shipped to Cape Town in the fresh-frozen or salted form annually. Two of the factories at Walvis Bay handle them. Some kabeljous, (a form of cod) are also caught and shipped fresh. Other types of fish which frequent these waters but which are not in great commercial use include steenbras, stockfish (hake), kingklip and soles.

The Town

A wide, bleak piece of empty land separates the wharf from the town. It is the realm of the wind and the dust, of rusting rail lines, of piles of ore heaped helter-skelter, of coal heaps and natives shoveling coal by hand into coal cars, of barren, gray, salty earth and dirty little seep pools.

The main street of town, Seventh Street, lies a half mile from the ships at the wharf. It runs northeast-southwest, parallel to the wharf and in conformance with the grid pattern of the town. It is paved with a mixture of salt and clay; and in this moist climate, the presence of certain deliquescent minerals (notably magnesium chloride) causes it to become damp and hence binding whenever the fog sets in. Tenders (bids) were received in July, 1958, for the tarring of Seventh Street and the road to the harbor.⁸²

Commercial District. The main street has stores only along its southeastern side--the northwestern side of the street being devoted to residences. The chief corner in town is at the point where the road⁸³ from the wharf joins the main street.

82. Windhoek Advertiser, edition 4001.

83. Curiously, this most important street is a private road, with a sign at either end stating the fact. It is the property of the Railways Administration, and in 1957 the owners threatened to close it and force the public to use a circuitous route to Main street, adding over a quarter of a mile to the distance.

The large stucco building of the Standard Bank is located there, and next to it is the ark-like wooden edifice of the Atlantic Hotel, the older of the town's two hostelrys, containing two bars and a dining room, as well as a number of bedrooms and bathrooms. A block further southwest is the Flamingo Hotel, modern, stucco, and above-average for South West Africa. It has eleven bedrooms, some with private bath, two bars, dining room, a theatre equipped with Cinemascope, and several shops. Beyond, the commercial district ends abruptly.

Northeast from the Standard Bank is the large store of Metje and Ziegler, an old, reliable German trading company, with a vast array of goods; then a line of shops of various types, and then Barklays Bank, D. C. O. Still further and still on the same side of the street, is a group of smart new buildings housing the post office,⁸⁴ the Magistrate's Office and Court, and the telephone exchange.⁸⁵ Above the building rises the tall tower of the short wave radiotelephone unit, beamed at Swakopmund, nineteen miles away.

On the opposite side of Seventh Street the residential district gives way for a little more than a block to the school (where 11 teachers were training 355 pupils in 1955) and to a large new building housing the Municipal Offices.

Just beyond, the commercial and administrative section ends, and both sides of Seventh Street become residential.

Residential Areas. The residential areas are of two distinct types, which may well be termed "pre-dike" and "post-dike." The pre-dike houses were constructed so as to rise above the occasional floods of the Kuiseb. They were wooden, frame houses, built high on stilts. To combat the sea breeze and its burden of sand and dust, they had no windows on the southwest side; and their stoeps faced northwest and were boxed in on the southwest side. Most of them were once painted yellow and now appear very drab with the coating of dust and mud that has accumulated on them. Many had picket fences, which are now completely buried in sand. They face onto streetless streets--streets that were platted, but never improved, and consist of a maze of wheel-ruts. No vines, flowers or trees relieve the barrenness of the scene. There are still several dozen of these houses left, and all are still inhabited by Europeans.

The post-dike homes, constructed by a generation that knows no fear of flood, are low, stucco houses with gently-pitched roofs. They have been built chiefly by the Railways and Harbours Administration to house the families of the workers who are being brought in in increasing numbers (120 were so employed in 1955) from the Union, and are painted in the same drab "railway yellow." They are well-built, pleasant-appearing homes. Some of the occupants, as well as the occupants of some of the privately built homes, are making valiant attempts to have flower gardens.

84. The post office has 450 mail distribution boxes. Throughout the Territory, mail is distributed only through the private boxes rented to individuals or companies, situated within the Post Office building; there is no house-to-house delivery.

85. As in most areas of the British Commonwealth, Posts and Telegraph (and hence Telephone) constitute one unified branch of the government.

Soil is brought in by the sackful each time one of the family makes a trip to the more humid lands across the desert; it is carefully placed in the future garden, behind a wall of cement blocks, boards, or tins from the canneries which formerly held tomato sauce and are now filled with sand. The results in some instances have been very rewarding. The climate is not adverse to plant growth--only the soil.

Native Quarters. To the southeast, well removed from the rest of the town, lies the native location. Throughout the Territory, natives and mixed bloods⁸⁶ live apart from the white population. In some instances, a house is provided for their use behind the home of the employer (this is particularly the case where a family employs a contract Ovambo houseboy). In all other cases, however, the native families live in the Location, an area distinctly allocated to them. Whites are not permitted in the Location without a pass, which is not freely given; and natives similarly are not allowed on the streets of the town after a certain hour unless they have a pass from their employer. While such regulations seem harsh to an outsider, they are so much a part of general custom that the local population of either group outwardly appeared to pay little attention to it. This is no commentary on conditions in the larger cities of the Union where the basic situation is vastly different.

86. The principal native groups at Walvis Bay are:

1. Herero--a tall, thin, erect people, with very dark brown skin and the usual negro characteristics. The men dress in cast-off European clothes; the women dress elaborately in copies of mid-Victorian costumes worn by the wives of the first missionaries: leg-of-mutton sleeves, tight bodices, and immense skirts.
2. Hottentot--a short, almost dwarfed people with yellow-gray to bronze skin, peppercorn hair, and strangely Mongoloid facial features. Their women develop extraordinary steatopygy (enlargement of the posterior due to storage of fat).
3. Ovambo--a tall Negro group from the northern part of the Territory, where they still live in very primitive conditions. Only the men come to the European portions, under labor contract arrangements made with the South West Africa Native Labor Association (SWANLA) and closely controlled by the Administration.

Only a very few of the Hottentots are of local origin; all the other natives come from the higher interior of the Territory.

In addition, Walvis Bay has a considerable population of Cape Coloureds--largely associated with the fisheries. A mixture of white, Malay, and Hottentot indigenous to the Cape Province, these people have a role intermediate between the native and the European. There are also some Coloureds from South West Africa, representing mixtures between Europeans and members of any of the indigenous tribes; and some Bastards from the Rehoboth Gebiet in the interior--a special type of Coloured resulting from inter-marriage (as distinct from inter-mating) between certain Boers (Dutch farmers) and Hottentot women in the northern interior of the Cape Province over a century ago.

The Location at Walvis Bay is a shanty town constructed largely of pieces of sheet metal and flattened tin cans nailed over a framework of wood. Many of the houses are windowless. Cooking is done over an open fire in the dooryard, usually in a three-legged cast iron pot (universally called a "Kaffir-pot"). Water is supplied by the Municipality; it is run to open taps scattered about the area. Bucket privies, constructed and serviced by the Municipality, constitute the sanitary facilities. Despite the primitiveness, the Locations are not usually dirty places: there is no litter of garbage, refuse or jumbled storage heaps; nor do they constitute a serious health hazard.

The Ovambo laborers at the canneries are housed nearby in large compounds, which consist of well-built structures in which the men sleep dormitory style, and where they are fed by a cook staff employed by the company. The Ovambos (345 in 1955) in the employ of the Railways and Harbours Administration live in a compound on the opposite side of town from the wharf, in the direction of the Location. At starting and quitting times, they can be seen in large numbers, walking to or from work through the center of the business district.

Industry

With an active port and a prosperous fishing industry, it is only to be expected that industry will be attracted to the city. The first of such enterprises appeared in December 1957 with the opening of an industry subsidiary to the fish canneries: a factory for the high speed production of tin cans.⁸⁷ It is likely that a number of other industrial developments will occur in the near future and will occupy some of the empty land between the water front and the main streets.

Population Growth

The rapid expansion of the fisheries, the industry, and the increase in port business has resulted in a sudden prosperity and a major boom in Walvis Bay. The town received municipal status back in 1931 but remained an unimportant shack town until after World War II. In 1946 it had a total population (all races) of only 600. By 1952 this had increased to 6900, of whom the Europeans numbered 1500, the Coloureds 400, and the natives about 5000. In 1957 the total was estimated to be about 9000 including 3000 whites, 2000 Coloureds and local natives, and some 4000 contract Ovambo laborers.

Foreign Trade

Exports from Walvis Bay consist of overseas shipments of canned and frozen fish (especially pilchard) and lobster, fish meal and fish oil, ore and ore concentrates (especially lead and manganese), karakul pelts and wool; and shipments of frozen and canned beef, butter and cheese bound for the Union of South Africa. Imports from northwestern Europe (particularly the United Kingdom, Germany, Switzerland and Scandinavia) and from the United States are composed chiefly of manufactured goods and petroleum products. Exports exceed imports in value, bulk and tonnage. Ships of all flags call, but the most frequent visitors are of South African, English, German, Dutch, and American registry.

87. Windhoek Advertiser, edition 3971, March 18, 1957.

Political Situation

Politically, Walvis Bay occupies a curious position. From the 1880's to 1915, it was a British enclave within the old German colony; but when the mandate was established, it became attached for convenience to South West Africa. Today it is in almost every way a part and parcel of the mandated territory; South West African currency and postage are used. Local automobiles bear plates marked "Sd" for Swakopmund, for it is considered part of the Swakopmund magisterial district. Yet technically it is still an outlier of the Cape Province of the Union of South Africa.

The effects of the long English background are still present. This is the only town in South West Africa where the minutes of the town council are kept in English--and a motion proposing that they be kept in Afrikaans or bilingually was defeated at a council meeting in September 1956.⁸⁸

It is the only town in the territory where a goodly portion of the natives speak English.

Until World War I it was completely English. In the period between the wars a few German business firms were established here--often as branches of larger houses with headquarters in Windhoek (such as Metje and Ziegler). With the boom, large numbers of Afrikaners have come in, especially in connection with the railways and municipal and Administration activities. The English still dominate in administrative and technical positions in the canneries, the shipping offices, and municipal affairs, but Administration affairs (including the courts, the post and telegraph, the customs, the police and the railways) are in the hands of the Afrikaans-speaking group. Businesses are divided trilingually and Germans are significant in the retail trade and the shipping offices.

Swakopmund

(Landscape Type I - E)

As one approaches Swakopmund from the landward, coming out of the wastes of the Namib, it seems unreal. In the foreground is the vast, flat emptiness of the desert. In the distance is the sea, blue or gray, depending upon the time of day, and the location of the gray wall of the fog. Between is Swakopmund with towers and turrets and castles. Even close up, the place continues to seem unusual.

History

Swakopmund was formerly the chief port for the old German territory of South-West Africa. It was constructed by the Germans, beginning in 1892, because they had no other place along the entire coast of the central and northern part of the territory where goods could be landed. Walvis Bay and its immediate environment had been taken over a decade earlier by the British and the proud Germans would not have used it had they been invited.

There was nothing here but an open roadstead and a long stretch of beach on which the southwest rollers pounded incessantly. True, the sweep of the rollers is

88. Windhoek Advertiser, edition 3823, October 5, 1956.

broken somewhat by the presence of Pelican Point more or less to the windward, but nonetheless the surf here is still very respectable. With great effort the Germans constructed a long iron pier (locally called "the jetty") and equipped it with cranes by which goods could be lifted from surf boats loaded from the steamers lying in the roadstead offshore. Goods that could "take it" were frequently floated ashore in the surf, and it is said that cavalry horses were dropped overboard in slings and forced to swim ashore.

After World War I the Territory came under the control of the Union of South Africa, and the separation between Walvis Bay and Swakopmund no longer existed. A railway line was constructed down the coast to that well protected harbor and Swakopmund was abandoned as a port. Although now it is officially closed, its lighthouse (so much a symbol of the town that it appears on the coat of arms of the municipality) still operates from its 92 foot tower. Ironically, it is still the major light of the southwest African coast, though it functions for a deceased port. Gradually in the last two years its function and its personnel are being shifted to Pelican Point at the entrance to Walvis Bay.

The beach suffered a pronounced change as a result of the 1934 flood. In that year the Swakop River ran for over three months--a most unusual occurrence--and built its delta seaward for over one and a quarter miles leaving the pier stranded far inland. For years afterward the pier was used as a promenade reaching out from the shoreline across a waste of sand. During the intervening years the beach has gradually eroded but only in 1956 did it reach its original shoreline, 22 years after the flood. The deltal materials were carried away northward by the littoral current.

Social Life

With the demise of the port, the town of Swakopmund took on a second role--that of summer capital and spa of the territory. In contrast with other areas wherein the lowland capital goes to the hills during the summer,⁸⁹ the government here moves down from Windhoek (6000 feet up in the interior plateaus) to this cool, foggy littoral. Usually the move takes place a couple of weeks before Christmas and the return occurs late in January or early in February. The result is that the town of Swakopmund becomes the center of social life for the Territory. Everyone of consequence, farmer, businessman or government administrator, feels that he must be seen in Swakopmund during this period. The winter population which numbered 1861 in 1951 (Europeans only) swells suddenly to 3000, with probably nearer 5000 on weekends and over the Christmas-New Year holiday. All of the five hotels are filled to overflowing as well as a number of boardinghouses. Every vacant room in private homes is occupied by friends or paying guests; a tent colony operated by the municipality springs up on the beach, and over Christmas, the railways even rent space in sleeping cars parked on sidings in the station. For two months Swakopmund is the place of South West Africa.

Site

The town is situated on a marine terrace about sixty feet above sea level just north of the mouth of the Swakop River. The flatness of the terrain has allowed a

89. Spencer, Joseph E. and W. E. Thomas, "Hill Stations and Summer Resorts of the Orient," Geographical Review, October 1948, Vol. 38, pp. 637-651.

rudimentary rectangular grid pattern to develop, oriented more or less north-south and east-west and at approximately right angles to the beach (See Plate XVI). The town is almost broken into two parts by the barrier of the railway lines across which there is no grade crossing. The streets are very broad and straight and often have a line of powerline poles down the center. The houses and stores are built practically on the street separated from it only by the "pavement" or sidewalk. The main roads are paved with a mixture of salt and clay making a good surface which holds down the dust and binds the sand particles together. The minor roads are wide wastes of rutted sand; it is not unusual for cars to get stuck right in the middle of such streets.

Water Supply

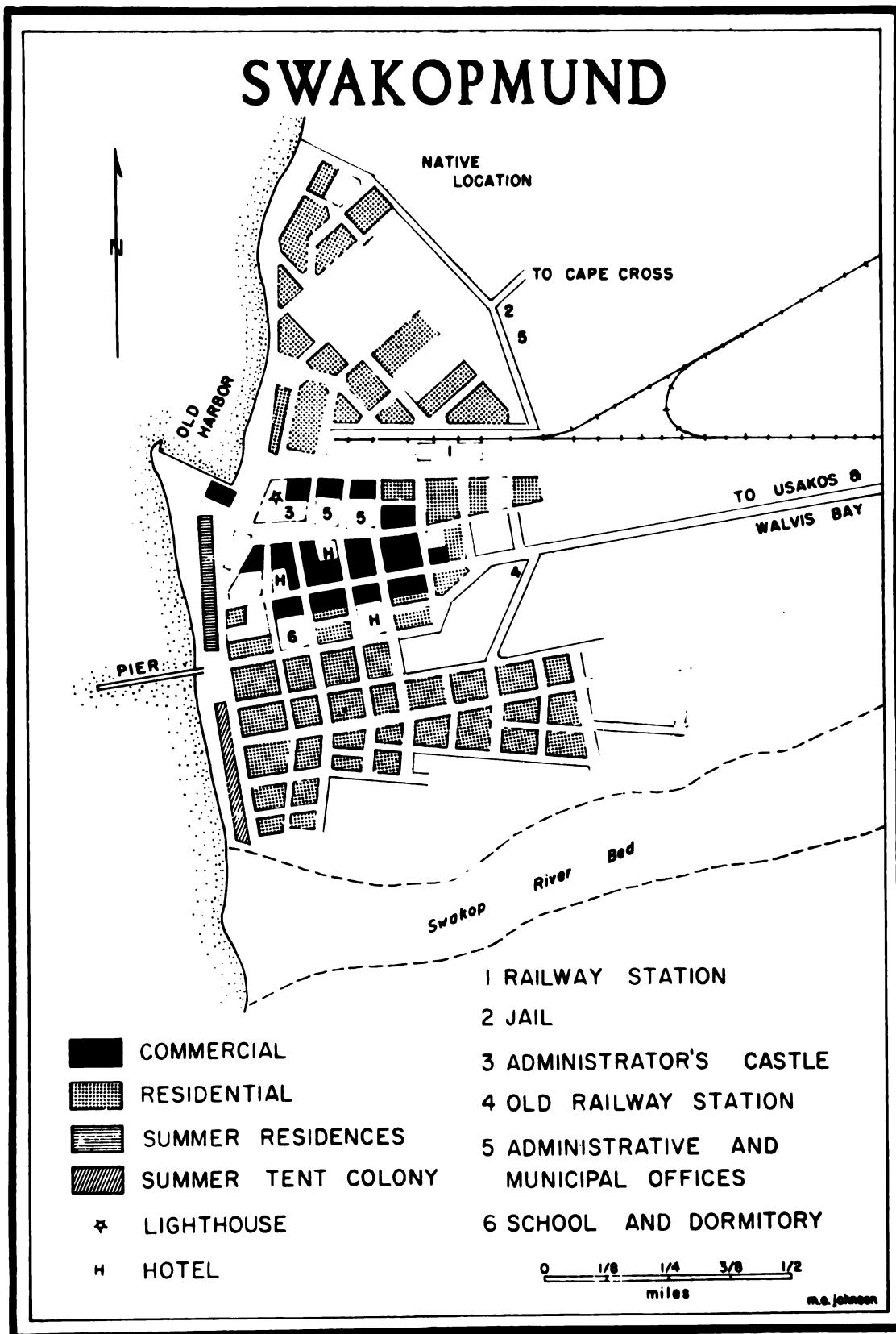
The town has water "laid on" (i.e., running water) supplied from a series of tube wells and bore holes in the bed of the Swakop River adjacent to the town. Its quality leaves something to be desired: it ranges from about 400 parts per million dissolved salts (after the 1934 flood) to as high as 4650 p.p.m. in drought years (September 25, 1948). The "normal" for the present time is pretty high: November 30, 1956 had 4286 p.p.m.⁹⁰ At that time the writer found it ideal for flushing toilets --and little else. When used for showering it merely rearranged the pattern of dirt, and left the person washed feeling even stickier than before. The local residents make coffee and tea with it; and grow so used to the taste that they salt coffee or tea made with ordinary water when visiting other towns.

The Water Resources Branch of the Administration is trying valiantly to improve the situation. The original bore hole sunk in the German time lay immediately south of the town in the bed of the Swakop River about 2000 feet from the coast. In the present decade several tube wells have been put down slightly up stream from the original well. Studies of the river channel have shown that the lower zones contain the most brackish water, and that the fresher water lies atop nearer the surface. Unfortunately there is an insufficient amount of this fresh water to supply the town adequately, especially during the drier years. Hence at present salt water from the deeper zone is mixed with the fresh water from above to provide a mixture of the quality described above--poor but still usable.

To further augment the supply, sheet piling has been driven down to bedrock across the entire width of the stream bed upstream from the well in order to impede the flow of the water downstream through the sediment. Small openings at the base of the piling force all water, fresh and salt alike, to mix thoroughly before flowing on downstream. Formerly the fresh water after floods flowed directly into the sea, being unable to displace the saltier water beneath. Hence the usable part of the sub-flow was lost. It is now planned to pump out the extremely salty water from the lower level when it becomes strongly concentrated during drought, and discharge it directly into the sea in order to make room for the infiltration of new fresh water during the next flood. A system of interconnecting pipes between certain of the tube wells will also aid in the intermixing of the two qualities of water.

To obtain a more potable water supply, the Municipality has an agreement with the Railways whereby a tank car of water is hauled from Walvis Bay on alternate days. This water is sold to the public on a cash and carry basis for a tickie (3 pennies) per

90. Data from Wipplinger, op. cit. pp. 6-9.



gallon. In restaurants it is necessary to specify that one desires "Walvis tea" or "Walvis coffee"--otherwise, the beverage will be made with the salty local water.

On the alternate days the tank car is used to haul water for the local brewery which produces several forms of excellent German-type beer. This beer is shipped all over South West Africa--a curious export for a practically waterless town!

The railways both on the trains, at the station and in the station cafe use neither Swakop water nor Walvis water but water brought by tank car from their own wells at Usakos nearly 100 miles to the northeast. This water is brought down on the way freights to supply the gangers' (section foremen) cottages and the native pondoks (huts) along the railroad, and what water is left over is used at Swakopmund.⁹¹

Other Public Utilities

The town is supplied with 220-volt electricity from a new diesel powered station recently completed (1958) near the eastern end of town. Its output is approximately 1000 kilowatts.⁹² While the town still resorts to cesspools and bucket privies a water-borne sewerage system is under construction and it is hoped that it will be in operation by 1959. A sewerage disposal plant is being constructed at the coast one mile north of town.⁹³

Swakopmund is connected with Walvis Bay by short wave radio-telephone and with the rest of the Territory by ordinary telephone.

Swakopmund is on the main line of the South African Railway between Walvis Bay and the rest of the territory. The Windhoek line formerly came into the town from the northeast, skirted the town to the southeast and crossed the Swakop River near its mouth. The destruction of the bridge in the flood of 1934 and the subsequent relocation of it four miles upstream resulted in a most curious rearrangement. A new station was built north of the center of the town and the line from Windhoek extended past it to a dead end a couple hundred yards beyond. The line to Walvis Bay was curved back from the new bridge and fed into the main line a few hundred yards east of the station (see Plate XVI). Thus the station is actually on a spur line. A train from Windhoek bound for Walvis Bay pulls into the station; the engine is uncoupled and pulls forward to the end of the line; backing up, it is switched over to another parallel track and, passing its own train, runs out on the Walvis line; reversing it is switched by way of a half circular curving crossover onto the Windhoek line. Facing in an outbound direction, it then backs into the station again and is coupled to what was formerly the rear end of the train. The cars are then pulled "backward" all the way to Walvis Bay.

The town has the usual facilities providing most of the necessities of modern life: a number of stores and shops including up-to-date appliances, a good photo supply house, excellent jewellers and watchmakers, garages with first-class mechanics, gas stations and grocery stores, a butchery, a bakery and even a dairy.

91. Even the ganger's cottages and the native compounds at Rand Rifles, in the dunes fifteen miles from Walvis Bay, are supplied from the Usakos source.

92. Windhoek "Advertiser" edition 3966, February 28, 1958.

93. Windhoek "Advertiser" edition 3968, March 7, 1958.

Milk, bread and vegetables are likely to be in short supply during the "season"; but most other goods are generally available within reason. There is an active arts association, a cinema and a surprisingly fine museum of local history and natural science.

German Influence

The excellence and the quality of many services and amenities listed above can be attributed to the fact that the predominant ethnic group in Swakopmund is German. The town, like all of South West Africa, is officially bilingual (Afrikaans and English); but above all it is German. During the winter the white population is almost entirely German.

The German influence shows visibly in the architecture. The stucco buildings invariably have some feature imported from the old country: overhanging balconies, patches of half-timbering, curiously-shaped facades, ornate cornices, buildings surmounted by towers and turrets. The Administrator's summer residence is a real castle (built for the German governor) and one of the school hostels (dormitories) has a tall watchtower. Some buildings have very steep roofs to shunt off the winter snows of Germany--in a land where snow has never fallen! The most ornate of buildings is the jail--so elaborate it is often mistaken for the Administrator's castle.

To the north of town lies the Location, the usual collection of shacks made by flattening out all manner of tin cans and pieces of sheet metal and nailing them over a framework of wood. It houses approximately one thousand natives, largely Hereros, Berg Damaras and Hottentots who do manual labor in town.

Still further north is the new beachside community of Vineta largely developed since World War II. It has a number of nice modernistic bungalows largely built by people from Windhoek and other inland towns and occupied during the summer "season."

This then is Swakopmund; a bit of old Germany set down in the grey fog on the drab edge of the Namib. Cold and clammy, it has become the beach resort and summer capital of sun drenched South West Africa. Here in the season crowds of people of three language groups walk the salty streets, lie on the beach, sip tea and eat ices and listen to lilting German music at the Strand Cafe on the old mole of the abandoned harbor; walk beneath the Araucarias and look at the desert succulents in the carefully tended little "Namib garden," (the only green spot in town besides the cemetery) and dance and drink Swakop beer in the casino of the largest hotel. The rest of the year it is just a quiet, seaside town.

Accessibility of the Coastal Namib

South of Walvis Bay

From the southernmost corner of the town of Walvis Bay, a sinuous line of poles marks the best route toward Sandwich Harbor across eight miles of treacherous mud flats which are submerged at high tide. At the end, several wheel tracks diverge; some go rather directly between the dunes westward to the foreshore; others head southward across miles of pan. Because of its flatness, the pan would seem to offer the best route. And so it does, for the foot traveler in dry weather and periods

of low tide or low ground water. But for the wheeled vehicle, or in times of moistness, considerable difficulty may be encountered.

The pan surface is usually subject to the results of strong capillary action: water is drawn to the surface from below, and is evaporated there, leaving behind its abnormally heavy load of dissolved minerals. Later, water drawn up in similar fashion, builds its mineral load atop the previous accumulation: thus "self-rising ground" develops. When a deep layer of such materials has been built up--frequently to a depth of a foot--it offers real resistance to the operation of a two-wheel-drive vehicle. However, in a dry state, the pans are easily traversed by four-wheel-drive vehicles at a moderate speed--although the gasoline consumption is inordinately high.

When wet, the pan becomes utterly impassable by any kind of vehicle, or even afoot. The surface becomes plastic; the mud clings to the wheel or foot, and the vehicle or the pedestrian founders within a few yards of shore. At such times, the pans must be strenuously avoided.

Eventually, at a distance of some twenty miles from Walvis Bay, all of the routes are forced to the beach by the westward trend of the Great Sand Dunes. Travel along the beach is usually very difficult: four-wheel-drive is necessary all the way, hence petrol consumption is high and the speed slow; and the sand is treacherous, with occasional soft patches. Vehicles usually travel as close as possible to the edge of the surf, as the sand is more firm there; but at the same time the risk is greater there for if the vehicle bogs down it is vulnerable to the rising tide.

Near the north end of the Sandwich Lagoon the route diverges inland from the beach, crosses the salt marshes by a series of fords and islands, and terminates at Anichab, the werf of Hans von Braus on the east side of the lagoon nearly opposite the opening in the bar.

South of this point there is no route whatever. Under some conditions, and obviously at the lowest stages of the tide, it may be possible to ford the inlet. This is exceedingly dangerous, however; police patrols from Walvis Bay have done it successfully several times; but in 1955, a jeep and a lorry were lost in the inlet and never recovered. The Harbour cannot be passed along the eastern side, because in places the Great Sand Dunes come to the water's edge, leaving no room for passage.

Beyond, there is only the trackless waste where the Great Sand Dunes fall directly into the surf--where the beach changes from tide to tide. No route has been improved or even marked out. That a road down this coast is shown on the Aeronautical Charts⁹⁴ is purely the work of the imagination of a desk-bound cartographer who had no knowledge of the area. It is one of the most inaccessible and dangerous areas in the world, the realm of the sea-bird, the seal and the jackal, but not of Man.

94. World Aeronautical Chart, No. 1273 "Pelican Point" scale 1:1,000,000, Aeronautical Chart Service, U. S. Air Force, Washington, D. C., 1948.

Walvis Bay--Swakopmund

Railway. Quite different is the transportation situation northward from Walvis Bay. From that port, the main line of the South African railways⁹⁵ runs northward along the coast, and a main road connects the port with the rest of the territory.

From Walvis Bay, the railroad skirts the shore past the sidings of Cables and Rand Rifles. To the east, the Great Sand Dunes tower above it like a great wall. Beyond Rand Rifles (ten miles from Walvis Bay), it passes inland between the dunes for several miles, but eventually returns to the coast which it follows to the Swakop River mouth. Despite the efforts of a crew of natives under the supervision of a white "ganger" (section foreman) kept permanently at Rand Rifles, the railway is not infrequently blocked by encroaching sand dunes for hours or even days during the winter when the East Wind is blowing. The daily southwest sea breeze causes little drifting--hence there is no problem in the summer.

The railway originally crossed the Swakop River only a few score yards inland from its mouth. But the footings for the bridge were not well based and the bridge was destroyed in the floods of 1934. The route was then relocated on a bedrock footing in the narrows of the river four miles inland.

Highway. At the present time a highway route is under construction along the route of the railway including even a crossing of the river at the former bridge site. Being entirely within the fog belt, the road will be surfaced with a salt and clay mixture that has proven so successful elsewhere in the vicinity.

However, it is to be expected that the new road will suffer as the railway always had from invasions of drifting sand during periods of the east wind.

The existing highway leaves the northeast limits of Walvis Bay and turns abruptly southeast for three miles across the delta of the Kuiseb River. This area presents real difficulties for the road maintenance crews. The foundation is extremely poor: sandy patches soon "chew out" under the wheels of trucks and cars, making so deep a hole that it is not at all unusual for a standard car to get stuck in the middle of the highway in broad daylight in good weather. When moist some of the clayey material swells and rises up in the road, while other types squeeze away from the weight of vehicles passing over creating potholes.

Equally bad is the persistence of the drift sand. At several points the present road is forced around the point of advancing dunes where the sand is continually invading the road. Here the road can be scraped and in good condition at 10 a.m., and be nearly impassable by 3 p.m.

95. The railways of the Territory are an integral part of the South African railway system, and are operated directly by the South African Railways and Harbours Administration, a branch of the Union Government. They are not in any way under the authority of the South West Africa Administration. The engines are entirely coal-burning, the fuel being imported by rail from the Transvaal. The rails are laid on wooden "sleepers" (ties) in the fog belt because of the rapid rusting of iron. The gauge is the standard gauge of the Union--3' 6".

This whole situation might be improved, though at considerable expense, by:

1) Excavating a ten-foot trench considerably wider than the road, filling it with crushed rock, topping it with gravel and tarring the surface. This would take care of the sinking and rising of mud, the sand pits, and would give a firm base from which to scrape the sand.

2) Spraying the windward (S.W.) sides of the encroaching dunes with light oil to deter their encroachment.

However, the construction of the new road along the coast northward to Swakopmund may remove the necessity for maintenance on this road and thus solve the problems mentioned here.

After passing the southern end of the massive sand dunes which flank the coast, the road turns north and divides into three parts: one runs north immediately in the lee of the sand dunes, remaining usually within one-quarter to one-half mile of the dune-foot. The second skirts the western edge of the gravel terraces of the western Namib rising and falling in this dissected belt. The third road continues eastward rising to the surface of the terraces and not turning north until well clear of the dissected zone some eight miles east of Walvis Bay.

Because all of these routes lie east of the sand dunes the air which passes over them during the day is warmed by the radiation from the sand surface and is reduced greatly in humidity. Consequently it is not feasible to surface the road with salt and clay. Because it is situated close to the dunes there is an overly large admixture of sand in the road bed of the westernmost route and sand drifts into the road from the daily southwest winds at a rapid rate. The other two routes have less difficulty with sand but have a tendency to "wash board" or "corrugate" excessively. The Roads Department of the South West Africa Administration grades the three routes frequently but it is always a moot question whether to endure the endless corrugation of the upper routes or to risk being stuck in the deeper drift sand of the lower.

South of the Swakop River, the three roads reunite, and ford the stream just above the railway bridge. During those rare periods when the Swakop (and the Kuiseb, for that matter) is in flood, the road becomes impassable, and the only connections between Walvis Bay and Swakopmund are by rail or air.

Northward of Swakopmund a fine well-maintained salt road leads northward to the salt pans and the seal rookeries, terminating at Cape Cross. It parallels the coast, seldom more than a mile inland.

Air. Three landing fields are situated within the Walvis Bay--Swakopmund area. On the flat gravelly terrace-top crossed by the easternmost Walvis Bay-Swakopmund road is the abandoned Rooikop Aerodrome, used by planes of the South African Air Force as a submarine patrol base during World War II. It is still used occasionally when the regular fields are fog-bound. Its longest runway is about one mile in length.

On the broad mud flats adjacent to the lagoon in the south corner of Walvis Bay lies the official aerodrome of that municipality. Its runway, which is pointed into the sea-breeze, is 2500 feet long. There is no control, no radio and no lighting. The

field is used by South West Air Transport (a private company) as terminus for its service from Windhoek. Its first scheduled biweekly flight with mail and passengers was made on August 2, 1956;⁹⁶ as of December 1, 1957, the service was extended to six flights per week, carrying passengers, freight and 300 kilograms of mail per month.⁹⁷

On arriving over Walvis Bay, planes usually buzz the Shell installations at the northeast end of the town, whereupon a truck for refueling and a taxi for passengers are dispatched to the aerodrome.

The Swakopmund aerodrome is located about 3 miles inland from the town, on the outer edge of a gravel terrace at an elevation of about 250 feet. Its gravelly runway is 3100 feet long and oriented approximately east and west. There is no control, no lighting and no radio. There are three small hangars, privately owned, at the field. Upon request, SWAT will extend its Windhoek-Walvis Bay flight to pick up or drop passengers at Swakopmund, but there is no regularly scheduled service. Planes arriving unexpectedly usually buzz the home and store of Hans Kriess, Swakopmund merchant, who sends out a refueling truck and a car to bring in passengers.

Chapter IV

THE NAMIB PLATFORM

(Sub-Region II)

One of the most striking aspects of the Namib north of the Kuiseb River is the monotonously flat plain referred to herein as the Namib Platform. In its western part, it descends below the waves of the Atlantic; at its eastern margin it lies 3000 feet above sea level; but the rise across the intervening eighty miles is so gradual as to be imperceptible to even the keenest observer.

Despite its apparent monotony, it actually has considerable variation, as will be disclosed in the section on Landscape Types. Its most conspicuous differences result from contrasts in landforms (inselberge vs. flats); soil (gravel flats vs. pediments); water supply (exotic streambeds in contrast with the uplands); and climate (the Inner vs. the Outer Namib).

Geology

As far as is determinable in the light of present knowledge, all of the Namib Platform in the area under consideration is underlain by rocks of the basement complex or by certain granites very anciently intruded into them.

The most widespread and most characteristic (although not the most conspicuous) formation in the area is the great mass of mica schist which constitutes the upper part of the Damara system. Grading all the way from almost pure biotite-muscovite schists to micaceous quartzites, these beds are found from sea level at the coast to the tops of the Khomas Hochland well over a mile above the sea. Although silver grey on close inspection when fresh, they commonly appear darker on weathering, often become almost black and making a dark and foreboding landscape. Over great expanses they strike in a northeast-southwest direction. Certain more arenaceous layers resist weathering somewhat and stand as ridges above the troughs eroded in their weaker neighbors--hence the country takes on a corrugated aspect of low relief. The age of the formation is undoubtedly pre-Cambrian, probably Archaean.⁹⁸

98. For further more detailed description of the bedrock geology and of the disputes regarding the age relationships, the reader is referred to:

1. Gevers, T. W. Geology of Northwestern Damaraland in South-West Africa. Geological Society of South Africa, Transactions, Vol. 32, 1929, pp. 31-55.
2. Gevers, T. W. The Morphology of Western Damaraland and the Adjoining Namib Desert of South West Africa, South African Geographical Journal, Vol. 19 (1936), pp. 61-79.
3. Reuning, E. "Der Intrusionsverband der Granite des mittleren Hereroland und des angrenzenden Küstengebietes in Südwest-Afrika," Geologische Rundschau, Vol. 14 (1923), pp. 232-239.
4. Wagner, Percy Albert. Geology and Mineral Industries of South West Africa, Geological Survey, Memoir No. 7, Pretoria (1916).

Stratigraphically below the mica schists (which are often called the Khomas series) and sometimes interbedded with them, lie a number of bands of crystalline marbles. Their pristine whiteness in contrast with the darkness of the schists makes them conspicuous from afar. Often they consist of a very heavy massive bed accompanied by a varying number of thinner beds above and below. Like the schists they evidence great folding and metamorphism.

Still lower stratigraphically is the quartzite series consisting of four members: the Chuos tillite, the Khan quartzite, the Chuos quartzite, and a basal conglomerate. The chuos tillite⁹⁹ is a fossilized glacial deposit with many wheel-striated stones indicating its boulder-clay origin. It possibly can be correlated with the Keewatin of North America.

The Khan is a dark green quartzite with some included masses of a dark gray phyllite. The Chuos, on the other hand, is a more massive red-brown quartzite prominent as a ridge-maker. The basal conglomerate has little importance to this study.

Intruded into these schists, marbles and quartzites of the Damara system are a group of granites. Their age is indefinite but they may very well also be pre-Cambrian. The most important one is the Salem, a grey porphyritic biotite granite with tabular phenocrysts of orthoclase and microcline feldspar, often exhibiting conspicuous carlsbad twinning.

Geomorphology

The Namib Platform is one of several erosion surfaces displayed extensively in South West Africa. The highest and oldest surface is probably the now-dissected plateau of the Khomas Hochland. Its age is in dispute: King¹⁰⁰ believes this may possibly be part of the Jurassic plain of southern Africa; Martin¹⁰¹ believes it to be a pre-Karoo (Karoo = Permian-Triassic) surface re-exposed after burial under sediment and lavas; whereas Gevers¹⁰² made it simply a late Cretaceous surface. At a somewhat lower level and intersecting the Khomas surface either with an escarpment or by low-angled juncture surfaces are the plains of Damaraland. These, King believes to be part of the South African Miocene peneplain, although Cretaceous elements may enter the picture in places.

Either at a lower level than, or merging into the plains of Damaraland is the Namib Platform, the surface with which we are primarily concerned here. Two theories have been advanced to explain its extraordinary flatness. The earlier geologists¹⁰³ pronounced it a surface of marine planation: a natural enough assumption since it slopes off so smoothly into the present ocean. Later writers, however, have leaned toward subaerial agencies as the major causative factors.

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99. Gevers T. W. "An Ancient Tillite in South West Africa," Geological Society of South Africa, Transactions Vol. 34 (1931), pp. 1-17.
 100. Lester C. King, "Scenery of South Africa," pp. 291-292.
 101. Dr. Henno Martin, Personal Communication, 1957.
 102. Gevers, T. W., op. cit. (1936), p. 67.
 103. These are reviewed in Gevers, op. cit., (1936), p. 78.

This writer has no doubt in his mind. It is unquestionably a peneplain, a statement which can be supported by a number of facts:

- 1) The surface is broken by scattered unreduced remnants standing as monadnocks or inselberge well above the present flat level.
- 2) These become increasingly plentiful eastward away from the ocean and towards the retreating escarpment.
- 3) The escarpment presents a face typical of an area of stream erosion and cliff recession with valleys of all sorts and sizes fretting its westward face and with numerous rugged, detached outliers in front of it.
- 4) The Namib surface extends with accordant surfaces into each of these valleys.
- 5) In the neighborhood of Usakos the surface continues far back inland and eventually merges with the peneplain of Damaraland.
- 6) There is no evidence of marine activity except in the last few miles seaward and the lowest few hundred feet altitudinally. There it is clear and unmistakable.
- 7) Even on the outermost inselberge or monadnocks there are no evidences of wave-cut platforms nor any forms other than what would be produced by normal desert erosion under a climate like that existing today.

As to its age and its relations with the peneplains of the interior there is no agreement, nor does the writer have strong ideas. Kaiser¹⁰⁴ considered it to be the result of humid peneplanation during the late Cretaceous. This has been accepted by King¹⁰⁵ who presents the following sequence of events:

- 1) Peneplanation during the Cretaceous.
- 2) Marginal submergence during the Eocene.
- 3) A re-elevation during the Miocene with resultant incision of streams into the platform.
- 4) Increasing aridity with resultant excess of sediment.

The detailed description of the various parts of this peneplain surface and its superincumbent materials will be treated separately in the following section dealing with the individual landscape types and unit areas.

104. Kaiser, E., Die Diamantenwüste Südwestafrikas, Berlin, 1926.

105. King, op. cit., p. 318.

Landscape Types of the Namib Platform

In this section the Namib Platform will be subdivided for more detailed description into a number of typical areas, each with distinctive landforms and vegetative characteristics. Inasmuch as the rainfall increases across the area from west to east, there is a corresponding change in the nature of vegetation. Consequently, in many cases two variations of the same landscape type will be described.

Gravel Flats of the Outer Namib

(Landscape Type II - A)

In the coastal portion of the Namib there occur vast expanses of completely barren, gravelly country of unbelievable flatness--areas of extraordinarily monotonous appearance, almost totally devoid of vegetation. In many cases their extent is measurable in tens of miles, while their relief can be measured in inches per acre.

At certain localities in the area immediately adjacent to the coast, several levels of flats may be recognized, separated from one another by somewhat dissected escarpments. These are apparently former marine terraces representing successive uplifts of the region. Earlier writers (as mentioned above) attributed the geomorphology of the entire desert to marine abrasion and cited these terraces as evidence thereof. While the writer is inclined to agree with King that marine encroachment was probably limited to the coastal region and that only the more seaward of the flats are of marine origin, it would be difficult to prove either thesis conclusively.

A good example of the marine terraces and the intervening partly-eroded scarp is to be seen north of the Kuiseb River between Walvis Bay and the Rooikop. The dunes northeast of Walvis Bay have been constructed atop a lower terrace just a little above the present sea level. The lowest (westernmost) road from Walvis Bay toward Swakopmund traverses it through the southernmost dozen miles. Farther inland, this terrace is succeeded by the higher Namib Platform, whose featureless surface sweeps eastward for scores of miles. Aside from its slightly dissected seaward face, the deep trenches of its major stream valleys, and occasional un-reduced remnants of bedrock, its monotonous level is uninterrupted. (See Figure 2)

Actually, this is not a level surface, but a gentle slope which carried the Namib Platform (and its accordant gravel flats and pediplains) up from the coast to a 3000 foot elevation at the foot of the Great Western Escarpment eighty miles inland--about 40 feet per mile.

Typical sites of the gravel flats show a slight to moderate development of desert pavement. This is seldom a strong development, owing perhaps to a lack of large pebbles in the travel. Surfaces such as those developed on the relict bajadas of Arizona or on the fluvial terraces of the Colorado Valley in California are strikingly absent. Frequently the "pebbles" are less than 1/4" in diameter and cover no more than 10% of the surface. In a few instances, where coarser materials are present, the pebble cover is more complete, but seldom does it exceed 50%. Occasionally the pebbles are distinctive for their mineralogical composition: there are areas surfaced chiefly with milky quartz pebbles derived originally from inclusions in the mica schist. Elsewhere they are composed of small, rounded water-white to pale yellow quartz.



Figure 2. The Gravel Flats of the Outer Namib are of almost unbelievable monotony. Over large areas, their local relief can be measured in inches per acre.

Some localities have white marble pebbles on which dew-rilling is visible. The larger stones are frequently beveled as a result of wind polish: true dreikanterers sometimes occur, but textbook examples are rare. The smaller pebbles are often rounded into teardrop or more elongated dog-toothed form, apparently as a result of sandblast combined with repeated rolling into new positions.

The colors of the landscape vary from gray-white through gray and yellow-gray to yellow. In some places, the individual pebbles may be darker, but they make up so small a part of the total surface that their darkness is diluted by the far larger exposure of the lighter colored sands.

The zone immediately beneath the surface is composed of the original parent gravel. The writer failed to detect anything resembling the illuviated zone commonly present beneath the desert pavement of the Southwestern United States. This is to be expected, of course, in view of the much lower rainfall of this area. The parent gravel varies greatly in composition depending upon the nature of the materials from which it was derived, and few generalizations can be made about it. Walter¹⁰⁶ states

106. Walter, Heinrich, "Die Ökologischen Verhältnisse in der Namib-Nebelwüste (SWA) unter Auswertung des Aufzeichnungen des Dr. G. Boss (Swakopmund)", Pringheims Jahrb. Wiss. Bot., V. LXXXIV, p. 135.

that the surface is salt-free but a slight saltiness was encountered in the lower layers (2740 ppm NaCl dry weight; 33,400 ppm Na₂SO₄). Actually, while no quantitative measurements were made, it was found that the exteriors of the surface pebbles frequently had a salty taste.

Though over the depth of an inch or so the soil may be cemented by either lime or gypsum or a combination of the two, to the writer's knowledge cementation of the actual surface material never occurs and in some instances the top of the cemented layers is well over a foot beneath the surface. In all areas investigated, however, cementation to some degree did occur in the upper 2 feet of the soil. In all cases, however, this cementation was very weak and the soil was easily broken apart by hand.

This lack of strong cementation poses an interesting problem. In most desert areas, cementation by calcium carbonate is common. The cemented beds are variously termed "caliche" (Latin America), "calcrete" (British areas) and "surface limestone" (South-West Africa). The calcium carbonate is generally thought to have been dissolved from the bedrock and subsoil by the ground water, drawn upward by capillarity and deposited just below the surface upon the evaporation of the ground water.

In this case, the lack of cementation may be due to the virtual absence of ground water in the soil over large areas. It would appear that the formation of the cemented layer occurred at a time in the past when precipitation was more plentiful and when ground water was higher or more abundant. The writer makes no attempt to place this in the geologic time-table.

The presence of gypsum--often in the form of extensive beds--in the place of the more normal calcium carbonate also warrants explanation. A most intriguing hypothesis has been put forward by Dr. Henno Martin,¹⁰⁷ Geologist of the South-West Africa Administration. It is his belief that the carbonate radical has been replaced by a sulphate radical produced from the H₂S of the submarine explosions offshore, borne landward by the sea breeze and condensed out with the dew during the early morning. Whether this is possible the writer does not attempt to decide. It is a fact, however, that the noxious odor of the eruptions can be smelled clearly at least a dozen miles inland and that the gypsum ceases at about the same distance inland.

In some areas the gravel flats are underlain at some depth by layers of salt. Gevers¹⁰⁸ described localities along the south rim of the Swakop Valley in which the salt occurs in two distinct layers: one 50 cm. thick at a depth of about 8 feet; and the other at a 25 foot depth with thicknesses up to 30 cm. He describes it as of excellent quality, crystalline, columnar, pure white, brittle and free of mud.

Although he stated that it was too thin to mine, especially in view of the extent of the overburden, others have been more optimistic. Several claims have been "pegged" for this salt on the South rim of the Swakop River gorge. Of greater importance is the fact that the municipality of Swakopmund obtains the salt for street paving from similar deposits flanking the Walvis Bay Road just south of the Swakop River ford.

107. Dr. Henno Martin, personal communication.

108. T. W. Gevers and J. P. van der Westhuysen, "Occurrences of salt in the Swakopmund area, South West Africa," *Geological Society of South Africa, Transactions*, Vol. 34 (1931), pp. 62-63.

These salt beds occur in different thicknesses and patterns at various places beneath the gravel flats. Often, no doubt, they go undetected, being brought to light only in the walls of the section's stream channels. But they are neither necessarily present everywhere in the area nor in such a state of purity as described by Gevers.

Over broad expanses the gravel flats are totally devoid of all forms of vegetation (with the probable exception of certain microflora within the soil). This is particularly the case where the pebbles are small and widely spaced.

On most tracts, however, no matter how barren the land appears, close inspection will reveal the presence of considerable numbers of lichens growing on the western side of the larger pebbles. (See Figure 3) Both foliose and crustose lichens occur, and their colors include gray-brown, gray-green, yellow-gray, brown-black and orange-red. The latter make a most striking contrast with the white quartz pebbles on which they sometimes grow. The lichens are not omnipresent. It is seldom that more than 25% of the pebbles bear lichens, and ordinarily the count is more in the neighborhood of 10%. There seems to be little correlation with the lithology.



Figure 3. A view of the north side of a white marble pebble in situ on the surface of a gravel flat of the Outer Namib. The right-hand, western or seaward face of the pebble is covered with an orange lichen; the left-hand or eastern face is polished by the sandblast action of the infrequent Berg Winds.

In addition to the lichens attached to stones, one species grows in an unattached form. It is commonly found lying loose in the bottoms of little drainage ways where it has obviously been blown by the wind. In its normally shriveled form with its edges rolled in toward the center, it looks like fragments of dried kelp, and the writer at first assumed that the drifts of it he saw several miles inland were masses of seaweed blown from the shore by the sea breeze. This delusion is quickly dispelled when it is seen on a wet, foggy morning. Under such moist conditions, the edges unroll, the inner protected surface is exposed, and the chlorophyll, activated by the dew, turns the color from its normal brownish-black to a soft gray-green. But as the sun penetrates the sea fog in mid-morning, the edges roll in again and the plant assumed its dried-seaweed appearance.

On some of the flats very widely-scattered specimens of *Aerva leubnitziae* and *Zygophyllum stapffii* occur. In most cases it will be observed, however, that such bushes are not actually on the flats themselves, but are situated in little drainage channels incised slightly below the surface. From the air such plants are seen strung out in dendritic patterns conforming to drainage systems.

Nevertheless, a few of these plants do exist on the surface of the flats where they stand out very conspicuously. In some instances they have accumulated long low dunes of sand behind them. The dune always occurs on the side toward the prevailing wind--that is, to the southwest. Except on the immediate coast, however, the southwest sea breeze is not a mover of sand; rather, the dune has been formed on the southwest in the lee of the bush at the time when the violent East Wind is blowing. This phenomenon can be observed on many kinds of surface throughout the desert. These plants have a very pronounced root system which serves both to gather water over a large area and to anchor them firmly against the wind. The system, however, is limited to the upper zone of the soil, and does not penetrate the salt or the gypsum beds when they occur below.

Table XV illustrates quantitatively the nature of the vegetation on one of the more densely covered areas. Even here a very minute portion of the area is occupied by the shrubs which seem even more conspicuous than they actually are because of their dark color.

Table XVI illustrates the more normal type of area in which the vegetation is so sparse as to be scarcely measurable. To complete the picture, of course, an additional table should be presented in which no plants whatever are recorded other than lichens. This would be typical of large stretches of the gravel flats.

Welwitschia Flats

(Landscape Type II - B)

Walter, in his ecological discussion of the Namib desert,¹¹⁰ paid considerable attention to the *Welwitschia mirabilis*, a most curious plant indigenous only to this desert. He stated that the species is limited to a narrow strip, a few miles in width between the Inner and Outer Namib, extending from the Kuiseb River northward well into Angola. It would thus be implied that its physical requirements are extremely rigid and only to be met with in that precise situation.

110. Walter, op. cit., pp. 103, 217.

Table XV

Vegetation on Gravel Flats¹⁰⁹
(Five Miles Northeast of the Rooikop)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
<i>Aerva leubnitziae</i>	18"	2'	0.2	80	0.16
<i>Zygophyllum stapffii</i>	18"	2'	0.1	50	0.05
<i>Zygophyllum simplex</i> (?)	4"	18"	1.0	60	0.60
Grass	0	0	0	0	0
Lichens	T	T	T	T	T
Total					0.81

109. Terms used in this and subsequent vegetation analysis tables are:

Height: The average height of the plants of the designated species within the plot studied, expressed in feet unless otherwise indicated.

Diameter: The diameter of the typical plant, expressed in feet unless otherwise indicated.

Foliage area: The area outlined by the terminal points of the widest lateral branches and leaves of a plant--the gross area occupied by the stem and foliage--expressed as a percentage of the total area of the plot studied.

Foliage density: The percentage of the foliage area actually shaded by the stems and leaves of a typical plant with the sun in a theoretical zenithal position.

Area shaded: The percentage of the total area of the plot shaded by all the plants of the given species; obtained by multiplying the foliage area by the foliage density.

Table XVI

Vegetation on Gravel Flats
(Three miles north-north-east of the Rooikop)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
<i>Aerva leubnitziae</i>	15"	2	0.05	80	0.04
Lichens	T	T	T	T	T
Total					0.04

The writer found the distribution pattern to be very different from that previously described. The older, better-known sites in the vicinity of the old railroad line from Swakopmund to the interior and on the gravel flat south of the Swakop River lay within the prescribed range, and at a distance of twenty-five to forty miles from the sea west of the Brandberg, extensive colonies occur some forty to fifty miles from the coast. In all these cases, the Welwitschia is a major constituent of the flora.

On the other hand, Welwitschia also occurs in the "petrified forest" area near the town of Welwitschia about 100 miles from the coast. This is definitely not a part of the Namib Desert, but rather is a steppe brush land well outside the desert itself. The Welwitschia here grows in company with mopane (Copaifera mopane), a plant of shrub-to-tree proportion which grows commonly in the savanna woodland areas extending from South West Africa well into Rhodesia. The mopane is here near its arid extremity--but its presence on the general surface of the landscape (outside of stream beds) would seem to indicate a rainfall of at least several inches--much more than is experienced in the so-called optimum areas of Welwitschia.

Walter states that most Welwitschia sites are broad drainage ways on the surface of the gravel flats, yet specimens have been seen by the writer in quite different localities: on small rocky benches above the Swakop gorges, on the low rocky ridges and thin-soiled uplands of the "Petrified Forest" area, and on very stony relict fans developed into an excellent desert pavement west of the Brandberg.

The Welwitschia, a gymnosperm, is a most curious plant. It has only two leaves but they are huge things, often more than six and sometimes as much as eight feet in length. That only two leaves exist is sometimes not evident due to the fact that they are split longitudinally into many segments, sometimes so narrow as to be almost ribbon-like. The leaves are zeromorphic in the extreme, being very hard and leathery--a fine example of sclerophyllous foliage.

The leaves grow out from opposite sides of the thick, woody trunk which protrudes only a few inches from the ground (or sometimes not at all) and which has a depth of only two or three feet, and yet which has a diameter of one to one and a half feet at the surface. At the base it divides into one or more tap roots which penetrate deeper into the soil. The whole trunk looks like a much magnified human molar.

The plant is dioecious with the female plant having small, modified cone-like seed cases--which has resulted in it being placed in the Gnetaceae by some botanists. The blossoms are borne on short stalks in the angle between the leaves and the trunk.

Each plant is host to a number of brilliantly red-orange beetles which seem to be peculiar only to the one plant species. It is said that the leaves are also eaten in bad times by zebras, who spit out the fibers after chewing such pulp as the plant tissue contains.

The writer had originally intended to recognize a special sub-area of the gravel flats as an area dominated by the Welwitschia. However, there seems to be no one type of situation peculiar to the plant, and so the classification has been dropped.

Gravel Flats of the Inner Namib

(Landscape Type II - C)

While topographically very similar, the inland extension of the gravel flats is quite different from the coastal portion. The inland climate is at once drier and wetter: lower in humidity, yet with greater frequency and amount of precipitation. The flats are clothed (albeit scantily) in grassy vegetation and are well populated with native animals. Their gravels are cemented and their component materials are coarser.

The gravel flats apparently represent vast quantities of alluvium deposited by streams at some time well back in the past onto the surface of the Namib Platform. Over some large areas they appear to be still in their original form; but elsewhere dissection has segregated them into various segments. Where intact their surfaces are flat to slightly undulating and monotonous in the extreme.

Detailed inspection of the surface reveals that the flats are composed of two or three levels separated from one another by low breaks. The difference in elevation is slight--usually between five and twenty feet. The higher surfaces are monotonously flat; some are composed of loose material, some have calcrete at the surface, and others have a veneer of sand covering them. The lower flats, often very extensive, have widespread accumulations of coarse sand. Into these, broad, shallow stream channels have been carved. These areas are treated individually below in five separate groups: 1. Surface limestone flats, 2. Gravel flats, 3. Sandy flats, 4. Sandy vleie, 5. Omurambas.

Surface Limestone Flats--(Unit Area II - C - 1)

Over vast areas of the Inner Namib, the gravels have been cemented strongly by calcium, forming layers of calcrete or "surface limestone." This is in direct contrast with the flats of the Outer Namib, where such cementation is weak or non-existent. The presence of the calcrete here is interpreted as being the result of infrequent but heavy rains which temporarily saturate the gravel and permit the solution and later redeposition of the calcareous material. It is the writer's belief that the present climate is not sufficiently moist for such activity, and that the calcrete in this area is therefore "fossil calcrete," having been formed in earlier times of greater rainfall.

In many areas, the calcrete is present on the very surface and is hardened to the consistency of bedrock. Firmly cemented pebbles often rise above the general level; elsewhere the surface is strewn with flakes, chunks and blocks of calcrete and/or the included pebbles. From the trafficability standpoint, such areas are good and bad: good in that any vehicle can traverse them in any direction at any time; bad in that due to a multitude of small holes and protuberances, a ride across such a surface is exceedingly rough.

The surface limestone areas are virtually devoid of vegetation. An area about two miles west of Lintvelt's Poort weather station inspected in October 1956 was practically barren as shown in Table XVII; the rains of the succeeding summer brought up a "good crop" of grass which, mapped in June 1957, gave the coverage listed in the

second part of the table. In other areas, as shown in Table XVIII the vegetation consists solely of low, mat-like succulents ("Brakslaai") and scattered, dwarf bushes. Such nearly barren areas merge seaward with the vast empty stretches of the Outer Namib Flats.

In contrast to the coastal areas there are no lichens on the pebbles here--a reflection, no doubt, of the fact that the humidity almost never reaches the saturation point.

Table XVII

Vegetation on Surface Limestone Flats
(Two miles west of Lintvelt's Poort)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
<u>October 1956</u>					
Unidentified succulent ("Brakslaai")	3"	1'	3	40	1.2
<u>June 1957</u>					
Aristida obtusa	1'	4"	4	75	3.0
Unidentified succulent ("Brakslaai")	3"	1'	4	50	2.0
				Total	5.0

Table XVIII

Vegetation on Surface Limestone Flats
(Three miles west of Lintvelt's Poort)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Rhigozum trichotomum	10"	2'	1	60	0.6
Unidentified succulent ("Brakslaai")	2"	4"	0.5	50	0.25
				Total	0.85

Gravelly Areas--(Unit Area II - C - 2)

In some parts of the Inner Namib flats the strata cemented by calcium carbonate lies buried deep beneath a layer of unconsolidated gravels. Whether this has been deposited since the cementation of the gravel beneath or whether the cemented layer has been exposed elsewhere by the subsequent erosion of this unconsolidated layer is not clear to the writer.

These surfaces are well compacted and easily traversable by any form of vehicle at almost any time. After a soaking rain they probably tend to soften and become slippery and may seriously impede movement of wheeled vehicles. Such occasions are extremely rare, however.

Although such areas would seem to be ideal for the development of desert pavement, no really good examples of this desert feature were seen in the area. This would seem to be an indication that the area is not subject to high wind and consequently that the deflation of the fine materials and the resultant concentration of a surface layer of coarse materials has not taken place.

As will be seen by Table XIX, the vegetation of these areas is somewhat richer than on the surface limestone flats.

Table XIX

Vegetation on Gravelly Areas
(Four miles WSW of Lintvelt's Poort)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
<u>October 1956</u>					
GRASS					
Aristida ciliata	6"	3"	1	25	.25
Aristida obtusa	6"	3"	2	40	.80
Unidentified succulent	3"	14"	2	50	1.00
				Total	2.05
<u>June 1957</u>					
Aristida ciliata	18"	6"	2	60	1.20
Aristida obtusa	12"	4"	5	80	4.00
Unidentified succulent	3"	14"	2	60	1.20
				Total	6.40

Sandy Areas--(Unit Area II - C - 3)

Windblown sand is not common in the Inner Namib north of the Kuiseb, but some areas display mottled patterns where sand accumulations alternate with the more common gravels described above. Such sandier patches usually have a much thicker cover of grasses than the surrounding areas as shown in Table XX. (See Figure 4)



Figure 4. Short grass covers large expanses of gravelly and sandy flats in the Inner Namib. In this view of a sandy flat, the tall grass is *Aristida ciliata* and the shorter species is *A. obtusa*.

Table XX

Vegetation on Sandy Flats
(Four miles SW of Lintvelt's Poort)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
<u>October 1956</u>					
<i>Aristida ciliata</i>	6"	3"	8	50	4
<i>Aristida obtusa</i>	6"	3"	12	50	6
				Total	10
<u>June 1957</u>					
<i>Aristida ciliata</i>	24"	10"	10	70	7
<i>Aristida obtusa</i>	18"	8"	15	80	12
				Total	19

Sandy Vleis--(Unit Area II - C - 4)

Incised a few feet below the level of the gravel or surface limestone flats are the broad, through flowing stream valleys. These streams are nearly always dry, probably having water in them on the average of not more than a few hours per year. The valleys seem to consist of two parts--the actual stream bed itself (described below as omurambas) and the low bench or benches slightly above the stream bed, yet well below the level of the flats. These probably represent deposits in the stream bed during very violent floods when the whole valley is filled from side to side with water--a rare, yet probable occurrence. They may have been formed only in the past, but the writer, himself familiar with the runoff from torrential storms, believes they are of modern construction. Such a lower-level flat is usually termed a vlei.¹¹¹

In the Inner Namib the vleie are usually not more than 20 feet below their surroundings, and only several feet above the stream.

Table XXI

Vegetation on Sandy Vleie
(Two miles west of Lintvelt's Poort)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
<u>October 1956</u>					
Aristida obtusa	8"	3"	10	40	4
<u>June 1957</u>					
Aristida obtusa	12"	4"	30	75	22.5

On the sandy vleie, the grass cover becomes steppe-like as shown in Table XXI. Seen from the ground, with perspective having its effect, one has the impression of still greater foliage cover and a greater frequency and closer spacing of the individual plants.

Omurambas--(Unit Area II - C - 5)

Incised slightly below the level of the gravel flats are occasional stream courses to which the Herero term Omuramba is usually applied locally. They are in all ways comparable to the "washes" of the Southwestern United States, but since their banks are not necessarily steep-sided they are not totally synonymous with the arroyo of Mexican-Spanish nor the Wadi of Arabic.

111. Vlei is a term of widespread use and variable meaning. The dictionary implies the presence of much water, giving synonyms such as "marsh" and "swamp," and the term vlei, derived from the Dutch is used in that sense in New York State today. But in South West Africa a vlei is simply a lower piece of ground in which greater amounts of ground water may be present. The plural is vleie.

In such a rainless area it is surprising to find a fairly complete network of stream channels. While it is true that they are widely spaced it is their very existence that is remarkable. Some have their origin in the area of greater humidity to the eastward of the Escarpment but many originate on the very flats themselves. The latter, obviously, are not reflections of the normal local rainfall but rather are formed solely during the infrequent and short-lived periods of torrential rains.

In all cases a rather well defined stream bed exists, devoid of vegetation and composed chiefly of loose sand. Where granitic rocks constitute the parent material such areas can be crossed without difficulty by standard cars, but in areas of other lithologic types they may impose a very serious hazard to travel.

The larger and more significant omurambas are those that rise in the plateaus east of the Escarpment. They apparently carry a moderate under-flow in the sands of their beds most of the time and a slight seepage in even the poorest years. As a result, they are conspicuous in the landscape because of the growth along them of irregularly-spaced camelthorn trees (Acacia giraffae) which contrast sharply with the sparse grass cover of the surrounding flats. (See Figure 5)

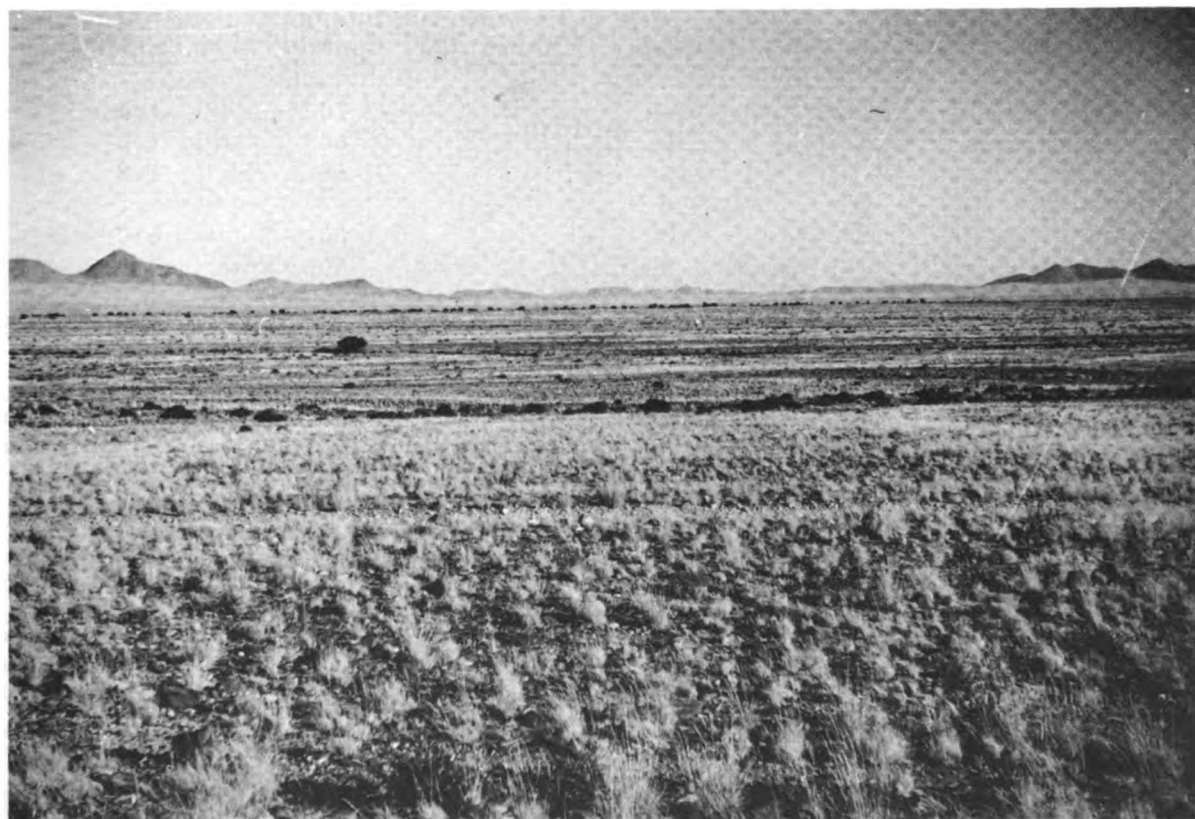


Figure 5. Lines of heavier vegetation (usually bushes and camelthorn trees) mark the routes of the water courses across the grassy flats of the Inner Namib.

On the other hand, these omurambas are unlike washes of many other desert areas in that they are not marked by a continuous or even discontinuous line of brush. In most cases the trees stand quite apart and alone surrounded by grass. Bushes do occur but they are relatively unimportant in the total picture.

The camelthorn near the inner edge of the Namib usually grows to a height of 20 to 30 feet. It ordinarily has an erect trunk or trunks and a fine spreading crown. Invariably it is open beneath, having been "pruned" upward by the browsing of the larger game animals. These trees will be described in detail later.

The narrow belt of wooded steppe thus produced was analyzed on the Tinkas Flats west of Lintvelt's Poort with the result shown in Table XXII.

Table XXII

Vegetation on an Omuramba
(Three miles west of Lintvelt's Poort)

June 1957

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Acacia giraffae	25'	30'	2	70	1.4
Acacia hebeclada	6'	25'	2	60	1.2
Lycium sp.	10'	15'	3	60	1.8
Aristida ciliata	24"	10"	10	60	6.0
Aristida obtusa	18"	8"	4	60	2.4
				Total	12.8

At varying distances from the edges of the flats the line of trees comes to an end owing no doubt to the combination of a declining water supply and its increasing salt content. The gravel flats are clear of trees beyond the distance of about ten miles from the inner edge, although along the deeply incised channels of the major streams (like the Swakop and Kuiseb) trees continue nearly to the sea.

Granite Pediment

(Landscape Type II - D)

The Namib Platform possesses seemingly endless expanses of monotonously flat to slightly undulating country in which the bedrock occurs right at the surface. Such landscapes represent the final stages in the development of a rock pediment. (See Figures 6 and 7)

The origin of rock pediment has long caused much controversy among geomorphologists and no explanation thoroughly acceptable to all schools of thought has as yet been offered. That such features do exist is unquestionable, and yet the magnitude

of those which exist in the Namib desert is scarcely appreciated by most geomorphologists. Nor are most students of the subject cognizant of the degree to which the process has developed there.



Figure 6. Over broad tracts, mass downwastage of the granite has produced an almost featureless landscape. Low rounded mounds of bedrock, covered with exfoliating scales, protrude from beneath a thin mantle of grus which masks the presence of bedrock. Here the granite pediment reaches an almost ideal development.

It is perhaps best to begin the discussion of pediments with a description of their physical appearance. When viewed grossly a pediment is seen to be a smooth surface of bedrock covered here and there with a veneer of alluvium and nearly everywhere with products of its own weathering. Classically, the pediment results from lateral corrasion and slope recession, and the final stage of the erosion cycle, as envisioned by Davis,¹¹² would be a landscape composed chiefly of low flattened domes. Such landscapes are common in the Namib, and in many places the process

112. Davis, W. M. "Granitic Domes of the Mojave Desert, California" Transactions San Diego Society of Natural History, Vol. 7 (1933), pp. 211-258.

has been carried even further than envisioned by Davis, with the result that the land has been reduced to an almost featureless plain, with the only appreciable slope being the seaward tilt of the entire platform.

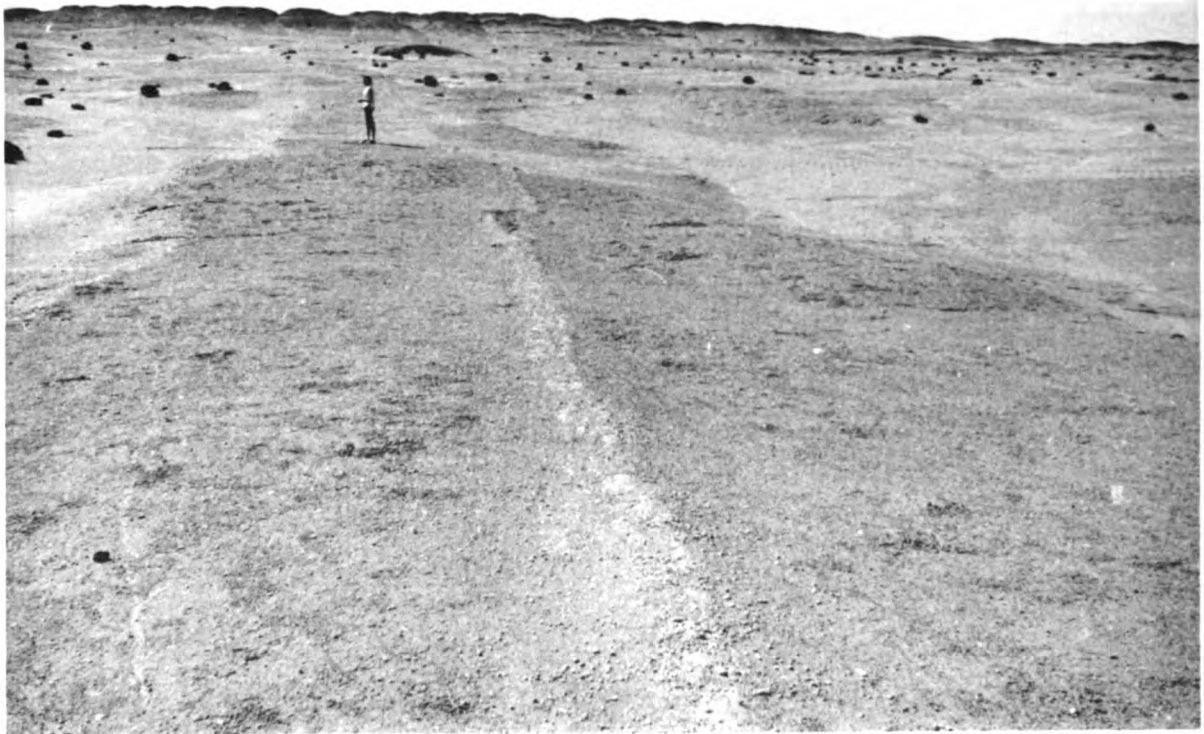


Figure 7. Bedrock appears at the surface in the form of a pediment over broad reaches of the Namib Platform. Here the normal granite has been intruded by an aplite dike (shown by the white streak in the foreground) and by a more resistant basalt dike (shown by the ridge across the skyline in the background). The small black bushes are typical aerva plants.

Until his work in the Namib, the writer was familiar only with pediments developed on soft, poorly-consolidated sediments, and on homogeneous granitic masses. As will be shown below, the Namib possesses extensive tracks of pediment developed on mica-schist. Let us first consider the granitic developments.

Close inspection shows that the surface of the pediment is not quite as smooth as was at first indicated. Unreduced remnants of various sizes rise above it, producing more inequalities than are apparent from a distant view. Aside from the obvious inselberge which will be discussed later, most of the unreduced remnants seem not to be fortuitous but due to some very apparent lithologic cause. Among the most common of these are aplite dikes, which stand in long ridges several feet higher than the surrounding granite surfaces, thanks to their superior resistance to physical

disintegration. Thick quartz veins and pegmatite dikes cause similar irregularities but of lesser magnitude. In some areas where these features are plentiful the casual observer might erroneously assume on the basis of the exposed bedrock that all of the countryside was composed of aplite and quartz.

Half to two-thirds of the area is covered with a thin veneer of loose material technically known as grus--detritus from decomposing granite. The surface of the bedrock itself either where directly exposed to view or where hidden under the veneer of grus will be found to be fresh and only slightly weathered in appearance. But despite its appearance a swipe with a hand or a kick with the toe of the boot will invariably dislodge both grains and flakes of rock, for the surface actually has been undergoing considerable mechanical, although not chemical, weathering.

In these granitic areas granular disintegration as a result of mechanical weathering occurs on all exposed surfaces: on the surfaces of the bedrock itself, whether flat, tilted or vertical, and on the faces of detached blocks which have become separated out either by exfoliation or along joint planes. In this process the individual grains of which the rock is composed become loosened and eventually removed from their sockets. Yet at the same time the cleavage faces on feldspar and mica are still untouched by weathering indicating that mechanical weathering is of sole importance.

A casual observer would not recognize the best developments of pediment surfaces at all, for they are so flat and are so completely veneered with grus produced from their own weathering that there would be a strong tendency to place them in the category of the gravel flats instead. However, a mere scraping with a trench shovel will reveal the unweathered bedrock just beneath the surface. The same casual observer would have a tendency to place in the pediment classification the slightly more rolling or undulating surfaces of granite which represent old granite pediments now slightly uplifted and dissected. These are most conspicuous in the area and quite widespread. They will be described later.

The true pediments lie at present base-level. Above them rise occasional low residuals: sometimes in the form of whale-backed domes, low elongate and smooth; sometimes as rugged areas of pitted bedrock. In a few cases, real inselberge rise conspicuously above the pediments.

Where the bedrock itself is exposed at the surface, it is often exfoliating in thin sheets, usually in a most irregular fashion. The commonest form is that of small scales, from two to six inches in diameter and one-half inch or less in thickness. This produces a mottled appearance by removing the older, desert-varnished surface and exposing the new, fresh, unweathered granite beneath. Elsewhere, granular disintegration is more common, producing grus. These processes are obviously going on strongly today, and probably indicate the method by which all of this pediment surface has been produced.

There is nowhere any suggestion of soil; nowhere is there sufficient depth of mantle for it to develop nor sufficient water to permit the initiation of soil-forming processes. The mantle that does exist consists of unaltered disintegrated granite. The cleavage faces of feldspar crystals are still fresh and sharp with no evidence of kaolinization. The surface materials and even the landscape range from a light gray to a gray-brown or a red-gray, depending on the hue of the parent granite.

Owing to the climatic differences, there is a marked contrast in the vegetation of the pediments of the Inner and Outer Namib. Consequently, they are considered herein to constitute two separate unit areas.

Granite Pediments of the Outer Namib--(Unit Area II - D - 1)

As might be expected, vegetation is extremely sparse on the pediment areas of the Outer Namib. Curiously, however, the vegetation is actually denser there than on the adjacent gravel surfaces. This is probably due to the fact that dew is a more common source for water than rain, that dew condenses more readily on the rocks than on the gravel, and that this water is stored in the crevices of the rocks and becomes available to the plants, whereas it is merely lost through downward percolation in the travels.

The granite pediments about the Rooikop, some eleven miles east of Walvis Bay, were studied in detail by the writer and an analysis of their vegetative cover is presented in Table XXIII. (See Figure 8)



Figure 8. The Rooikop, an isolated granitic inselberg, rises abruptly above the smooth granite pediment of the Outer Namib, ten miles east of Walvis Bay. In the foreground, exfoliating surfaces of granite (right) are buried beneath a thin veneer of grus (left). During periods of Berg Winds, a small sand dune has formed in the lee of the Aerva bush in the foreground.

Table XXIIIVegetation on Granite Pediment
(Near the Rooikup)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Aerva leubnitziae	18"	2	0.8	75	0.6
Zygophyllum stapffii	18"	2	0.2	50	0.1
Salsola aphylla	1'	1	0.1	50	0.05
Unknown shrub	1'	1	-	-	-
Grass	0	0	0	0	0
Lichens	T	T	T	T	T
Total					0.75

Granite Pediments of the Inner Namib--(Unit Area II - D - 2)

The vegetation on the pediments toward the eastern border of the Namib Platform, while far from luxuriant, is considerably denser and richer than that just described. In the vicinity of the weather station at Lintvelt's Poort, the vegetation might, by a stretch of the imagination, be called a "bush steppe." Its components in June, 1957, are shown in Table XXIV

Table XXIVVegetation on Granite Pediment
(Lintvelt's Poort)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Barleria sp.	1'	1'	5	70	3.5
Petalidium sp.	1'	1'	5	60	3.0
Boscia foetida	1'	5'	1	40	0.4
Other shrubs	1'	-	1	40	0.4
Grasses--annual	15"	-	5	50	2.5
perennial	1'	-	5	25	1.25
Total					11.05

This "bush-steppe" has a very open appearance. (See Figure 1) The shrubs are all low and dwarfed (seldom over a foot in height) and are very widely scattered. Between the bushes there appears to be a rather continuous cover of grass, but this is purely the result of perspective. Closer inspection shows it to be very widely scattered, and individually, very thin in its coverage. Nevertheless, the area provides a fair food supply for game or certain types of domestic animals. The grasses are the more valuable, having a far higher feed value than comparable amounts of grass from more humid environments. The shrubs, on the other hand, are of relatively low feed value.

A study was made of the vegetation of another granite pediment area--located adjacent to the Swakopmund-Usakos road, and near the railway line 24 miles by road from Swakopmund, and about 1 mile southwest of Trekkopjes Siding. There the undulating pediment, with low protrusions due to occasional more gneissic phases of the granite, is irregularly covered with disintegration residue, but nowhere to a depth of more than a couple of feet. The average annual rainfall at this point is probably about three inches. An analysis of a typical plot is given in Table XXV.

Table XXV
Vegetation on Granite Pediment
(Near Trekkopjes)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Euphorbia gregaria	7	20	8	90	7.2
Zygophyllum stapffii	2	3	1	50	0.5
Aloe asperifolia	2	10	2	80	1.6
Grass			2	25	0.5
				Total	9.8

The vegetation consists of widely-scattered, large, dense clumps of Euphorbia gregaria interspersed with low Zygophyllum bushes, aloes and scattered annual grasses. The Euphorbia (known in Afrikaans as melkbos and in German as Wolfsmilch from the nature of its sap) is striking because of its hundreds of vertical blue-green pencil thick stems. All manner of rodents, birds and reptiles make their homes within the maze of stems and branches. While not thorny, the bushes are repellent to man because of the milky sap which causes blisters on the hands and great irritation in the eyes.¹¹³ It is of no value whatsoever; cattle, sheep and wild game do not eat it, and attempts to use its sap as a latex for rubber have not proven successful.

113. Dinter, op. cit. (1909) pp. 12-13.

The Zygophyllum is a low, scraggly bush with short, thick stems. Its thick, flat, succulent leaves are borne in pairs, with one placed curiously atop the other, and both tipped up so as to present only the edges to the sun. The leaves hold a very large amount of salty sap of a consistency not much heavier than sea water: the plant is a fine example of a halophytic succulent. Because the shape of the leaf is similar to a coin, the plant is called in German, "taler-busch" (dollar bush), and in Afrikaans daalderplant.

In a very widely scattered manner the Aloes grow in dense circular groups, consisting of as many as 30 to 40 rosettes of fleshy leaves shaped like blunt up-curving swords. They are not erect or tree-like (as many of the other Southwest African aloes) but rather sprawl out horizontally over the ground. During the autumn (March and April) loose clusters of orange-red blossoms appear on long slender branchlets rising 18 inches to 2 feet or so above the rest of the plant.

Dissected Granite Pediments

(Landscape Type II - E)

In scattered areas the granite pediments are being subjected to dissection. Some areas are adjacent to the deeply entrenched rejuvenated valleys of the Kuiseb, Swakop, and Khan Rivers. Others seem to be due to less obvious causes of dissection--perhaps local minor uplifts. The relief varies from undulating to extremely rugged. While there is a basically dendritic stream pattern some control by local joint patterns and dikes occurs.

In all other regards these areas are comparable to the pediments described above and to the inselberge described below.

Granite Inselberge

(Landscape Type II - F)

A few isolated inselberge rise conspicuously above the pediment surfaces and are well represented by the Rooikop, a conspicuous knob ten miles inland from Walvis Bay. (See Figure 8) The Rooikop is an exfoliating, dome-shaped mass of normal granite about 200 ft. in height. Its entire surface is covered with exfoliating flakes seldom exceeding 1 ft. in diameter and usually only 3 inches to 5 inches in their greatest dimension. Most of them are between 1/4 and 3/4 inches in thickness. Viewed grossly, the slopes are not in excess of 60°.

The western face of the knob exhibits most remarkable weathering characteristics. It is creased by a series of clefts separated by minor spurs. These spurs are, in turn, cut into a series of steps and risers, each of them triangular in cross section and slightly cavernous on the lower part of the risers. Each step has an overhanging edge a few inches to a foot in thickness. The steps range up to 25 feet across with risers averaging about eight feet in height. Other areas on the western face are covered with a rash of small pits--several inches in their greatest dimension. These features are nearly absent on the eastern face and even there, they occur only on minor north and south exposures. All of the important ones face west toward the seabreeze.

The origin of these is not known to the writer. They might appear to be sandblast phenomena were it not for the fact that (as has already been demonstrated) the sea breeze is not a sand-carrying wind. If sandblast were the cause of the features they would be located on the eastern side where they would be exposed to the Berg Wind.

Lichens are plentiful on the western side of the knob and are infrequent on the east. This appears to indicate that there is much greater moisture on the west as would be expected due to the exposure to the sea breeze. This immediately raises the question as to whether the pitting may be due to dew and evaporation. The writer has observed cavernous types of weathering on all scales in many portions of the world which he believes can be attributed to a combination of solution, capillarity and crystallization: rain water penetrates a rock, dissolves salts therefrom, is drawn to the surface by capillarity and there evaporates. The dissolved salts crystallize in the pore spaces of the rock and, as they grow, exert stresses upon the abutting crystals which cause them to be popped out of their sockets. In this case it is possible that dew and fog act in the same way and that the action is accelerated by the presence of hydrogen sulfide from the submarine eruptions off shore.

As indicated above, the eastern face is not pitted or subject to cavernous weathering in the manner just described. It is, however, creased with very conspicuous rill gullies.

It appears from a study of the Rooikop and of the dissected pediments in its vicinity and elsewhere over the Namib that the chief agent active in the production of granitic landscape types today is the mass wastage of rock by exfoliation and granular disintegration. That this has gone on in the past as well seems quite likely. For this reason the author believes that the granite pediments of the Namib (as well as those of the Mojave and other deserts of the world) are a result of down-wastage of the area rather than lateral erosion or sheet flood action as has been proposed by other writers.

The Rooikop itself is totally barren of all vegetation except for the lichens described above.

At the foot of the bedrock granite slope lies a slope of unaltered granitic fragments mixed with finer material of windblown origin. This material has obviously been deposited by sheetwash and later reworked by wind action. The wind sorting has removed the finer particles from the surface leaving a semi-pavement of larger fragments and yet the weakness of the wind on the western side is shown by the small size of these particles--the largest of which are 1/2 inch in diameter; most of them are less than a quarter of an inch in diameter. While this area is generally barren it does have occasional scattered bushes. Conspicuous among them are the Zygophyllum stapffii described before and a few clumps of Lycium marlothii. About each bush is a small sand dune of gray-white sand contrasting sharply with the red-brown hue of the apron. On a few larger dunes banked against the foot of the Rooikop itself are the barbed-wire-like entanglements of Narra Bushes (Acanthosicyos horrida) with their round melon-like fruits.

These bushes are found all the way around the inselberg. On the eastern side they are joined by several additional plants: Pentzia annua, a strongly odorous, rayless composite about eight inches tall forming a tight compact dome from a single

root--an excellent example of a cushion-plant; Asclepias filiformis, a broom-like milkweed five feet tall growing in the little channel ways; Dolichos sp., a flat-growing purple pea; and rarely a fiddle-necked annual, Heliotropium sp. But while the number of species listed is considerable, the area covered by them is slight and the general appearance of the area is one of great barrenness, as indicated in Table XXVI.

Table XXVI
Vegetation on Inselberg Apron
(Rooikop)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Zygophyllum stapffii	18"	3'	0.5	60	0.3
Lycium marlothii	24"	4'	0.5	60	0.3
Acanthosicyos horrida	24" *	10'	0.3	10	0.03
Pentzia annua	8"	1'	0.8	80	0.64
Dolichos sp.	2"	8"	0.2	80	0.16
Asclepias filiformis	60"	2'	0.3	30	0.09
Heliotropium sp.	6"	8"	0.1	50	0.05
Total					1.57

* Measured above the surface of the dune.

The vegetation of the inselberge of the Inner Namib will be described in the section dealing with the rocky ridges of that area.

Mica-Schist Pediments

(Landscape Type II - G)

Over large areas of the Central Namib steeply-dipping beds of mica schist have been truncated by erosion, producing what appears to be a pediment surface. The method of formation of such a surface is not easily explained. Granular disintegration is not possible, for the schist is not granular; hence, mass wastage seems unlikely. The author has no ready explanation for such developments.

In some areas the mica schist is apparently homogeneous, and the surface is monotonously flat and featureless. Elsewhere, beds of ordinary mica schist alternate with a more arenaceous and hence more resistant variety. The latter stand out as low ridges usually aligned in a NE-SW direction, making a slightly corrugated country. The relief is usually small: in the neighborhood of 20 to 50 feet. From the trafficability standpoint, however, it is rather difficult to travel across the "grain," for the ridges culminate in jagged crests and are steep enough to make travel even by a jeep or a Land Rover extremely uncomfortable.

Vegetation in these areas is very sparse. In the more coastwise portion lichens grow on the rocks exposed to the west and south. In the central portion lichens are sometimes accompanied by "brakslai" which usually is very scattered but in a few isolated cases comes to be quite conspicuous, in part because of its golden yellow color. Vegetation samples representing two rather opposite extremes are given in Tables XXVII and XXVIII.

Table XXVII

Vegetation on Mica-Schist Ridge
(Six miles Northwest of the Grosser Ubib)

January 1957

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Unidentified succulent	4"	15"	8	60	4.8
Lichens	-	-	-	-	-
Total					4.8

Table XXVIII

Vegetation on Mica-Schist Ridge
(Six miles Northwest of the Grosser Ubib)

January 1957

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Unidentified succulent	4"	12"	0.5	60	0.3
Lichens	-	-	-	-	-
Total					0.3

The lower areas between the ridges are veneered with materials washed and blown from the higher parts often including much quartz from inclusions within the mica schist. Usually the materials have been cemented together to form calcrete. Such areas in the Middle Namib are usually totally devoid of vegetation.

Despite the extreme aridity of the Central Namib a network of stream channels exists throughout the area, in most cases cutting directly across the grain of the country. This is in keeping with a general slope of the Namib Platform and seems to indicate superposition of the stream pattern from the present lithologically controlled

topography. It also seems to indicate that, despite the general aridity, occasional heavy downpours do occur resulting in some runoff.

Such stream valleys are inclined to be choked with large quantities of sands. Hence, while they are the natural roadways, four-wheel drive is invariably required to negotiate them.

Rocky Ridges of the Outer & Central Namib

(Landscape Type II - H)

Rising conspicuously above the monotonous flats of the Namib Platform are many elongated rocky ridges. These usually rise rather abruptly above the flat surface; their sides are smoothed only by minor slope wash and talus accumulations. Alluvial fans are practically nonexistent, due to the lack of rainfall. In keeping with the trends of the stratigraphic outcrop, most of these ridges are elongated in a NNE-SSW direction, the only exception being the granite kopjes and a few diabase or dolerite knobs.

The exposed portions of the ridges are strongly sandblasted on the northeastern sides. The white marbles, in particular, take a fine polish. There is no sandblasting or polishing on any of the other exposures. Small lee side accumulations of sand occur in some localities, but the amount of drift sand trapped by such ridges is usually very slight.

Rhyolite Dike Ridge--(Unit Area II - H - 1)

One type of rocky ridge of the Namib is well exemplified by the rhyolite dike ridges southeastward of the railway line midway between the sidings of Namib and Nonidas. (See Figure 9) Here a dike or sill of rhyolite intruded into the local granite-gneiss forms a ridge rising some 40 feet above its surroundings. The material has weathered outwardly to a reddish-brown, hence the ridge makes a red-brown splash across the glaring gray-white plain. The ridge does not run in a perfectly straight line, but meanders slightly. Where its sinuosities cause small pockets, sand has accumulated in the protected spots on the southeastern side. The blocks on the crest of the ridge have split up into thin sheets parallel to the exposed horizontal surface creating an appearance very similar to that of huge "books" of mica flakes breaking up.

Most of the ridge is totally barren of vegetation. However, in sheltered spots on the southwestern side a few scattered bushes of Aerva leubnitziae and Zygophyllum stapffii grow out of the bare rock itself. Lichens grow on the pebbles everywhere and plaster the southwestern exposures of bedrock.

Vehicles of all kinds can be driven everywhere except on the actual ridge crest itself, and even that can be crossed frequently with a standard car.



Figure 9. This typical ridge of the Outer Namib has resulted from the greater erosive resistance of a basalt dike intruded into the granite of the Namib Platform. The slope on the right, outlined against the sky, is a composite form resulting from gravity transport, slope wash and wind action. A small pocket of fresh sand has accumulated near the crest, and older sand, reworked by slope wash, mantles the middleground.

Domes of Vesicular Basalt--(Unit Area II - H - 2)

Near the unit area described above a number of nicely rounded domes composed of jet-black vesicular basalt stand roughly 100 feet above their surroundings. On these domes no bedrock is visible at all. Only shattered basalt comprises the surface, intermixed with much fine clayey material which probably represents wind-blown dust. Like the land form described above, these areas stand out conspicuously amidst the dazzling whiteness of the surrounding granite pediments.

Aside from lichens which occur on the pebbles principally on the windward side, the domes support only scattered Aerva bushes.

White Marble Ridge--(Unit Area II - H - 3)

A few miles farther inland at Rössing, a small ridge partly composed of white marble was studied in the early years of this century by Dinter¹¹⁴ and more recently

114. Dinter, op. cit., pp. 7-9.

by Walter. It is not a typical ridge of the Namib at all--on the eastern side it is composed of a dark gray schist, on the west of white marble. Were it not that it was the object of study by the botanists previously named the writer would probably have ignored it completely; he believes the hill was selected merely because of its proximity to the railway siding of Rössing. Other hills such as the Witpoort are much better sites for the study of marble-dwelling plants, and schist ridges are plentiful throughout the Namib.

The ridge rises some 30 feet above its surroundings. It consists of a core of rock elongated NE-SW and a flanking apron of fragmental material transported from the bedrock core by slope wash and creep. The ridge is nowhere steep--not over 20 degrees anywhere except on the broken rock ledges of the actual crest.

The northeastern-facing crags are strongly sandblasted by the east winds, but there is almost no accumulation of sand in the lee of the ridge.

The vegetation was thoroughly studied by Walter the year following the extraordinary rains of 1934. He reported¹¹⁵ the following plants at the site: Trichocaulon dinteri, Trichocaulon pedicellatum, Hoodia currori, Anacampseros albissima, Aloe asperifolia, Lithrops ruschiorum, Senecio longiflorus, Pelargonium rossingense, Sarcocaulon marlothii, Othonna protacta, Euphorbia lignosa, Euphorbia sp., Zygophyllum stapffii.

As shown in Table XXIX the writer found some of these plants during his study of the hill in 1956-57. In addition, he also found good specimens of Aerva, and a plethora of tiny Barleria which were not mentioned by Walter.

The remarkable thing about this and other similar ridges of the Namib is the presence of such a relatively large amount of vegetation upon it. By contrast with more humid environments these ridges are, of course, extremely barren, but by contrast with the surrounding gravel flats and pediment surfaces they are relatively richly clothed. The answer seems to lie in the presence of deep crevices in the rock and the occurrence of dew during the early morning hours. Condensed moisture occurs in great quantity upon the rock surfaces--so much so that exposed fragments of rock sticking well into the air are found to be dripping wet at dawn. In gravels such water would undoubtedly be re-evaporated during the early hours of the morning, but on the rocky ridges it has the opportunity to penetrate deep into crevices where it remains protected against evaporation through the ensuing day. By pulling apart such rocks it may be observed quite frequently that at depths of several inches the soil in the crevices is slightly moist. Such plants as grow here have to be adapted to taking advantage of such small quantities of water as is occasionally available; they are not dependent upon the preservation of a permanent supply. Virtually all of them are succulents. With fog occurring some 300 nights per year, such plants are able to obtain water for at least a few hours on a great many days.

Also significant is the fact that rock splinters extending high up into the air cool rapidly by radiation and hence become condensing surfaces early in the night.

115. Walter, op. cit., pp. 104-105; 131-134.

Table XXIX

Vegetation on Marble Ridge
(Rooskop)

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Aerva leubnitziae	12"	1"	0.5	80	0.4
Aloe asperifolia	18"	4"	3.0	80	2.4
Zygophyllum stapffii	18"	2"	3.0	50	1.5
Barleria sp.	4"	4"	2.0	10	0.2
Senecio longiflorus	6"	6"	0.5	40	0.2
Lithops ruschiorum (?)	1"	1"	-	-	-
Trichocaulon dinteri	1"	1"	-	-	-
				Total	4.7

Several species of plants which we have not described previously are found on these ridges. Trichocaulon dinteri (Asclepiadaceae) grows very obscurely amongst the rocks. It consists of a group of two to six leafless, very succulent, cylindrical stems radiating out and up from a common base. The grey-green stems are covered with little squarish or five-sided tubercles looking like kernels on a miniature ear of corn. They were found by the writer on the western slopes of the Zebra Mountains north of the Swakop River and were reported by Dinter from a pass (probably on the old railway line) 82 kilometers east of Swakopmund and in the Hanaosberg (Rössing Mountain).¹¹⁶ Walter¹¹⁷ describes them from the Rössing marble ridge, but the writer failed to find it there.

Among the rocks on both schist and marble ridges (at the Witpoort and the Marmor-Pforte and near the southwest base of Rössing Mountain) another obscure member of the Asclepiadaceae--Hoodia correri-- is to be found by diligent searching. Its several grey-green stems the size and shape of small cucumbers are scarred with longitudinal channelings and are protected by short thorns. Their bitter juice is said to have been used by the Bushman and Topnaar Hottentots to quench their thirst.¹¹⁸

Also present among the rocks are specimens of Anacampseros albissima-- insignificant "bushes" (actually of woody tissue) growing to heights of only a couple inches at the most. Although they at first glance appear leafless, close examination reveals minute roundish leaves (perhaps 1/8 inch long) arranged in spirals on the

116. Dinter, K., op. cit., pp. 8, 114. Detailed descriptions of the flowers are available also in Jacobsen, H., "Succulent Plants," Pasadena (1935) p. 289.

117. Walter, op. cit., pp. 131-134.

118. Dinter, op. cit., p. 7.

stem and almost totally obscured by silvery, papery scales.¹¹⁹ These obscure plants are useless as far as the writer is aware.

The writer observed a number of specimens of Lithops growing in the crevices of the bedrock on the marble ridge at Rössing as well as the Witpoort and in the Zebra Mountains. Because they were never in bloom and because his lack of knowledge of the genus prevented him from making his own identification the writer is forced to accept Walter's statement¹²⁰ that they are Lithops Ruschiorum but he retains a mental reservation because of the contrast in the environment between this site and the type locality of the species (Farm Lichtenstein, Windhoek District, an area of 14 inches average annual precipitation).

These are among the vegetable freaks of the world. So similar are these plants to the pebbles about them that one can search diligently in places where they are known to exist without ever finding them. Not infrequently one can look directly at groups of them without being aware of their existence. The writer has never witnessed such perfect mimicry. They are known both to the natives and to the whites in different languages as "Living Stones." At the same time they are the ultimate in the development of the succulents. Virtually the entire plant is devoted to water storage.

The plants are stemless, perennial succulents. Each plant consists of a single, simple, fleshy body which is split into two parts by a deep fissure. From this cleft a single flower blooms when climatic conditions are favorable.

The plants grow up to 1-1/2 inches high and about 1-1/2 inches in width, but only the upper half inch or so usually protrudes above the soil and in crevices the plant is often nearly buried by the detritus accumulated about it. The flower is usually about the same dimension as the plant itself and consists of a large number of long, narrow, yellow petals opening (in the afternoon) into a flattened halo. In general appearance the blossoms are very similar to the Mesembryanthemum or ice-plant (to which they are closely related), which have been much imported into the southwestern United States as soil-binding, drought-resistant plants.

On many of the rocky ridges of the Central Namib a small bushy composite is to be found: Senecio longiflorus. Its very succulent blue-green stems grow in an erect upright manner to heights of 1 to 2 feet, making it appear somewhat like a Euphorbia, although the absence of milky sap distinguishes it readily from that genus. It is usually leafless or nearly so during most of the year. It is to be found in the mountains about Rössing, in the Zebra Mountains and in the Witpoort.

Very conspicuous on the hillsides are what appear at first glance to be clumps of pineapples. These are colonies of Aloe asperifolia growing in rather dense circular groups from a half dozen to a score of rosettes. Sometimes they stand erect, in which case they may be as much as two feet tall; but they usually sprawl on the ground. The stems re-root, allowing the older portion to die. The thick fleshy leaves bend upward and taper to a sharp point; their margins and midribs are toothed and their upper surfaces feel gritty and rough. The orange-red or red blossoms borne in long

119. Vide: Jacobsen, op. cit., pp. 37-38.

120. Walter, op. cit., pp. 131-134; vide: Jacobsen, p. 203. They are not mentioned by Dinter.

racemes rising above the plant or twisted off to one side and sometimes even lying on the ground appear in the autumn (March and April). The writer found them widely distributed in the Namib: at Swartbankberg on the Kuiseb; widely scattered over the hills and pediments from Rössing to Trekkopjes and westward for many miles; in the area about Jakalswater and Salem; in the Zebra Mountains and east of the old station of Welwitsch. ¹²¹

Mountains of the Outer Namib

(Landscape Type II - I)

Only two eminences worthy of the term "mountain" rise above the flats of the Outer Namib: the Rössingberg (or Hanaosberg) and the Swartbankberg.

The former is a mountain of complex geology rising as a conspicuous inselberg just northwest of the railway line near the Rössing siding. Its summit elevation is 2,335 feet above sea level, and it rises approximately 1,000 feet above its eastern base and 1,200 feet above its western.

Like desert mountains throughout the world, it is surfaced almost entirely with bare rock; the little soil it does possess is found only in crevices and cracks and little pockets. Slopes everywhere are steep. Crests are jagged. Fallen blocks are plentiful (although talus is not common). Mechanical weathering is more important than chemical, for despite the prevalent high humidity, actual water is not plentiful. On the other hand, rain wash has had its effects, producing gullies and ravines and serrations of the crestlines. No real stream channels exist on the mountain, but the transportation of detritus by water has been and still is of consequence in the development of the present land forms.

Wind polish is present only at the lower levels of the northeast side, and there only in particularly exposed places. Above the base it seems to have had no effect whatever. That no appreciable accumulation of sand or dust occurs on the leeward side of the mountains would seem to be an indication that transportation by the wind is largely a local matter.

The vegetation is essentially that of the rocky ridges of the Outer Namib. Most conspicuous is the growth of lichens on the southwest side where they are "plastered" liberally over the surface of the bedrock.

The Swartbankberg is a mass of white marble cut by dark sills and dikes of dolerite. It is situated on the northeast side of the Kuiseb Valley, some 65 miles southeast of Walvis Bay. Its appearance is most striking: a shining white mountain with black streaks on its side, rising abruptly out of the glaring white expanse of the Namib Flats.

121. Dinter, op. cit., pp. 7, 46; Reynolds, G. W. "The Aloes of South Africa," Johannesburg (1950), pp. 312-314.

Rocky Ridges of the Inner Namib

(Landscape Type II - J)

Since the Inner Namib has greater precipitation than the middle and outer parts of the desert it is to be expected that its ridges will have a greater vegetative cover. This is well borne out by a contrast of the two Tables, XXX and XXXI, with Table XXIX.

The first table describes a plot on the northern slope of a granite knob a hundred yards south of the Lintvelt's Poort weather station. Here, on a 40° slope composed of bedrock and large angular blocks of normal granite with only shallow accumulations of soil on shelves and in little pockets, a surprisingly rich flora was observed. (See Figure 10)

Most conspicuous are two species of Commiphora - dwarf trees with trunks well over a foot in diameter and yet only a couple of feet in height. Equally interesting is the Resurrection Plant (Myrothamnus flabellifolia), a low bush whose shriveled brown leaves become green with reactivated chlorophyll within a half hour after being moistened.

On the south-facing slope opposite (north of the weather station), the vegetation is even heavier as shown in Table XXXI and Figure 11. To the species of the plot just described are added a large cactiform Euphorbia, a tall Croton and a specimen of Boscia albitrunca--an important ingredient in the bush belt of the more humid interior. Not included in the plot, but conspicuous on the crags just above it, tall (8 foot) kokerbome (Aloe dichotoma) stand guard along the desert border.

A few miles farther eastward the same Commiphora grow to short but respectable trees reaching heights of 15 feet. Their dwarf form here is due to lack of moisture, not to beating by the wind as is sometimes the case of such dwarfing. These trees have a gummy exudate, especially where they have been bruised. As far as is known no use of this has ever been made; yet it is from a similar exudate from another Commiphora species in northeastern Africa that myrrh of Biblical fame was derived.

Myrothamnus flabellifolia is a small, woody, aromatically fragrant shrub. It endures droughts by putting itself into state of dormancy wherein its leaves shrivel, turn brown as the chlorophyll becomes inactive, and eventually becomes so dry that they can be crumpled into dust between one's fingers. At the same time its branches bend upwards into a vertically-bunched position. Yet at the first rain the plant suddenly becomes "alive" once more. The branches descend into more normal positions, the leaves become soft and pliable and the chlorophyll becomes green and active. This transformation takes only an hour at the most, and can be brought about artificially by spraying the plants with water or by immersing them in a tub of water for only a few minutes. Because of this ability to return to life after apparent death, the species is called "Resurrection Plant" (in German, Wunderbusch). The natives use the plants for the brewing of a pleasantly-scented tea,¹²² hence there is a name for the species in each of the native tongues: in Herero it is Ongandukaze and in Nama is !gododosib.

122. Karl Dinter, "Die Vegetabilische Veldkost Deutsch-Sudwest Afrikas." Okahandja (1912), p. 39; op. cit. (1909) p. 73.

Table XXX
Vegetation on North Slope of Granite Kopje
(Lintvelt's Poort)

June 1957

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Commiphora spp	5'	15'	10	50	5.0
Petalidium rubescens	2'	2'	2	50	1.0
Myrothamnus flabellifolia	1'	6"	1	70	0.7
Hermannia coccocarpa	2'	3'	1	40	0.4
Unknown	2'	3'	1	50	0.5
Cryptolepis decidua	1'	1'	1	50	0.5
Limeum sp	1'	1'	1	50	0.5
Malhania dinteri	2'	1'	1	60	0.6
					9.2
Grasses	1'	1'	5	50	2.5
				Total	11.7

Table XXXI
Vegetation on South Slope of Granite Kopje
(Lintvelt's Poort)

June 1957

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
Petalidium variabile	1'	1'	3	90	2.7
Limeum sp.	2'	5'	1	80	.8
Cryptolepis decidua	1'	2'	1	90	.9
Commiphora sp.	3'	5'	1	75	.75
Myrothamnus flabellifolia	1'	6"	2	90	1.8
Barleria sp.	1'	1'	2	90	1.8
Boscia albitrunca	3'	5'	1	75	.75
Euphorbia dinteri	6'	12'	1	60	.6
"Brakslaai"	8"	1'	1	50	.5
Limeum sp.	2'	3'	1	50	.5
Croton sp.	6'	5'	2	60	1.2
					12.3
Grass	1'	-	5	50	2.5
				Total	14.8



Figure 10. Amid the broken rocks of the north-facing hillside at the Lintvelt's Poort weather station, the flora is surprisingly rich. Note the thick-trunked dwarf Commiphora tree to the right of the clipboard.

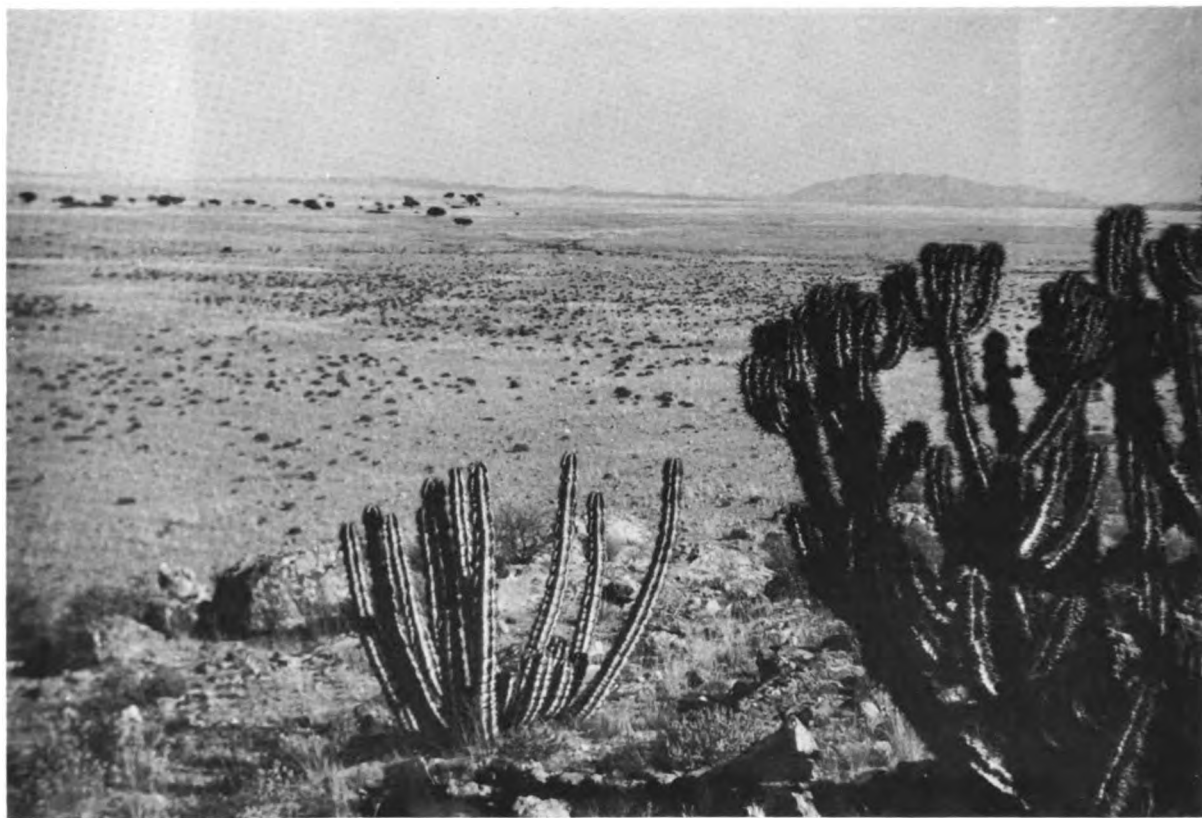


Figure 11. The south-facing slope opposite the Lintvelt's Poort weather station supports tall cactiform Euphorbia. In the distance, a long line of camelthorn trees along a watercourse stand in sharp contrast to the grassy plain dotted with low bushes.

Mountains of the Inner Namib

(Landscape Type II - K)

While the prevailing impression of the Inner Namib is that of an endless plain, there are a number of mountains within its boundaries. Most of these are merely larger phases of the rocky ridges described above and have all the characteristics of those features. Among them are the linear ridges arrayed in conformance with the outcropping of strata--such as the Witpoortberg and the Zebra mountains. Others are granite outliers of the Great Western Escarpment and are similar to the granite kopjes of Lintvelt's Poort described above. Still others, like the Langer Heinrich and the Heinrichsberg, are of complex geology like Rössing Mountain but vegetatively more like the Lintvelt's Poort kopjes. Completely separate from all of these is the greatest mountain of South West Africa--the Brandberg--110 miles due north of Swakopmund and 60 miles from the coast. This 8,556 foot mountain mass is in a class by itself and will not be considered in this paper, as it is neither representative of, nor really a part of, the Namib.

The Witpoortberg is a fine example of the linear type of mountain. It is oriented NNE-SSW--in conformance with the strike of its component group of marble strata.

These beds are of a high degree of resistance here, due to the aridity of the climate. The slopes on the two sides are nearly uniform, and were the ridge in America, it would be designated as a "hogback."

While apparently steep, the over-all slopes do not usually exceed 30°, and 45° is probably an absolute maximum. Bedrock is at the surface everywhere, and since this is a very white marble, the entire mountain shines brightly from a distance and glares almost painfully into the eyes of the person upon it at midday. It even seems to glow in the light of the full moon.

Weathering and erosion seems to proceed slowly, although several different processes are involved:

1) Solution (the Achilles heel of marble and limestone) is of very minor consequence. Some minor rill-marking (probably the result of dew as well as rain) is visible, but no important solution-cavities were observed.

2) Exfoliation of marble occurs on some exposed areas. This was first pointed out to the author by Dr. Henno Martin on a low marble ridge north of the Swartbankberg on the Outer Namib and later observed elsewhere in the desert.

3) Sand blast is evidenced on exposed rocks on the lower eastern slopes of the ridge. While it produces visible effects, its importance as an erosional agent is negligible.

4) Removal of material by the wind (especially the Berg Wind) is of considerable importance.

5) In general, rain wash seems to be of greater consequence in erosion than any other agent, despite the prevailing aridity of the area.

A very abrupt break usually occurs between the rocky erosional slope above and the depositional apron below. The apron seems to be of complex origin, its materials having accumulated there after falling by gravity from the slope above, being deposited by slopewash, and having been blown up from the flats below by the wind. Occasionally large boulders bounce and roll down the slopes and come to rest amidst the fine materials far out on the apron.

While such aprons are surprisingly smooth, they are occasionally cut near the foot of the steep slope by shallow stream erosion channels. Although these channels disappear within a few score yards down slope, their very existence testifies to the intensity of the infrequent thunder-storms.

Thin veneers of driftsand occur in the sheltered spots well up onto the western slope, apparently indicating that the violent East Winds occasionally carry sand completely over the top of the ridge.

Water Holes

(Landscape Type II - L)

Water is a scarce commodity in the Namib and its presence greatly changes the whole aspect of any area in which it occurs. So important is it that each water hole,

no matter how small, even the slightest trickle, has a name, not just in one, but in several languages. In the paragraphs that follow a few typical examples have been described.

The three Tinkas water holes lie near the northern edge of the flats of the same name about 60 miles inland from Swakopmund and about 10 miles south of the Swakop River at Salem. Middle Tinkas is a quite typical water hole occurring in the granite country. (See Figure 12) Here converging tributaries rejuvenated by the downcutting of the Swakop River have cut a group of channels into the mica schist and granite deep enough to intercept a slight seeping flow of water. Two clumps of Salvadora persica grow luxuriantly here, one clump being 25 feet in diameter and some 5 feet in height. This rambling, climbing vine grows up into the top of a Euclea pseudebenus tree, some 15 feet in height. A form of reed and certain small bushes grow about in the neighborhood. But the actual water hole itself is most unimpressive in the dry season. Instead of the fine pool shaded by trees which one always pictures in one's imagination, there is only a sandy stream bed, glaring in the sun. In its center, a wide crater, several yards in diameter, four or five feet deep, has been pawed into the sand by the animals as the water receded after the last rainy season. In the floor of the crater are a couple of steep-sided holes, each a yard in diameter and two feet deep, and in the bottom of each is a little puddle of muddy water skimmed over with dead wasps.



Figure 12. Middle Tinkas waterhole lies in a stream channel carved in granite bedrock. It supports two clumps of Salvadora persica, a couple of Euclea pseudebene trees and innumerable game and other animals.

This is Middle Tinkas, a major water hole of the Namib! But unimpressive as it may seem, this water hole is of utmost importance, for it supports some hundreds of mammals--gemsbok, springbok, zebras, jackals, and perhaps some members of the cat family--as well as bands of ostriches and smaller birds. It is literally the source of life for the surrounding area.

Grosser Tinkas is about a quarter of a mile eastward from Middle Tinkas. Here is a broad stream bed with a rocky floor, water seeps out of a couple of places. It is somewhat salty, but the animals seem to like it well enough. It supports a fine clump of Tamarix austroafricana, several Euclea pseudebenus trees and a great mass of reeds.

Quite different is the water hole of the Grosser Ubib located about 45 miles ESE of Walvis Bay, and about 35 miles southwest of Tinkas. A more desolate place is hard to imagine. The country round about is utterly treeless, bushless and almost grassless. It is composed largely of mica schist, grey to grey-black in color and cut with occasional dikes of dolerite standing as low ridges trending NNE-SSW.

The actual water hole lies in the midst of a shallow depression in the mica schist occupied by a thin salt pan. The water, which is very brackish, seeps out into salt-rimmed channels at several places and trickles only a short distance before disappearing again.

The depression in which the pan lies was probably formed by lateral erosion due to salt crystallization. This process, not observed by the author anywhere previously, appears to be the result of the formation of salt crystals between sheets of mica schist as brackish water, drawn up into the rock by capillarity, evaporates. The schist ledges surrounding the salt pan are undercut by this process just above the level of the pan. Such sapping leads eventually to the collapse of the overhanging ledge, whereupon the tumbled fragments are themselves attacked by the same process.

Although the presence of the pan would seem to imply a basin without an outlet, the Grosser Ubib actually has a surface outlet which drains eventually to the Kuiseb River. It would seem likely that in times of extremely heavy showers (which do occur occasionally in the Namib), much of the salt must be dissolved and carried away. Thus the salt observed in the pan in 1956 had probably accumulated there in the interval since the last heavy rainstorm. The infrequency of such rain is implied in the fact that until very recently the ranchers of the highlands to the east have come here occasionally to gather salt for their stock. ¹²³

Washes of the Outer Namib

(Landscape Type II - M)

Cutting across the flats of the Outer Namib are occasional shallow stream courses, the result of erosion by the runoff of episodic torrential precipitation on the surrounding areas. These washes are usually choked with sand eroded from the surrounding flats. Some drain directly down the slope of the Namib Platform to the

123. Personal communication, Herr Attila Port, Farm Valencia, Rehoboth District.

sea, and are very shallow in their incision; others draining to one of the master exotic stream valleys incised below the level of the platform have been incised more sharply and deeply themselves.

Because they lack the strong underflow from the more humid highlands of the interior, these washes lack the tall trees and fairly dense vegetation of the major stream courses. But because they do preserve for long periods in their deep sand beds the water that does occasionally fall here, they have a more varied and denser vegetation than the surrounding flats.

A typical wash of this nature was studied five miles southwest of Rössing. It measured approximately 100 yards in width. Its western bank was indistinguishable, but on the east it was incised about five feet below the surrounding flats, and the bank itself was slightly dissected (the result of local runoff). It contained many permanent bush clumps with small sand accumulations to the southwest--resulting from sand drifting in the Berg Winds. Its vegetation is listed in Table XXXII.

Table XXXII

Vegetation in Wash
(Five miles southwest of Rössing)

January 1957

<u>Species</u>	<u>Height</u>	<u>Diameter</u>	<u>Foliage Area (%)</u>	<u>Foliage Density (%)</u>	<u>Area Shaded (%)</u>
<i>Aerva leubnitziae</i>	2'	3'	2.0	80	1.60
<i>Zygophyllum stapffii</i>	2'	3'	1.0	60	.60
<i>Galenia sp.</i>	2'	4'	.8	60	.48
<i>Euphorbia phylloclada</i>	2"	5"	.1	70	.07
<i>Citrullus ecirrhosus</i>	1'	8'	1.0	30	.30
<i>Acacia horrida</i>	8'	6'	.1	50	.05
<i>Mesembryanthemum sp.</i>	3"	1'	.2	60	.12
<i>Asclepias filiformis</i>	3'	1'	.5	10	.05
Total Shrubs					3.27
<i>Aristida ciliata</i>	1'	5"	1.0	75	.75
<i>Eragrostis viscosa</i>	2"	2"	.1	80	.08
Total Grass					.83
Grand Total					4.10

In addition to the species listed, clumps of Acacia heteracantha¹²⁴ and Tamarix austroafricana grow in the vicinity, but not within the area actually measured. Acacia heteracantha grows to heights of four feet. It is readily distinguishable by its greatly differentiated spines and thorns borne in mixed fashion all on the same bush.

One of the most interesting plants in this group is the tsamma melon, Citrullus ecirrhosus. The sprawling vine sends branches out over the ground to a distance of four or five feet from the central root. The large round melons, the size of grapefruit, retain a large quantity of very bitter juice long after the plant has died, and are to be seen long afterwards surrounding the shriveled remains of the parent plant. When a flash flood sweeps down a wash, the melons are swept along with it, distributing them widely downstream.

Their bitter juice precludes their use in the same manner¹²⁵ as another Citrullus species, C. vulgaris, prevalent in the Kalahari Desert. The less bitter juice of vulgaris (the "true" tsamma) is the dry-season water supply of the Bushman tribes of that area.

Seen from the air, the fine dendritic pattern of these washes is clearly emphasized by the lines of vegetation along them. Even though the vegetation is very sparse, in a country as nakedly empty as the Outer Namib even this meager vegetation shows up clearly.

Exotic Stream Beds

(Landscape Type II - N)

Flowing across the Namib from the better-watered highlands to the east are a series of stream courses, none of which have perennial surface flow, but all of which have a limited (or in some instances strong) underflow. In the northern half of South-West Africa many of these reach the sea--among them the Hoanib with its mouth at 19° 30' South, the Unjab (20° 11' South), the Huab (20° 55' South), the Ugab (21° 10' South), the Omaruru (22° 05' South), the Swakop (22° 40' South), and the Kuiseb (22° 58' South). South of this several other streams (notably the Tsondeb and the Tsauchab) similarly flow into Namib, but finding their way blocked by the Great Sand Dunes terminate in large salt pans and vleie.

The presence of water beneath the surfaces of these streambeds means that a humid climate prevails at least within the soil, and as a result a humid-type vegetation is to be found along them. Thus, a riparian vegetation stands in marked contrast to the barrenness of the surrounding desert. This vegetation is characterized chiefly by several species of trees and a number of types of bushes.

The most conspicuous trees are two species of Acacia. (See Figure 13) Because its leaves and shoots are a favorite food of the giraffe (known to the Afrikaners

124. Acacia heteracantha is now termed A. tortilus. Personal correspondence, B. de Winter, Agriculture Department, S.W.A. Administration, Nov. 7, 1958.

125. B. de Winter, botanist, Agriculture Department, S.W.A. Administration, personal correspondence, Nov. 7, 1958.

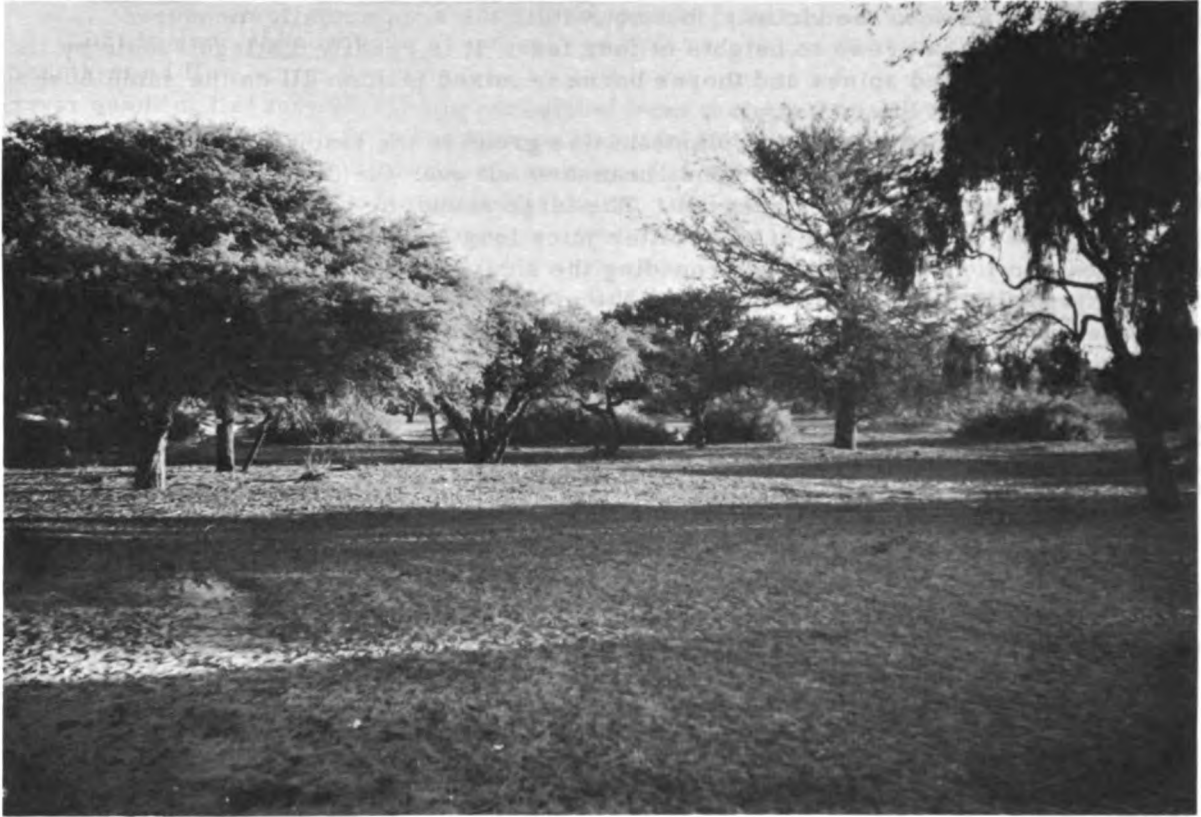


Figure 13. Tall trees, especially the camelthorn (Acacia giraffae) on the left and the Anaboom (A. albida), background right, characterize the vegetation of the riparian zone of the major rivers.

as the "camel-horse"), one of these trees is known in Afrikaans as the Kameeldoringboom ("camel thorn tree"), in German as the Kamelbaum, and in Latin as Acacia giraffae. In Herero it is called Omumbonde, and in Nama //ganab. It is a tall tree (often 30 to 40 feet high) with a fine spread and thick foliage. Its leaves are doubly compounded--the overall leaf is a couple of inches in length and is divided into 2 to 5 branches arranged in pairs. Each branch in turn holds 9-12 pairs of leaflets, each of them 2 mm broad, 7-8 mm in length. The leaflets are shed in the late winter and are replaced almost at once. The leaves are borne in the axils of the pairs of long, straight spines.

The trees bear thick blue-gray pods, curved into a half-moon shape and measuring 3 to 4 inches in length and 1 to 3 inches in breadth, and covered with a thick felt. They make an important feed for goats, although dairy cattle fed on them will produce a bitter milk.

The other important acacia tree is the Anaboom (Acacia albida). Its European name is derived from the Hottentot Anadi or Anaheib; in Herero it is called Omuš. It is a noble tree, growing 50 to 60 feet in height with fine thick trunk. Its thorns are short, seldom more than an inch in length (those of Acacia giraffae are often 2 to 2-1/2 inches long). Its leaves are simply compounded. It bears a spiral pod up to 6 inches

in length and over half an inch broad, which is of great value as a stock feed.

Also commonly found in the stream bed is Euclea pseudebenus, one of the Ebenaceae. Because of the drooping habit of its branchlets it might well be mistaken for a weeping willow. It grows to a good height, often over 20 feet tall in these river bottoms. It has a fine upright trunk which often reaches a diameter of 1-1/2 to 2 feet. It has long narrow leaves (over 1 inch long by 1/8 to 1/4 inch in width). It is named for its wood which (although light in color on the exterior) is dark brown to black towards the center and thus resembles its relative, the ebony. Because of this it is called Ebenholz in German and Ebbehout in Afrikaans. In Herero it is called Omusema. Its bittersweet berries were not much eaten by the natives, nor are they of any use today.

At least as far down the stream on the Swakop River as the mouth of the Khan, occasional milky-juice Ficus damarensis (Moraceae) trees are to be found. Their edible fruits were used by most of the native people. The tree is known as the Hereroland-Feigenbaum in German, Wilde vyeboom in Afrikaans, Omukuju in Herero and Inomas in Nama.

A number of bushes are also of importance. Particularly in areas where they have not been eradicated by the grazing of native goats, a Lycium called Bokdoring (buck thorn) in Afrikaans, Bocksborn in German, and Okahua in Herero, is quite plentiful along the lower Swakop. It grows to a height of five feet in good-sized clumps and bears small reddish berries which were formerly eaten by the natives.

Clumps and even thickets of tamarisk (Tamarix austroafricana), called Davib in Nama and Afrikaans, Gemeine Tamarisk in German and Omunguati in Herero are to be seen discontinuously along the entire course of the streams across the Namib, with a greater incidence toward the lower part due to the strongly halophytic properties of this shrub. The sap of the plant is very salty and excess salt is disposed of by the development of crystals of salt on the exterior of the twig, so large that they gleam in the sunlight and produce a very salty taste when licked. Because of the needle-like appearance of the blue-green leaves, it can easily be mistaken for a pine or other conifer.

A coarse bush-like grass (Eragrostis spinescens) binds the sand together in some parts of the river bed, growing often in large sprawling clumps. From place to place where water is very close to the surface, or where declining floods have formerly left pools, dense clumps of reeds, some alive, some dead, are to be seen.

All in all, the stream beds are completely different worlds from the surrounding desert flats. Shady, cooler, filled with food-bearing plants, they provide a much more genial habitat for both man and beast than the surrounding country. These ecological relations, both animal and human, will be dealt with later.

Dissected Belts

(Landscape Type II - O)

Each of the major exotic streams crossing the Namib desert flows in the bottom of a deep gorge incised into the Namib Platform. At the outer edge near the coast the depth is inconsequential, but near the foot of the Highlands, the excavation may be of

considerable magnitude. The Kuiseb lies in a gorge well over 1,000 feet deep, as do the Swakop and the Khan rivers.

Were the precipitation in the surrounding area greater, the rejuvenation of the various tributaries by the downcutting of the master stream would have long since reduced the whole country to a dissected hill land. Because of the extreme aridity prevailing, such dissection has not proceeded very far. The master stream, thanks to the erosive power of floods provided by rainfall in the highlands well to the eastward, has cut its trench deeply, but the belt of dissection by the tributaries is limited to a surprisingly narrow band. Within this band, however, the relief is very great and the landforms strikingly rugged.

The larger tributaries run as omurambas or washes, broad and sand-choked, practically on the surface of the Namib Flats (as described above under Landscape Types II - C - 5 and II - M). Rejuvenation having worked upstream from the major river to a particular point on a given tributary, that stream suddenly, within a distance of yards, plunges into a confined, steep-walled, rock-bedded gorge, and descends rapidly until within a relatively short distance it has reached nearly to the altitude of the bed of the major stream. From there to its confluence with the master stream its bed is strongly aggraded and the valley broadened out rapidly, its bed of coarse sand contrasting sharply with the rocky walls which bound it.

As has already been described, the larger omurambas normally have a line of well-separated camelthorn acacia trees growing along them. In the confines of the narrow rock-bedded gorges, these trees disappear, being replaced by the vegetation typical of the rocky ridges as described above under Landscape Types II - H and II - J. In the aggraded lower reaches of the tributary the camelthorn reappears, sometimes joined by the anaboom, and the vegetation comes to have the appearance of that of the exotic stream beds.

The minor tributaries not having a broad drainage area of the flats to feed them, head abruptly at the juncture between the gentle profile of the Namib Flats and the steep one of the rejuvenated gorge, descend very steeply, pass into narrow slots and emerge abruptly into the bed of the master stream. Where the underlying sediments are relatively weak, groups of such rivulets often form crude amphitheatres and merge together like the ribs of a fan downstream before passing into the narrow slots just mentioned.

This erosion results in a variety of landforms. In the granitic areas the usual appearance is that of a multitude of knobs, massive domes and piles of boulder upon boulder, separated from one another by the white sand of the aggraded stream channels. In the mica schist area, particularly where the beds stand vertically on edge and the colors shift from dark gray to black, ragged crags and pinnacles rise from the deep canyons. The weaker sediments often erode into typical badlands topography, with knife-edged interfluves, and deep, steep-sided, narrow-bottomed gulleys. This almost impenetrable country is referred to locally as gramadullas, a word of unknown origin.

Chapter V

THE GREAT SAND DUNES

(Sub-Region III)

Stretching in an unbroken sea from the Kuiseb River to the Aus-Lüderitz Railway line, and extending from the waves of the Atlantic inland for a distance of 20-80 miles are the Great Sand Dunes. These rank among the great sand accumulations of the world, both in area and in height, for at some places along the eastern border, these dunes exceed 800 feet above their bases. The dunes lie atop the Namib Platform and hence postdate the formation of that erosional surface. At many places, both along the eastern border and along the Kuiseb River at the North, this fact is clearly evident and in many places the sand is today actively encroaching on this surface.

On the other hand, just as scattered mountains rise as inselberge above the level expanse of the Namib flats, north of the Kuiseb, so in the area of the Great Sand Dunes are there occasional high rocky mountains protruding from beneath the veneer of sand. Some of these have long been known, since they are visible to navigators plying the coasts. Others have been discovered in the past two decades, since aircraft have begun flying over the desert. One particular peak, the Witberg, discovered from the air in the middle 1950's excited much attention recently when an aerial expedition explored and photographed it.¹²⁶ It will be described in greater detail below.

The Origin of the Sand

It has often been stated that the sand of the Namib is cast up on the desert by the waves of the Atlantic. Anyone familiar with the action of undertow knows this to be virtually impossible. While there may be some reworking of the sand by the sea, its ultimate origin lies on the land.

The drainage pattern of southern South-West Africa is a curious one. All of the interior east of the Great Escarpment drains southward to the Orange River, which forms the Boundary with the Union of South Africa. That stream manages to carry a perennial flow westward through all of the north-south trending ranges and fault blocks into the Atlantic Ocean. The interior is a land of torrential rains, sheet floods and gully erosion, and the Orange consequently carries a vast burden of sediment to the coast--especially in times of flood, and this it has done for a great length of geologic time.

After the floods have dwindled away some of its deposits are dried out and blown in a north-northeasterly direction by the prevailing sea breeze. The Great Sand Dunes are partly formed of these materials.

126. Windhoek Advertiser, Ed. 3807.

From the Orange River northward to the Kuiseb, no stream has its headwaters back of the Great Western Escarpment. Thus no stream in all that 400 miles is able to tap the more humid interior and obtain a large volume in a perennial flow. Rather, each stream heads in the face of the Escarpment, descends steeply to the Namib Platform and there dwindles away to nothing. Not a single stream reaches the sea.

The loads of sediment carried are very great, for the streams come from an area of rapid mechanical weathering and of steep slopes, and the showers that produce their floods are torrential in nature, though widely spaced in time. This material is dumped on the Namib Platform at the point where the stream evaporates, and reworked by the wind, also becomes drift sand.

Thus, the Great Sand Dunes have developed from the accumulation of sand borne here by the streams flowing from the interior and reworked and drifted by the daily south-southwesterly breezes. From the Orange, northward to the Kuiseb, nearly all of the Namib Platform is buried under a vast sea of sand.

Along its entire course from the Khomas-Notas-Nauches Highlands to the sea, the Kuiseb River has been successful in removing from its bed by means of its periodic floods all of the sand that is blown by the southwest winds across the several hundred miles of coastal desert. Hence the river acts as a barrier to the advance of the dunes. From the foot of the mountains the river pursues a southwesterly course in a deep gorge across the Namib Platform to a point southeast of the Gorob mine, and there it turns westward, still in its gorge. It is at that turn that the dunes first come to the river, spilling down the south wall of the gorge in great cascades into the river bed below. For about 35 miles, the river runs nearly west; then, at the Hottentot werf of Natab, it turns northwestward. Here it ceases to be in a gorge, occupying, rather, a broad flaring valley scarcely eroded into the Namib Platform. Even here, the dunes encroaching upon the river across the Namib Platform have their northeasterly edge swept away occasionally by the river floods. This northwesterly course is pursued to the Rooibank, the old mission station of Scheppmann.

Through the last ten miles or so of its course on this bearing, and for the remainder of its 25 miles or thereabouts to the sea, the Kuiseb seems to have no bedrock on its western banks, and it is quite possible that it formerly discharged directly westward through the dunes of today to the sea at Sandwich Harbour. There is no proof of this whatever, and the usual feeling that such is the case has been based partly on the shape of the river's course, partly on the presence of the harbor at Sandwich, and partly on the presence there of fresh water flowing out from under the dunes.

In the northernmost part of the course of the Kuiseb, its flow today is greatly weakened by the splitting of the stream into separate channels, each of them shallow and wide and much interfered with by vegetation. Here its erosive power is weakened, and the sand has succeeded in blowing completely across the river bed and reaching the northern bank between floods. That this occurs here closest to the coast is due to the fact that the wind is strongest near the coast and that the river flow is weakened by spreading out on its deltal plain. The result is that the Great Sand Dunes resume their development in a grand manner on the northern bank of the Kuiseb. They stretch in a great barrier a couple of miles wide, 200-300 feet high from Walvis Bay to the south bank of the Swakop River opposite the town of Swakopmund, a distance of some fifteen miles. (See Figure 14)



Figure 14. North of the Kuiseb River, the Great Sand Dunes are advancing over the Namib Platform. In the foreground is the typical gravel surface of large areas of the Platform. The automobile is parked at the edge of an area of cracked mud, deposited the year before, following a torrential rain when runoff was ponded by a recent dune encroachment.

The dunes are apparently relatively recent comers to the smooth surface of the Namib platform north of the Kuiseb. This is evidenced by the way they have blocked the mouths of numerous channels which are eroded slightly into the surface. When the infrequent rains come to the Namib, the dunes block the free drainage of water, ponding it temporarily on the upstream side of the dunes. This water, turgid with silt, deposits much of its load in the small ephemeral lakes, and after it seeps away through the porous sands, and evaporates into the air, the wet muck cracks, leaving small mud playas behind. Some of the sediment-laden waters make their way through the first few hundred yards of dune sand and fill little depressions among the dunes themselves with small temporary lakes.

Thus far the Swakop River has been successful in preventing the passage of sand across its course, and today the dunes are finally terminated at that line.

The Pattern of the Dunes

The accumulation of sand is irregular in pattern and disorderly in appearance, since the arrangement of its component grains represents the momentary state of

equilibrium between two forces--the steady drawing of the southwest sea breeze blowing daily from the sea, and the rare but violent outblowing of the east winds. The southwester blows the sand northeastward in a succession of waves, building dunes that are moderately inclined (10 to 15 degrees) on their southwesterly side, and which stand at an angle of repose on their northeasterly side (about 33 degrees). With this the only wind strong enough to move sand, it is quite likely that there would be an orderly row of well-aligned dunes, arrayed in a northwest-southeast direction. This is the gross pattern of the dunes as they now stand.

But the Berg Wind, blowing violently, although on only a few winter days, reverses the whole picture and blows the dunes back upon themselves, creating chaos. Blow-holes are made in the crestlines of the dune ridges. The intervening troughs are blocked by cross-drifts of sand of heights up to half that of the main ridges. These are then in turn reshaped by the succeeding months of southwesters, and so any real symmetry, or regularity, is destroyed.

The dunes are continuously active. This can be shown graphically by partly-buried bushes here, and by exhumed roots elsewhere, but it can also be perceived by several of the senses at any time. One feels the sting of sand when one stands near the top of a ridge on the leeward side. One sees the wind blowing a thin layer of sand across the surface as the gusts become a little heavier than usual. Even in a gentle breeze the intermittent movement of sand grains can be detected when one watches closely. And when all is quiet the whispering of sand slipping, seeping, almost flowing down the steep leeward face can be heard clearly. At times large movements of this gravitational nature occur and a roaring sound can be heard as countless billions of minute sand grains rub against each other. Such gravitational motions are almost glacial in nature, the sand flowing like warm tar or thick molasses down the slope with a rounded snout to the flow--shaped much like a mountain glacier discharging onto a plain.

Everywhere the surface of the sand is ripple-marked--the ripples being merely small scale replicas of the dunes themselves and like them being rearranged and re-oriented with every shift of wind. Since at times the wind is stronger than at others and hence more capable of moving heavier grains, a crude stratification exists within the interior of the dune. In the reshaping of the dune, this often becomes visible as a sort of grain showing through the surface veneer of moving sand and ripple marks. To the person afoot this sometimes becomes of consequence since certain layers are more capable of supporting weight than others.

One of the most striking things about the dunes is their coloration. The farther inland a dune is located the redder is its color. The coastal dunes are yellow-white and those of the interior are almost brick-red. Herr W. Schenck, pilot for South West Air Transport who has made many chartered flights across the Great Sand Dunes, says that he can always judge his distance from the coast by the color of either the dunes or their reflected light on the fog above them. This difference in coloration is believed to be the result of the greater age of the inland dunes which has allowed greater oxidation of the iron components within the sand.

But even individual dunes are not uniform in color. Their sides are streaked by accumulations of chocolate-brown material--minute grains of ilmenite and magnetite, perhaps derived from the dolerite dikes of the Namib itself or perhaps from other sources farther in the interior. Seen in perspective, these accumulations seem to

highlight sections of dunes, to accentuate profiles and curves, and to set off certain parts in relief. The dunes appear more animated, more full of light and shadow than dunes usually do. This frequently elicits from the observer the remark, "If I were to paint it that way no one would believe it to be correct."

Everywhere that dunes occur, the sand is very deep. On the other hand when the dunes cease, they cease abruptly. There is a distinct edge to them; a real border. There is no tapering off of the sand, not a gradual transition from sandless country through occasional scattered small dunes to the great massive dunes themselves. Rather, they end abruptly making a great front or wall. Thus it is usually possible to drive a car with normal pressure in its tires across the surface of the country to the very foot of the dunes themselves. Only in one case did the writer observe a transitional zone. In the extreme north where the dunes are narrow with their snout pointing toward the Swakop River a few scattered low barchan dunes lie detached from the main mass. Here, obviously, sand is in short supply and the dunes are migrating rapidly across the country pushed by the daily sea-breeze. What happens to them when subjected to the East Winds the writer had no chance to observe.

Vegetation of the Coastal Dunes

In the nearly rainless area adjacent to the coast the dunes are almost devoid of vegetation. Over great areas they are totally barren without a single plant either on the dunes themselves or in the hollows between them. In some areas, however, an occasional narra bush occurs. As far the writer could observe these never grow on the main dunes, but rather upon the smaller dunes within the hollows enclosed by the major dunes or about the borders of the large dunes.

The narra is a scraggly, thorny bush (*Acanthosicyos horrida*) looking like tangles of green barbed wire. They are leafless most of the time, but on occasion put out scattered, small, melon-like leaves. They bear a large number of melon-like fruit about as large as small grapefruit, looking much like a squash, covered with bumps and prickles, and containing many seeds. These seeds form the principal food of the Topnaar Hottentots, and have in recent years become an important article of commerce, entering into the candy business of the Cape Province in the place of almonds. In 1954, 20 tons of these were shipped from Walvis Bay to the Union.¹²⁷ To the Hottentot, these have always been of great importance. Gerald McKiernan,¹²⁸ in his journal for 1874 states "The Topnaars, a branch of the Namaqua nation, subsist on narras, an edible gourd-like fruit which grows in abundance on the sand hills." The Walvis Bay correspondent of the Windhoek Advertiser said, in the article cited above, that they were an important Hottentot food, eaten in several ways: the pulp boiled; the juice brewed into beer; the pulp made into pancakes and stored for winter use; a medicine extracted from the roots; and the nuts dried for export. Formerly, of course, the nuts were eaten rather than sold. Today it is more profitable to sell them and buy other types of food.

Vegetation of the Interior Dunes

Quite different in appearance are the red dunes of the inner portions of the Namib, for on them grows a considerable cover of vegetation, indicating that the

127. Windhoek Advertiser, Edition 3644.

128. McKiernan, op. cit., p. 34.

dunes are fairly well-fixed in position. There are occasionally a few widely scattered bushes, among them Galenia sp. After rains, which occasionally wet the dunes in summer, a crop of annual herbaceous material puts in its appearance and sometimes covers the dunes with a profusion of flowering plants. These are short-lived and soon wither and blow away. More permanent and common than either of the above are the perennial grasses. Most conspicuous is Aristida namaquensis, a tall, coarse, almost shrub-like grass often growing to heights of five feet above the surface of the sand and not infrequently accumulating dunes of three or four feet in height about its base. Aristida Sabulicola is another very robust, tall and stiff perennial grass with heights up to five feet. A third perennial grass common on the sandy areas is Aristida ciliata, a handsome, densely tufted perennial growing a couple of feet high in much smaller clumps than the former two grasses. Aristida obtusa, a much smaller grass than any of the preceding, grows from a tuft of crowded twisted leaves a few inches high, with its culms rising to the height of a foot above the sand.

Chapter VI

GENERAL OBSERVATIONS ON THE VEGETATION OF THE NAMIB

At this point it is well to make some generalized statements in regard to the over-all vegetation pattern of the Namib desert.

Coastal Areas

The coastal flats are almost devoid of vegetation. Very widely scattered, low, compact specimens of Aerva and Zygophyllum occur, but upon inspection their distribution seems to be limited chiefly to the very shallow rills which have incised themselves into the flats. Elsewhere low, yellowish mats of "brakslai" occur. Lichens cover the southwestern sides of pebbles, and an unanchored type drifts with the wind and becomes concentrated in shallow rills.

The sand dunes, aside from very infrequent narra bushes, are almost totally barren.

In the rocky places the vegetation is much denser. Nearly all of it is succulent. The greater growth here appears to be due to the more frequent condensation from the fog, resulting from the greater cooling of the protruding rock surfaces, and the concentration of this water into cracks in the rocks, without it being disseminated widely, as is the case in sand and gravel. Almost all of the plants are succulent and all must be able to grow during the relatively short periods of moisture.

In short, all plants here must be able to survive long droughts, to grow when moisture is present (even if only for a few hours) and to endure concentrations of salts which would be fatal to other plants. Hence, all the vegetation is in the form of halophytic succulents, with the exception of the lichen. No grasses appear in the outer Namib.

This coastal belt is limited to the area of diurnal or nocturnal fogs; hence it extends inland to a distance of some 40 or 50 miles. This is in keeping with the observations of Walter who noted the disappearance of Aerva 55 kilometers from the coast and of Zygophyllum at 60 kilometers, and there drew the boundary between the Inner and Outer Namib.¹²⁹

The Interior Namib

The interior Namib represents the transition from a desert to a grass steppe. The rainfall occurs only during the summer, which induces a grass vegetation. Most

129. Walter, op. cit., p. 94.

of the grass species are perennials. In good years, this area is a sea of grass, although in drought years virtually no grasses grow. The appearance even in a good year is apt to be misleading--the grass is inevitably thinner than it appears. It does make a good feed for grazing animals however. The grass grows on the gravel and sand flats, and over the sand dunes. On the rocky hills and on the rock pediments, however, bushes take its place. This again is probably due to the greater water availability within the crevices of the rocks--a result of the storage of rainwater, however, rather than the concentration there of condensation from dew (due to the lower humidities dew is not common in the inner Namib). The succulent vegetation is of less consequence and a much greater proportion of the bushes are of a normal type.

Gross Morphological Adaptations

All in all, the plant growth of the Namib has adjusted itself to the aridity of the environment in the same way as the plant growth of other arid regions around the world. This is exhibited in many aspects of the gross morphology of the plants.

1) Leaflessness is a common feature, well exemplified by the narra bush, Asclepias filiformis, and the succulent Euphorbias.

2) As indicated above, virtually all the plants of the Outer Namib are succulent and thus able to retain water over long periods of drought.

3) Many of the plants (such as the Euphorbia) have milky or other forms of juice which harden quickly upon exposure to the air.

4) Many of the plants have poisonous or bad-tasting juices such as the Euphorbias and the tamma melon.

5) Proliferation of seeds in order to insure continuation of the species is a common attribute.

6) Many of the plants camouflage themselves so as to escape detection by the animals that otherwise would devour them. The extreme example of this is, of course, the Lithops.

7) Many of the plants, especially along the stream courses and in the Outer Namib, have halophytic properties.

8) A great part of the vegetation is spinescent: this habit ranges from the lowly Barlerias to the tall cactiform Euphorbias.

9) Many plants have developed a tremendous spread of the root system for the purpose of gathering water.

10) Most of the seeds of the desert plants are able to endure extraordinarily long periods of extreme dryness.

Comparison With The Mojave Desert

In all of the ways just mentioned the vegetation of the Namib is comparable to that of the Mojave. Most striking perhaps are certain similarities in the growth habits

of plants: the presence of many sprawling and prostrate forms; the cactiform appearance of some of the Euphorbias and the similarities between members of the lily family (Yucca brevifolia and Aloe dichotoma).

The great differences lie in the much greater presence of grass in the Inner Namib, the lack of dominance of one or two bush species over great areas of gravelly surfaces (such as is found in the Larrea-Franseria associations of the Mojave), and the vertical zonation of the desert mountain ranges. In South West Africa even the great Brandberg, rising over 8,000 feet above sea level, seems to possess almost no vertical zonation; whereas in the Mojave vertical zonation is apparent even on the alluvial fans, and the mountain ranges rear themselves completely out of the desert into coniferous woodland vegetation. In the Mojave this results from a combination of orographic precipitation and the greater moisture effectiveness due to cooler temperatures at the higher altitudes. In South West Africa orographic precipitation is virtually nonexistent. The entire area lies in the rain shadow of the Great Plateau of Africa and such rain as does fall comes solely in summer and is in the form of convectional showers triggered off by inequalities in surface heating. Even when this results in upslope breezes the rain commonly falls to the side of the mountain rather than over it. The writer's studies in the Mojave showed this also to be the case with the summer precipitation there, and he attributed the greater moisture of the mountains solely to winter orographic rainfall. In the Namib there is no winter moisture.

Nowhere in the Mojave or any of the other deserts of the United States do such tremendous tracts of absolute barrenness occur as those of the Outer Namib. The only barren areas of the Mojave are the salt lake playas and occasional small reaches of desert pavement. Nowhere is there anything approaching the barren immensity of the Namib.

Chapter VII

ANIMAL LIFE OF THE NAMIB

Except in the case of the distinctive fauna of the coastal area, no attempt has been made in the foregoing pages to discuss the animal life of the Namib in conjunction with the various landscape types. Most of the animals are so mobile that they range over several or many of these areas and hence can be viewed better against a broader background. Consequently, in the discussion of the fauna which follows four geographical areas are recognized: The Coast (already described), the Inner Namib, the Outer Namib, the Exotic Rivers.

Animals of the Inner Namib

The Inner Namib with its sweeping expanses of perennial grasslands is the home of great herds of herbivorous animals and their attendant predators. Until a decade ago the size of the herds was beyond belief--some of the antelopes apparently being numbered in the hundreds of thousands. Since World War II, however, the introduction of the Land Rover, the improvement of the roads in South-West Africa, and the settlement of the desert borders has made it easy for hunters to get into the area and the herds have been greatly decimated. This matter will be discussed in greater detail later in this work.

The Herbivorous Grazers

The perennial grasses of the Inner Namib and the adjacent steppes are extremely nutritious¹³⁰ and upon them depends an extraordinary preponderance of grazing animals (in contrast with more humid regions both in South West Africa and elsewhere where most of the animals are browsers). Chief among these are several species of antelope: gemsbok, springbok, steenbok, duiker, and klipspringer.

Gemsbok (Oryx gazella). The gemsbok¹³¹ is an antelope which looks much like a horse with horns. It is the size and general proportions of a horse with a short mane and a typical horse-like tail.

Its horns are straight and slanted back from above and behind the eyes, continuing the line of the face. When seen in profile at just the right positions the horns seem to merge into one--which is believed by some to have been the origin of the myth of the unicorn.

130. Vice: Heinrich Walter & Otto Volk, "Grundlagen der Weidewirtschaft in Südwestafrika." Stuttgart, (1954), pp. 116-142.

131. Roberts, op. cit., p. 297-98. Commonly called "Oryx" by the Germans to avoid confusion with the chamois or gemse for which it was misnamed. The term gemse-bock was probably intended for the klipspringer.

The basic color is a medium gray. The face is white with vertical dark brown bars across it. The mane is brownish-black and from it a brown stripe extends along the backbone to the rump. The tail is black. The white undersides are separated from the gray flanks by smooth brown bars.

These are gregarious animals usually traveling in herds of a few to scores. They are primarily grazing animals, but do eat other things such as tamma melons (which augment their water supply considerably) and the lower leaves and twigs of camelthorn trees and such shrubs as grow in the area. In summer, when it becomes quite warm in the daytime in the Inner Namib, they graze from dawn well into the forenoon and again from near sundown into the early evening, but they take refuge from the sun under the camelthorn trees along the omurambas during the mid-day heat. At such times nearly every camelthorn tree on the Inner Namib has from one to four gemsbok standing under it. They are a wary animal with good eyesight and are difficult to approach. In the Inner Namib in 1956-57 they were reproducing well: young animals were plentiful in every band visited. They are regular visitors to the water holes in the dry season, traveling to them by very well defined trails apparently shared with zebras. When grass is moist they do not frequent the permanent water holes as often, but spread out much farther over the plains, deriving moisture from their feed and small ephemeral water holes.

Old males are sometimes "kicked out of the herd"; at first, they wander nearby but detached from the others; in course of time they may be encountered in very remote areas in feedless country where they seem to trek aimlessly often reduced to skin and bones. The writer has encountered such individuals in the barren schist country about the Ubib water holes, nibbling at mats of brakslaai and on the vast flats east of the Rooikop where there is neither water nor feed. In the latter place an old male was encountered who was so weak that he would lay motionless until approached within a few yards at which point he would rise and walk away a short distance. Yet the same animal (presumably) was seen over a period of two weeks in the neighborhood always in the same condition.

Most of the month the gemsbok apparently sleeps like other animals, usually lying down in the bare trampled areas beneath the camelthorn trees. But at the time of the full moon they are active all night, apparently traveling about in bands, doing a bit of grazing, and at times prancing about and fighting mock encounters to the accompaniment of a clashing of horns in the bright moonlight.

The great herds are confined to the great grasslands of the Inner Namib extending north and south along the foot of the Great Western Escarpment for hundreds of miles. Since the convectional rains on which the grass depends are notoriously spotty the herds trek about in search of feed. In times of drought, however, they are forced to leave this zone completely. Driven into the highlands to the east by both the lack of feed and the drying up of their waterholes, they become serious competitors with the cattle and karakul sheep in that settled country.

Springbok (*Antidorcas marsupialis*). Even more numerous is the springbok.¹³² It is a smaller animal (standing only a little over 3 feet tall), but it more than compensates for this in its agility, for as the name implies it is able to spring high into the air and does on the slightest provocation.

Its markings are particularly beautiful. A broad band of dark reddish brown separates the tan flanks and back from the snow-white undersides. The faces are pure white with a brown line through the eye into the angle of the mouth.

From a distance a grazing herd of springbok blends in so completely with the yellow grasses that they are almost invisible. To the casual observer seeing a herd of hundreds grazing distantly on a gentle undulation, the landscape seems to be slowly pulsating, as a part of the herd moves forward as a body and then stops to graze while another part pushes ahead.

But when disturbed, everything changes. Rather than merely running, they move by great leaps high into the air. At times the leaps are solitary but often they are repeated again and again. Most striking of all is their remarkable habit of "pronking." On their rumps they have an area of long white hairs normally lying flat and covered with a normal tan hair; but at times they leap high in the air, arch their back and spread these white hairs out fan-wise, giving a momentary flash of dazzling whiteness. The reason for such pronking is not known. Some believe it to be an alarm signal (refer to Roberts, op. cit., p. 315) and others associate it with mating. The writer believes it is done for different reasons at different times. That the foregoing are valid he does not dispute, but the springbok is inherently such a happy, light-spirited animal, so full of joie-de-vivre that it seems at times that it "pronks" just for the fun of "pronking." Traveling by car on the monotonous flats of the Namib the writer not infrequently has had a springbok detach himself from the herd, and keep pace with the car (at 20 miles an hour) for minutes on end, pronking all the time. This is no alarm signal--if it were he could easily outdistance a car and spread the alarm ahead. If the car stops he may circle about and repeat the process when travel is resumed. Sometimes the springbok changes sides with a car, pronking on the left, later on the right. Such exhibitions have gone on for several miles without interruption.

The horns grow up to 15 inches in length. They are close together at the base, slant back in the prolongation of the profile of the face at the same time spreading outwards and turning back towards themselves near the ends. They are a dark brownish color and heavily ridged.

Springbok graze in herds ranging from a dozen to a hundred; when migrating groups of such herds join together they make bands numbering into the thousands.

132. This is the national animal of South Africa in much the same way as the eagle represents the United States but to an even greater and more popular extent. In South Africa the leading team of any sport (comparable in a sense to our All-American) is the springbok team and its members are ever after referred to as springboks. One branch of the state radio system (SABC) is known as Springbok Radio, the South African Airways has a "Springbok Service" and the little animal appears symbolically on all sorts of things--including even the official airmail stickers.

Such migrations are partly seasonal, but are most conspicuous when in droughts the animals migrate great distances in search of grazing.

Their diurnal regime does not seem to be as fixed as that of the gemsbok. The writer has seen them grazing in large numbers in the full sunlight on the hottest days (at times when the gemsbok were all in the shade).

Steenbok (*Raphicerus campestris steinhardti*). In contrast with the gemsbok and the springbok the steenbok are neither conspicuous, numerous, nor gregarious.¹³³ They are diminutive antelopes standing less than two feet tall, dainty and timid. They are tan on the back and flanks, white beneath on the undersides of the throat and about the eyes. The legs are brown all around. The horns are flat, straight, sharply pointed and about four inches long.

They are usually seen alone or in pairs and usually only at dusk and dawn. Apparently they spend the day in hiding; being so small they can hide themselves easily in the grass or amongst the rocks. Because their numbers are so small and because they are so diminutive they can scarcely be ranked among the common game animals of the Inner Namib.

Duiker (*Sylvicapra grimmia steinhardti*).¹³⁴ Similar in all ways to the steenbok is the equally tiny antelope, the buiker. They differ chiefly in their color, the duiker being more yellowish and lacking the white undersides except for a small patch on the throat and on the inside of the legs. Their habits are almost identical.

Klipsinger (*Oreotragus oreotragus*).¹³⁵ This amazing little antelope is very similar in gross appearance to the Duiker and the steenbok, yet is strikingly different in habit and habitat. Its size is comparable to that of the others; in color it is yellowish-tan dappled with brown, with very little white beneath.

They differ in their ability to clamber about on rocks (whence their name which means "rock jumper"). Their hoofs are broad and stout and they stand on the blunt ends of their hoofs like ballet dancers. They are both grazers and browsers, living on whatever grows among the boulders and the ledges of the kopjes. When startled they soar upwards over what seem to be impassable zones, jumping by stiff-legged bounces from one precarious perch to another. They often stand on ledges commanding a view of the country below, and when danger is noted give out a whistling note of alarm.

While they are known to drink at water holes when water is available they probably go for long periods without water by making use of succulent browse including many of the smaller rock plants and bushes. Nothing is known of their migrations or even if they occur.

Zebra (*Equus zebra hartmanni*; in Afrikaans bergkwagga).¹³⁶ Grazing over the plains in herds now numbering scores, but until a decade ago numbering hundreds,

133. Roberts, op. cit., p. 342.

134. Roberts, op. cit., pp. 329-330.

135. Roberts, op. cit., pp. 331-332.

136. Roberts, op. cit., p. 246.

are these wild horses. They have the general appearance of a horse with a good mane and a flowing tail, a typical horse-like head, and the same manner of motion. Their characteristic black bands alternate with cream or buff-color stripes (not with the white of the traditional zebra).

They are grazers with typical horse-like incisor teeth. Water is an absolute requirement, and they visit water holes by night where they spend a long period (over an hour usually) drinking. While they are usually in herds, sometimes these herds are mixed, containing a few gemsbok, springbok or some ostriches; and the writer has seen a flock of over forty ostriches grazing leisurely with three zebras.

During bad times the desert bands of zebras migrate into the highlands to the east--an area which is always frequented by numbers of indigenous zebras, for these animals are not by any means restricted to the plains country.

Hares. Two species of hares are to be found¹³⁷ in the Inner Namib: the Namib hare (Lepus capensis narranus; in Afrikaans Namibse vlakhaas); and the scrub hare (Lepus saxatilis khanensis; in Afrikaans Ribbokhaas or Kolhaas), but they are not plentiful, are rarely seen and are not an important part of the fauna of the area. While a member of the Game Commission of the Administration sent into the Namib to study grazing conditions, the writer helped extricate a lone hare from a crevice of a granite inselberg in the Central Namib near Ubib. All of the party, persons well acquainted with the Namib, were surprised to find a hare in that area.

Owing to their ability to get along with very little water and their vegetarian diet it would seem logical that the area would be well populated with these small rodents, and it is difficult to explain their paucity. Possibly it is a result of epidemics in the past (this group of animals is especially susceptible to certain epidemic diseases and parasites) and perhaps it is due to an overabundance of predators. The latter seems unlikely, however, in view of the large number of other burrowing rodents in the area.

Springhare (Pedetes cafer; Afrikaans, Springhaas). One of the burrowing rodents of the sandy country of the Inner Namib is the Springhare.¹³⁸ They are fairly large rodents measuring 12 inches to 18 inches in length, with a tendency to stand on their hind legs (which gives them the appearance of a kangaroo or a kangaroo rat, or of the American prairie dog). They are reddish brown above and buff beneath. Their forelegs are short and their hind legs long and powerful, which gives them the ability to jump high and far, hence their name. They are great burrowers, making mazes of holes in sandy country for protection against their enemies. Completely vegetarian, they subsist chiefly on grass seeds, roots and bulbs, all of which they gather at night, emerging from their burrows in the dusk and returning at dawn. They are distinctly a steppe-country animal, and cross into the Namib only along its borders.

137. Roberts, op. cit., pp. 513, 519.

138. Actually this is not a hare at all. It has long posed a problem to the systematist who today usually places the animal in a separate family between the Cane Rats (Thrynomidae) and the Dassie Rats (Petromyidae), and fairly close to the Porcupines (Hystricidae). Roberts, op. cit., pp. 349-352.

Smaller Rodents. A great number of smaller rodents and similar mammals burrow into the soft sands of the Inner Namib, or find homes in the crevices of the calcrete or the joints of the granite inselberges and kopjes. Their tracks and their burrows are in abundance nearly everywhere, especially in the better years. What becomes of them in the dry years, the writer cannot imagine. Too small to migrate very far, they must simply endure deprivations during those periods. No doubt most of them succumb, but enough survive to repopulate the area (thanks to their reproduction potentialities) when the rains return. No attempt was made to study them in detail. Among the species most likely to be found in the Inner Namib are:

Elephantulus barlowi okombahensis	Barlow's elephant shrew
Geosciurus inauria	Ground squirrel
Desmodillus auricularis	Gerbille
Gerbillus paeba swalius	Gerbille
Gerbillurus vallinus	Gerbille
Liotomys littledalei namibensis	Karro rat
Petromyscus bruchus	Rock mouse
Aethomys namaquensis namibensis	Golden rat
Rhodomys pumilo namibensis	Striped field mouse
Rhodomys pumilo bechuanae	Striped field mouse

Carnivores

Cat Family. Dependent upon the herbivorous population are predatory animals of all sizes and all kinds, ranging from the larger members of the cat family downwards. Lions prowled the region until quite recently, the last apparently having been killed at the Grosser Tinkas in the middle 30's. Both cheetahs (Acinonyx jubatus) and leopards (Panthera pardus shortridgei) live in the area today or visit it from the adjacent highlands. It is probable that wild cats (Felix lybica xanthella or Microfelis nigripes) also hunt near the kopjes and the escarpment foot.

Dog Family. Several members of the dog family also prey upon the herbivorous animals of the Inner Namib. Chief of them are the jackal, including probably a couple of varieties of the common jackal (Thos mesomelas) and the silver jackal (Vulpes chama). Also present is the Hyena (Hyaena brunnae) which subsists partially on decaying flesh; and its relative, the erdwolf or maanhaar jakkals (Proteles cristatus), which subsist entirely on termites.

Ant Bear. (Orycteropus afer, in Afrikaans Aardvark or Erdvark, literally "earth pig"). On the sandy plains of the Inner Namib one occasionally encounters a crater several feet in diameter, from the bottom of which a round hole often 18 inches in diameter extends on a slope of 20 or 30 degrees down deeply into the ground. Usually these occur in groups or colonies, often literally undermining the area. These are the burrows of the ant bear, curious survivors of an ancient type of mammal, usually placed by the systematists into a separate order (Tubulidentata).

The ant bear is a powerful animal, a prodigious digger with an elongated nose terminating in a pig-like snout, and a long tongue with which it laps up termites and ants in their mounds.

Long Eared Fox (Otocyon megalotis--in Afrikaans bakoorjakkals, literally "Bowl-eared jackal"; or draaijakkals--literally "turning jackal"; in German, Leffelhund--"spoon (eared) dog"). This curious little jackal-like animal ranges far out into the Namib in search of its prey--mice, ground squirrels and large insects. The writer has seen one in the midst of the great flats eight miles east of the Grosser Ubib, an area virtually devoid of vegetation.

The most characteristic feature of this animal is its huge ears, hence some of its popular names. It is a diminutive animal, dainty and agile. While chiefly nocturnal in its regime, it is occasionally flushed in daytime from bush clumps where it has been hiding. When followed, it has the curious habit of doubling back on its trail repeatedly, hence the second Afrikaans name.

Burrowing Carnivores. The Mongoose (Myonax sp.--in Afrikaans Muishond, literally "mouse-hound") living in holes in sandy country, and amidst the rocks of the kopjes, preys on all the smaller animals, especially the other rodents. It is a long, thin animal (much like the weasels of North America) which permits it to pursue many of its victims right into their burrows.

Some areas are literally honeycombed with the warrens of mierkats (Suricata marjoriae) a smaller burrowing rodent, living on any small mammal, reptile or beetle it can catch. Groups of them love to sit in the sun on the edges of their burrows, sitting up straight on their haunches, much as the American prairie dog does.

Occasional Visitors. The desert border is occasionally visited by wandering animals from the adjacent highland areas, among them, troops of baboons (Papio spp.) and packs of wild dogs (Lycaon pictus). At some of the kopjes along the border of the desert there are colonies of dassies (Procavia capensis), small marmot-like animals which live among the rocks.

Packs of wild dogs occasionally wander far out into the Namib on hunting forays. As the name implies, they are a dog-like animal, but their heads and ears are more like those of a hyena. While not dangerous to an able-bodied man, they live on antelopes and all similar animals, and if sufficiently hungry, would probably not hesitate to attack a sick or crippled human. The larger game are attacked by the whole pack, who leap at the victim and tear out portions of flesh as it runs, until eventually it drops from loss of blood. Their weird wailing cries (not unlike that of the American coyote) are most distinctive.

No attempt is made here to report on the lower animals of the Inner Namib. There are large numbers of lizards of several different species, a number of types of snakes, many of them poisonous, and myriads of insects of all types.

Avifauna

The writer makes no pretense at being an ornithologist and hence will not attempt to present a picture of the avifauna of the Namib. Much work could and should be done along this line, for there are many birds and their ecological relationships are no doubt most interesting. In the following paragraphs, only a few of the more distinctive birds are described.¹³⁹

139. A start on the ornithological study of South West Africa has been made by W. Hoesch in his "Die Vogelwelt Sudwestafrikas" published by the S.W. Africa Wissenschaftliche Gesellschaft, Windhoek, 1955.

By far the most characteristic and conspicuous of the birds is the ostrich (Struthio camelus australis; German Strauss; Afrikaans volstruis) so familiar to most readers that it needs no description. Although flightless, it is one of the most mobile of animals, being able to run at speeds of over 35 miles per hour. They seem to be ubiquitous--the writer has as often seen them in the thick brush as on the wide open plains. They are often seen alone, and yet a bunch of over 100 in an area of not over 2 acres was encountered near the foot of the escarpment in October 1956.

Today the birds are of virtually no use. In former times, their meat and their eggs were an important food, and in other areas their feathers have been used commercially. At one period, several decades ago, large numbers of them were shot in the Namib, after it was discovered that their crops sometimes contained diamonds, obviously picked up in the alluvial gravels of the southern desert. Their eggshells were used for water storage by Bushmen and fragments of shell constitutes the raw material for various types of native bead work.

Another nearly flightless bird, often seen along the desert border, is the bustard (Neotis ludwigii; Afrikaans, kleyn pou; German Klein pau). While not as large as the giant bustard of the more humid highlands to the east, it is still a sizeable bird, standing 2-1/2 feet high with a wing-spread well over four feet. A heavy bird, they are reputed to have very good meat, tasting much like turkey; because of this, it has been necessary to make them "royal game" to prevent their extinction.

A very noisy bird easily recognized by its raucous quacking when disturbed and by its short but vigorous flight is the koraan (German, Kojhaan or Namib-gans) of which several species occur in the Namib (Eupodotis spp and Afrotis afra).

Occasionally a traveler along the inner edge of the desert is amazed to see where a small haystack has apparently been tossed or blown into the branches of a camelthorn tree, an arborescent aloe or a telephone pole. This is actually the collective nest of the social waver bird (Philetarus socius; German, Seidelweber or Gesellschaftvogel; Afrikaans, Familievoël). It is often composed of 20 to 30 individual nests, all so interwoven as to be inseparable, with private entrances for each apartment. Despite the immense size of the collective nests (which average six feet in diameter and three feet in thickness) the birds are only a medium-sized finch, measuring some 3 inches in length and quite unimpressive in appearance.

Wherever an animal has been killed, one is likely to find black vultures (Torgos tracheliotus, German Ohrengeier; Afrikaans, Swart-aasvoël) tearing at its carcass and circling in the sky overhead. These hideous birds, brownish-black above and dirty yellow-brown with darker streaks beneath, are made especially ugly by the bare, wrinkled red skin of their necks.

Animals of the Outer Namib

Amidst the vast wastes of the Outer Namib--the great expanses of gravel flats, the shifting sea of sands, the broad reaches of granite pediment and schist ridges--all of them virtually devoid of plants, there is naturally a dearth of animal life. That any exists at all is remarkable.

Of the lower forms there are a number: flies, beetles (Tenebrionids) and lizards. Even in the totally plantless areas such as the shifting sand dunes, these

are to be found. What constitutes a base of the chain of food supply the writer cannot state. Perhaps it lies in microflora present within the sands and gravel.

Certain beetles are endemic on the Welwitschia, being found on these plants and only on them.

Surprisingly, several types of birds frequent the great wastes. Small flocks of a small lark are occasionally encountered; they must be virtually independent of water considering the locations at which they have been observed. These are probably the Namib lark (Ammomanes grayi; in Afrikaans Grayse-lewerkie; in German, Namib Lerche).¹⁴⁰

A small sparrow-like chat, probably either the Namib tapuit (Oenanthe albicans; in German, the Namib Schmatzer) or the desert chat (Karrucincla schlegelii; in German Wüsterschmatzer, and in Afrikaans, Bleek-tapuit),¹⁴¹ is also to be seen from time to time. Crows, probably the pied crow (Corvus albus; in Afrikaans, Bontkraai; in German, Schildrabe)¹⁴² are quite common. Vultures visit the area from time to time, and ostriches are occasionally encountered in small flocks. Falcons were seen on several occasions, both in the mountains and well out onto the flats and dunes. Hoesch reports the rock kestrel (Falco tinnunculus rupicolus; Afrikaans, rooi-valkie; German, Turmfalken)¹⁴³ from Rössing Mountain, and it probably has its eyries on some of other more ragged peaks as well.

The writer encountered no snakes in the Outer Namib, nor did he see any evidence of them. However, the Topnaar Hottentots along the Kuiseb River informed him at more than one werf that in the Graat Sand Dunes there is a type of cobra (they called it a dwarssloper rinkhals, literally, "cross-running ring-neck") which does not move in the manner of a normal snake, but has rather a sideward manner of locomotion. One local headman, both by sketches on the ground and motions with his arms portrayed very vividly the type of locomotion familiar to those acquainted with the American deserts, as the habitual pattern of the sidewinder.

Tracks of small mice have been observed, particularly about clumps of narras on the edges of the sand dunes, and collections of their droppings were observed in crevices and other sheltered spots amidst rocky ledges on the Rössing Mountain, and at the Swartbankberg.

A few of the larger mammals also occasionally visit the area, though such visits are more likely to occur in transit than to be evidences of permanent occupants. In the washes at Rössing, springbok tracks are omnipresent, and the writer has seen gemsbok 15 miles west of the Grosser Ubib. Leopards visit the outskirts of Walvis Bay from time to time, and the writer followed the spoor of a cat with an 8-inch diameter footprint for well over a mile in the vicinity of the Rooikop. It is very likely also that some of the other predators, including jackals, hyenas, and leffelhund make occasional "patrols" across the area.

140. Hoesch, op. cit., p. 179.

141. Hoesch, op. cit., p. 203.

142. Hoesch, op. cit., p. 248.

143. Hoesch, op. cit., p. 104.

Animals of the Exotic Rivers

Just as the river beds are extensions of the vegetation of the more humid interior across the desert, so also are they extensions of the animal life. It is very likely the presence of these rivers which brings the animals mentioned above into the adjacent desert country. In former times, the animal life of these river beds was amazing indeed. The first visitor to the Swakop River, Pieter Pienaar, traveling up it for twelve days¹⁴⁴ in 1793, saw over 300 rhinoceros, and an even greater number of elephants, gemsbok, springbok, water buffalo and lions. Today, of course, all of the above have been exterminated except for the antelope groups, and the goats of the natives have very much reduced the grazing potentialities for these animals. There is, nevertheless, a considerable amount of game moving up and down the broad, dry river bed at all times.

144. Vedder, op. cit., p. 38.

Chapter VIII

HUMAN UTILIZATION OF THE NAMIB

The Saan

Until the last few decades, small wandering bands of Bushmen hunted and gathered food over the wide expanses of the Namib Desert. Most of them belonged to a tribe known as the Saan (a term meaning "gatherer"¹⁴⁵), closely related to the Hei-kom peoples of the northern part of the Territory today, but actually more akin to the Hottentot or Nama than to the true Bushmen. Their habits and ways of life, however, were strictly of the Bushman type. They traveled in very small bands without any permanent places of abode, and lived entirely by the chase, the gathering of fruits, berries and "veldkos"--plants with starchy tubers. Today their artifacts, consisting chiefly of flakes, chips, worked points, and ostrich shell bead remnants, are to be found at many points, especially on kopjes near water holes, which they use as lookout points while watching for game. That the desert was long inhabited by these or other similar people is quite obvious. In many places over its surface one can find stones which show signs of having been worked--many of them with a well-developed patina of desert varnish.

None of the Saan remain in the Central Namib today, and probably there are none at all in South West Africa, except for a few wandering groups in the remote vastness of the Kaokoveld in the northwestern corner of the country. The others were exterminated largely in the mid-19th Century by Herero and Nama tribesmen.^{145a}

The Topnaar Hottentots

Along the major river beds, such as the Kuiseb and the Swakop, water exists near the surface all year round and is easily reached by shallow wells. Semi-permanent pools actually exist in a few places. These valleys have been long occupied by small groups of Topnaar Hottentots--an off-shoot of the Nama tribes.¹⁴⁶ Like their relatives, the Nama, these people have been goat-raisers through all historic time, and today, as in the past, they graze their animals up and down the riverbeds, allowing them to browse on the bushes and small trees, and the lower branches of the tall Anabome and Camelthorn trees. In addition, they gather large quantities of narra seeds, which they formerly ate, but which today they sell for cash to dealers in Walvis Bay. Today their diet consists chiefly of "mealiepap" (cornmeal mush) and the meat and milk of their goats.

145. Vedder, op. cit., p. 124.

145a. Vedder, op. cit., p. 174.

146. "South West Africa and the Union of South Africa" published (no date) by the Government of the Union of South Africa, p. 92.

Despite the poverty of its present inhabitants, the Swakop and Kuiseb Valleys have a great potentiality. There is abundant water just beneath the surface of the dry river beds, and thus wherever sufficient land and good enough soil occurs, there is a great possibility for practicing agriculture. This is well exemplified by the situation at Rooibank. At that point the missionary Scheppman, founding a post for the conversion of the Topnaars in 1845, planted a small grove of dates. The progeny of these original trees are still growing, virtually uncared for. It takes but little imagination to picture an almost continuous strip of date palms growing along the Kuiseb all the way from the deltal flats near Walvis Bay to some point in the interior where winter temperatures would become too cold to permit their growth. Were this the Near, Middle, or Far East, or the northern part of the African continent, this would no doubt be a lush date garden, irrigated by wheels, windmills and well sweeps, and supporting a much denser population at a better standard of living than the Hottentots now enjoy. It seems probable that dates could also be grown along the lower Swakop, Omaruru, Ugab and other rivers northward along the coast.

Unfortunately it is not inherent in the philosophy of the natives of this part of South West Africa to practice cultivation of the soil. The Nama have always been grazers and it is very difficult to change their way of life. The influence of the kraal remains very strong, and it would take extremely strong measures and much education by the whites to alter the present practices.

European Settlement

The Swakop Valley

In the last several decades, several farms have been cleared by Europeans along the lower Swakop River Valley. Notable among these are Goanikontes, Richthofen, Palmenhorst and Douglas. They have been cleared with relative ease and are irrigated by pumps drawing water from shallow wells. (See Figure 15) The water is of a usable nature, being fairly high in salt, but not toxic. One major problem plagues these farmers: floods. Most of them have been wiped out at least once by floodwaters of the river, for that stream, rising far back in the rugged interior region with its torrential summer rainfall, is subject to great fluctuation in discharge. In most ways these farms are very comparable to the Mormon farms along the narrow floodplains and terraces of the rivers of southern Utah, such as the Virgin. Like the Mormon farms, they carry on subsistence agriculture, and at a relatively low standard in today's economic system. Unlike the Mormon areas, there are no uplands here to graze, and hence no cattle fattening is carried out. However, if sufficient alfalfa (lucerne) were to be raised here, it might be economically practical to fatten cattle for immediate slaughter in Walvis Bay. At the present time, grass-fattened steers from the interior suffer considerably from the long rail haul to the seacoast for slaughtering, and a final fattening here in the lower Swakop valley with a subsequent short rail haul would cut such losses to a minimum.

The most promising future seems to lie in the production of vegetables and milk from Swakopmund and Walvis Bay. There is a growing market in those two towns, and no other source of supply in their immediate hinterland. Vegetables hauled by rail from the interior across the desert deteriorate rapidly. The farmers of the lower Swakop should be encouraged in this direction as much as possible, even to the extent of providing them with government subsidy.



Figure 15. An aerial view of one of the small European farms on the lower Swakop River, showing the many small irrigated fields, the windmill and the irrigation water storage tank, the farmhouse and the domestic water tank, and the desolate nature of the surrounding country.

Outer Namib

Even with the development of a cheap method of desalination of seawater, or with the discovery and development of some other remarkable, as yet undiscovered source for water, it is very unlikely that any agricultural or pastoral development will or can occur on the uplands of the Outer Namib. The areas of pediment and sand dunes are obviously worthless, and in the great gravel flats, the gypsum and salt content of the soil is so great as to preclude any possibility of agricultural use.

In short, aside from the urban uses associated with the Port of Walvis Bay, the recreational development at Swakopmund and elsewhere along the coast, the agricultural potentialities of the Kuiseb and Swakop and other rivers, and a possibility of mineral extraction, there is no likelihood of any development of the Outer Namib in the foreseeable future.

Inner Namib

The Inner Namib alternates between being a sea of highly nutritious grasses and a vast, barren waste. This alternation is both geographical and chronological:

even in "good" years, some areas are barren, while others are grassy; and the "good" years alternate with periods of long-lasting drought. To found a modern economy on such an unreliable base is, to say the least, hazardous. Until very recently, the area was unoccupied, and only the game suffered from the deprivation associated with drought. Even the natives avoided the Namib.

But with the filling up of the better part of the Territory and of the Union of South Africa, population pressure has increased, and today these marginal areas are in demand to help satisfy the land hunger of the Europeans of Southern Africa. This is especially true in years of good rainfall, when the areas have a good cover of nutritious grasses, and are obviously supporting large herds of game. If the game can make a living here, so can Karakul sheep, or even cattle is the general feeling. And for that year, the statement is obviously correct.

However, the newcomer to the area, or the over-optimistic land seeker, loses sight of one important aspect of the situation: the extreme mobility of the game. With little apparent effort, the herds of game trek or migrate hundreds of miles in search of better grazing in the years when the rains fail. That such is the case is common knowledge, although no really scientific studies have ever been made to prove it. A succession of good years brings up the grass, and seemingly out of nowhere vast herds of springbok, gemsbok and zebra appear to feast on it. Anyone familiar with the country can recount experiences connected with such vast migrations.

In much the same manner, the early herders--both native and white--moved (trekked) their flocks and herds great distances in times of drought. There was little to restrict them: there was much empty land to and across which herds could travel and fences were nonexistent.

Since the German settlement in the 1890's, and especially since World War II, the more humid interior uplands have been gradually shut off to the migrating desert game herds by fences, by competition from domestic stock, and by the usurpation of the waterholes. Much game still exists on each ranch--but the mass movement of great herds is very much restricted today.

Similarly the division of most of the territory into ranches¹⁴⁷ (farms) and the steady growth of the cattle and sheep population thereon has diminished the possibility of trekking for drought-stricken ranchers. Hence the herdsman of the

147. The term "ranch" is derived from the Spanish rancho, and was introduced into the American Southwest from Mexico. It fills a gap in English vocabulary--there being no correlative in the British Isles for the extensive range-animal enterprise of the more arid world, and hence no terminology has developed. The other two languages of South West Africa (German and Afrikaans) are also of north European origin, and are similarly deficient in terminology. Consequently, the term "farm" has been extended by default to enterprises which in America would be called "ranches." No distinction is made in the language between pastoral and agricultural enterprises. A cattle or sheep raiser is a "farmer" even though he does not own a plow and his animals graze tens of thousands of acres. It is only since the advent of the motion picture that the word "ranch" has been known in the Territory, and it is never used in common speech.

desert border area, admittedly grazing marginal lands, will have no place to which to trek his animals for relief. So the effects of the drought will become much worse than formerly. When herds can migrate, the vegetation of the drought area is spared the excessive grazing that would otherwise ensue. Under the present conditions, "tramping out," overgrazing, and over-browsing will be commonplace, which will reduce the ability of the vegetation to recuperate with the return of the rains, and thus have the effect of artificially extending the desert.

Nor will the effects be limited to the desert itself. Many desert border ranchers have relatives or business affiliates in the more humid interior. It is inevitable that when grazing conditions become intolerable in the desert, these people will move at least some of their animals out to the ranches of their friends or relations, and so overgrazing will be carried into the areas of better natural endowment, spoiling them as well.

Ranches have already been granted too far westward into the Namib: it is most unfortunate that the outermost row was not left in "Crown Lands" or game reserves. People have been allowed to settle there, to build permanent homes, and to invest years of their lives in establishing ranching facilities in an area in which it is inevitable that the first major drought will bring financial disaster.

The second row of ranches is not in so critical a state. Establishments like Donkerhuk (Karibib District) date back to early German times and have succeeded in weathering the worst droughts. But to do so they have formerly used large unassigned tracts to which they could trek their animals in the bad years. By hemming them in with more "farms," a great injustice has been done both to the occupants of the older establishments and to the new pioneers.

Under no circumstances should "farms" be awarded farther westward into the Namib. The rainfall drops off very rapidly away from the top of the escarpment across the Namib platform. Any farm which is abandoned as a result of drought in this zone should be taken over by the Administration and returned to the status of "Crown Lands."

The once vast herds of game in the Inner Namib have been greatly depleted since World War II by hunters. This is as true within Game Reserve 3 as it is within the adjacent unassigned lands, or on the settled ranches. That this has been allowed to occur is most unfortunate, and it is the writer's hope that measures recently taken to curtail such hunting will be effective. Such herds of animals can be of direct practical value to the Territory, as well as being of inestimable esthetic value. In a day in which tourism is on the increase at a spectacular rate, the presence of immense game herds on an attractive landscape near a major port, such as Walvis Bay, could easily be developed into a major tourist attraction. No new legislation would be required, for the area has long been a game reserve (having been created during German time). All that is required is the enforcement and implementation of present regulations, and the establishment of some sort of transportation service by which tourists could be taken from ships at Walvis Bay to the Inner Namib. It would be quite simple and inexpensive to scout out the principal concentrations of game in advance by means of a light aircraft, so that the tourists' time would not be lost on fruitless searchings. The writer recommends strongly, not only that the game reserve be continued in existence, but that it be extended southward to the boundaries of the Diamond Reserve (sperrgebiet) and northward to the Red Line at the Ugab River,

thereby amalgamating it with the Brandberg Nature Reserve. This would provide a tremendous sweep of country over which the animals would be able to trek unmolested, as well as serving as a reproductive region from which game could trek out to adjacent highland areas. To range the land is a risky venture. Making it a great game park, handy to the coastal ports, would certainly do no harm and might prove profitable.

Transportation

Generally speaking, transportation has never been a major problem in the Namib Desert north of the Kuiseb River. Large expanses are floored with bedrock, usually beveled to a nearly smooth surface. Elsewhere flat surfaces of moderate to coarse gravel allow movement freely in all directions. The inselberge are few and small; the linear bedrock ridges are broken at convenient intervals; and the sand dunes are limited in extent. Only the major omurambas and the gorges of the Swakop, Khan and Kuiseb impose major obstacles. A wheeled vehicle can go almost anywhere in this part of the Namib.

Until the close of World War II, only one major route crossed the desert to the coast. Taking advantage of the absence of the Great Western Escarpment of Africa in the vicinity of Usakos, the railway, paralleled by a road, passed by easy grades from the upland plains of Hereroland onto the Namib platform and thence to the coast. This is still the major route from the interior to Swakopmund and Walvis Bay.

In the past few years, however, several new routes have been opened. A road, graded at irregular intervals, runs southeast from Walvis Bay across the Namib Platform to the point at which the Kuiseb River emerges from the Escarpment. There it trifurcates, one branch going eventually to Windhoek, another to Rehoboth, and a third to Maltahöhe. A few ranchers living on or below the escarpment haul their gasoline and other supplies from Walvis Bay by this route; otherwise it is very little traveled. There are no gasoline supplies or other facilities along it for several hundred miles.

A second route has recently been graded from Swakopmund directly east, parallel to the south edge of the Swakop Gorge to the farm Onanis (near the Lintvelt's Poort weather station) and thence up the escarpment and across the Khomas Hochland to Windhoek. Its long sandy stretches trap the unwary, and several parties have narrowly escaped death by thirst when stuck therein. The great distance (110 miles) of total emptiness along it poses a serious threat. It is little used as yet.

Further north a route has been recently graded from Usakos directly across the Namib to Henty's Bay. It is used by vacationers and fishermen going to the camps along the coast. Another route, very little used, runs south from Welwitschia through Sorris-Sorris, east of the Brandberg and past the Uis Tin mines to the coast north of Henty's Bay.

Although indicated upon the World Aeronautical Chart, there is no road parallel to the Kuiseb river.

For various reasons certain older routes across the desert have been abandoned in modern times. One of the oldest of these mentioned by McKiernan as being of importance in 1876, ran northeastward from Walvis Bay across the Namib Platform

to Heigamchab at the junction of the Khan and Swakop Rivers, and thence via the inter-fluve between those two streams to Usakos. This route is of no consequence whatever today, but its former importance is shown by the fact that the portion of it lying within the British enclave of Walvis Bay became the route of the first railway line in South West Africa--a line which hauled supplies from the port to the boundary of the enclave, a little north of the Rooikop. The old locomotive used on this line is at present on exhibit in front of the railway station at Windhoek. The old rail route can be seen today only as a line of rust stains across the gray Namib sands.

The original railway line built by the Germans from Swakopmund into the interior followed a different route from that of today. Branching from the modern line at Rössing, it crossed the Khan River near the Khan mine and climbing out onto the inter-fluve it crossed the Namib Platform directly eastward, making use of several gaps or poorts in the conspicuous linear ridges that characterize that area. From the siding called Jackalswater, south of Usakos, it curved gradually northward eventually crossing the modern line at Karibib, and thence heading northward to Omaruru. Only its grade is still visible today.

Another route no longer of consequence passed directly eastward from Walvis Bay across the Namib Platform to the Langer Heinrich Mountain. Descending into the Swakop Gorge at the farm of Salem, it followed the Swakop River upstream to the once-important mission station of Otjimbingwe.

It is of course impossible to say what the future routes across the desert will be. Without question, the present one from Usakos to Swakopmund, parallel to the railway, will remain important since it serves the entire northern part of the Territory.

In the writer's opinion the direct route across the Namib from Windhoek via the Khomas Hochland and farm Onanis should be improved, realigned and surfaced as soon as practical. Traffic between the capital and the port is increasing daily and this route is so much shorter and could be so much faster that it is well worth the trouble to develop it. The section in the Escarpment itself should be completely relocated since a much better route topographically is available. Surfacing should be applied at first in the areas of sand on the Tinkas Flats west of farm Onanis. Private enterprise should be encouraged by subsidy if necessary to establish a gasoline and repair station in the vicinity of the Escarpment, and a police post in the area equipped with either telephone or radio telephone would add greatly to the security of travelers using the route.

South of the Kuiseb River all surface and air travel is prohibited by law inasmuch as this is the region of the Diamond Reserves. But even were it permitted legally, the area would be practically impenetrable because of the nature of the surface: any form of surface travel would be almost impossible in this area of sand dunes of mountainous proportions. No roads or tracks of any sort penetrate far into the area. Only along the rivers which flow a short distance into the dunes is travel possible and even these routes end abruptly at the terminal Vleie.

Chapter IX

THE FUTURE

As a means of summarizing this study of the capabilities of the Namib Desert, it is well here to consider the future prospects of the area.

Mineral Resources

In the past, a few workings of copper, tin and other metallic ores have been carried on, notably at the Khan mine near Rössing, at the Sphinx mine south of Usakos and at the Uis and Brandberg Wes mines near the Brandberg mountains. Changes in price structures and operating costs and new ore recovery techniques might bring about their reopening at any time, but it is unlikely that the operation will ever be carried on on a large scale. Additional prospecting may reveal other reserves of some metallic or non-metallic ores, but large-scale developments seem quite unlikely.

The marbles exposed in some of the linear ridges may be used for cement; however, these same beds outcrop in more easily accessible positions in the vicinity of Karibib, and the construction of a cement plant is much more likely at that location on the railroad than at any place within the desert.

As has been indicated, large reserves of salt and gypsum occur. While these are the basis of the chemical industry in various other parts of the world, such a development here is unlikely due to the total absence of mineral fuel. Hence it is likely that extraction will continue in the future on the present scale, but not at any greatly increased rate.

The discovery of reserves of petroleum is extremely unlikely. The recent petroleum discoveries in similar locations relative to the coast in more northerly parts of Africa, have awakened a great interest in the subject here in recent years, and concessions for petroleum prospecting have been given out to various parties by the Southwest Africa Administration. However, the area is underlain only by igneous and metamorphic rock and no petroleum producing structures are at all likely. The eruptions of hydrogen sulphide gas from the harbor at Walvis Bay, which have been cited as evidences of petroleum, are very probably the result of purely surficial emanations not at all connected with natural gas reservoirs.

The discovery of diamonds in the area is a possibility. The likelihood has been reinforced recently by the discovery northward on the Skeleton Coast and it is not beyond belief that some of the deep gravel deposits underlying the Namib Flats are diamondiferous. Many shallow diggings made at various times in the past have apparently yielded nothing and the diamonds found in the crops of ostriches in the Walvis Bay area were undoubtedly secured somewhere much farther to the south within the present Sperrgebiet.

Grazing Capabilities

As already described in the section dealing with the Inner Namib, great care should be taken in the handling of the grazing of the desert and the desert borders. Very strict limitations upon the numbers of animals grazed and the season of grazing should be imposed. It would be possible to give temporary grazing licenses during good years, but the writer believes this to be a dangerous procedure in that it only encourages the carrying of herds and flocks larger than can be handled on the interior ranches during drought periods. During dry years no grazing at all should be permitted in the Inner Namib.

No grazing is possible at any time in the Middle and Outer Namib; neither water nor forage are normally available there.

In general the writer believes that the farms have already been pushed too far desertwards and that in spite of the good growth of grass during occasional wet years, grazing should not be permitted more than a few miles west of the foot of the Escarpment.

Agriculture

Cultivation of the soil is possible only along the Kuiseb and Swakop Rivers, as described in preceding chapters. The writer firmly believes that dates, citrus fruits, avocados and other tropical and semi-tropical fruits could easily be grown wherever topography permits along the lower region of those streams. Fruits grown there should find a ready market in Walvis Bay and Swakopmund as well as in Windhoek and should the supply be great enough and the quality high enough, it might be possible to make overseas shipments from the port of Walvis Bay.

Before any consideration is given to the development of agriculture in these two valleys, however, it is necessary for an agreement to be reached concerning the allocation of the water supply of the two rivers between agriculture and the municipal demand of Walvis Bay and Swakopmund. The supply is not limitless. Agricultural development can be sacrificed, but the port expansion cannot. Furthermore, any agricultural development should be preceded by a good agricultural survey of the area, including studies of the winter minimum temperatures and summer maximum temperatures, the testing of the soil and consideration of the water supply both in volume and in mineral content. At the same time arrangement must also be made to either guarantee the employment of the Topnaar Hottentots upon the farms to be developed there or else to find a satisfactory relocation site for them.

As has been indicated previously, it might well be advisable to allocate some areas to the raising of alfalfa (lucerne) for the fattening of beef cattle prior to slaughter at Walvis Bay.

No dry farming of grains should ever be permitted anywhere in the interior part of the area even in rainy years, since it would lay the land open to extreme wind erosion during ensuing drier periods.

Urban Development

Assuming continuation of world and hence Territorial prosperity, Walvis Bay will probably continue to grow in both size and importance. Its role as the only major port for the Territory will be augmented by important industrial developments. It is a natural site for the development of a large meat packing establishment, thereby eliminating the present expensive and awkward rail haul to the Union. Overseas markets for meat, especially in the frozen form, should be diligently sought. The proximity of the meatless tropics (such as the Belgian Congo) and their rising prosperity suggests great possibilities there; and shipment could easily be made to the Cape and to other coastal points in the Union.

The processing of goods prior to overseas shipment can be carried on most expeditiously at Walvis Bay and will probably result in a continued expansion of the industrial area. Packaging, bottling and canning of goods received in bulk form from overseas or from the Union for retail sale in South West Africa could logically be carried out at Walvis Bay.

Physically the expansion of Walvis Bay is limited only by its water supply, and careful consideration must be given to this aspect if any agricultural development is anticipated upstream on the Kuiseb River. There will be no problem in this regard, however, if the Water Supply Division of the South West Africa Administration continues its present farsighted policy. Obviously should the desalinization of sea water become a matter of practical development in the near future, there will be no water problem at Walvis Bay.

Swakopmund, as the traditional summer capital (socially as well as politically) will probably continue its seasonal fluctuations in population. At present it suffers seriously from lack of proper accommodations. Development of seaside hotels of the caliber of the Continental at Windhoek or the Minen in Tsumeb would enhance it greatly and would probably prolong the "season" very greatly. But because of its bleak surroundings, its cold ocean and its climate (which is attractive only by contrast) it can never hope to draw any appreciable number of visitors from the Union or other parts of Southern Africa. It will never have the attractiveness of Hermanus, the Wilderness or Margate.

If the town is to develop much beyond its present scope it must have an adequate water supply of high quality. Further development of the Swakop River will at best yield only a mediocre supply in regard to quality and only a moderately increased quantity. It will be essential to improve this supply by both quantity and quality if the town is to go ahead.

A pipeline from Rooibank is not out of reason and could greatly change the water supply picture at Swakopmund. However, since the supply is not inexhaustible at Rooibank it is suggested that Swakopmund be provided with two water supply systems: the existing supply to provide water for the sanitation system, and the Rooibank system for washing, bathing and drinking purposes.

Solar Energy

The writer is strongly imbued with a belief that the deserts of the world represent the next great frontier for mankind; and that within them a great industrial

development based chiefly on inexpensive solar energy is about to occur. For the deserts of the Western United States and even for areas such as the Sahara and Australia he envisions rapid expansion in the not-distant future.

He does not, however, make such predictions for the Outer Namib where the high incidence of fog and humidity greatly reduce the effectiveness of solar radiation and eliminate the usual advantage of desert areas. In the Inner Namib the incidence of sunlight is greater, but not truly spectacular. The high interior plateau with its extraordinary receipt of insolation is a far more likely site for solar-powered industry than is the Namib.

Tourism

As has already been indicated, the writer believes that the area has a considerable potential for the development of tourism. Passengers from ships calling at Walvis Bay would enjoy viewing the Great Sand Dunes between that port and Swakopmund, photographing the colorful Herero women of the Swakopmund location, and seeing the great game herds of the Inner Namib. Care should be taken, however, to guarantee that they do see game and that the Herero women are available for photographs. Otherwise Swakopmund will be merely another drab town and the desert merely an empty waste visited from a bleak, bad-smelling port. Groups staying longer than a couple of days should be taken directly to the Etosha Pan Reserve in the northern part of South West Africa in order to see there the vast game herds and to offset the belief that Walvis Bay is representative of South West Africa.

Such tourism will not be highly lucrative, but it will add some income to the Territory, improve the opinion held of it overseas, and turn a liability (the Namib desert) into a minor resource.

In summary, it may be said that while the Namib is one of the emptiest, bleakest, most useless areas of the world, it is not totally without possibilities and if properly handled, may serve as a not-too-unpleasant home for a limited number of people for an indefinite period in the future.

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