IMPRESSIONS OF THE NAMIB DESERT OF SOUTH WEST AFRICA

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On the west coast of southern Africa, next to the Atlantic Ocean, lies a narrow strip of arid land some 1,300 miles long and varying in width from 50 to 100 miles. This is the famous Namib Desert of South West Africa, which extends north into southern Angola and southward into the Cape Province of the Republic of South Africa. Geologically it is probably the oldest desert on this earth, well over a million years in age. It is also one of the driest deserts, virtually rainless with some areas receiving no moisture at all for several years. Yet the Namib is unusual because of its cool climate, high humidity, and frequent fogs.

Dividing this interesting coastal strip into two portions, one northern and the other southern, is an exotic river, the Kuiseb, which flows from the eastern highlands more or less in an east-west direction. Much of its course is underground. This intermittent river has its source near Windhoek in the interior and its mouth in the Atlantic at Walvis Bay. When there are heavy rains on the highlands, the Kuiseb may temporarily become a raging torrent of flood-water with considerable destructive power. Most of the time however, its bed is dry, with only a few scattered pools along its route, pools that eventually dry up but which may be populated by frogs, aquatic insects, and even fish for a few weeks.

The ephemeral Kuiseb River also plays a curious geologic role in preventing the northward migrations of the "sea of sand" that covers most of the southern half of the Namib. This vast area of sand consists of very long dunes that parallel the coast. Some individual crests are nearly a thousand feet high and these chains of dunes extend south of the Kuiseb for about two hundred miles. These sand mountains apparently do not migrate from side to side since the prevailing winds responsible for them are from the south, and they are on such a grand scale that American astronauts were able to see and photograph them from space. There are few roads into this area, most of which are prohibited to travel for this is a famous diamond region. The photographs taken from space have been of great help in mapping this desolate and forbidding territory.

What sand that does get blown northward into the Kuiseb river-bed is washed out annually by the flash-floods from the interior. Over hundreds of years' time, however, considerable sand has managed to accumulate just across the mouth of the Kuiseb and now huge dunes, parallel to the coast, stretch from Walvis Bay north to the resort town of Swakopmund and beyond. It was these dunes that were recently used as the location for the filming of the curious cinema "Sands of the Kalahari".

Another curious fact about the "sea of sand" is that the dunes do not have an uniform color throughout. Along the so-called Skeleton Coast the dunes are white, nearly approaching the dazzling whiteness of New Mexico's White Sands (which are of gypsum). But as one drives eastward, as from Walvis Bay to Gobabeb, one is soon aware of a gradual change. The white gives way to a pinkish hue, which gradually becomes more and more orange until by the time you reach the Research Station at Gobabeb the dunes have become a deep red color. In the late afternoon and at sunset, especially, the red becomes almost startling. The nearest thing to this color that I have seen in the States is in the Four Corners Country, especially in Monument Valley in Arizona and Utah.

From sea level, the elevation of the Namib Desert increases very gradually to the east. At Gobabeb it is just over 400 meters, about 1,300 feet. On the far side of the Namib the topography goes from uninterrupted flatness to low rolling hills. Locally, this is called the pro-Namib. Between 50 and 80 miles from the coast the 3,000-foot escarpment is reached. I shall never forget my first view of the Namib from the air, flying low in a small commercial plane from Windhoek to Walvis Bay. When we had eased over this mountainous highland, the pilot swooped our plane down low over the plain beyond, in true Cinerama fashion, so that we seemed to skim over the land. There were only a few scattered bushes and little to break the monotony of the flatness except a few fleeing groups of startled ostrich, springbok, and oryx.

This, my first view of the Namib, impressed me most by the lack of mountains on any of the horizons. I was prepared for flatness, but not quite on such a grand scale. Nor had I anticipated the very scanty vegetation: practically no bushes and certainly no trees! What a contrast to much of our American deserts which usually have such a cover of low bushes and scattered trees that they are called arborescent deserts. Only in California's Death Valley or in Idaho's Craters of the Moon or in some of the dry lake areas of the Mohave Desert have I seen country comparing to this part of the Namib, almost completely devoid of vegetation as it was. None of our areas like this are very extensive, yet here below me were hundreds of square miles!

Later on, when I drove over the surface of it, I began to get the "feel" of the Namib: a sense of loneliness and of being utterly detached from all other life. To many persons this might elicit fear; to me, it was a feeling of awe, almost religious, and there was a distinctive unique beauty in this great panorama of flatness .. as far as the eye could see in any direction.

What caused and what continues to maintain this oldest of deserts? As usual, several factors must be taken into consideration. Most of our arid regions in America are due to the fact that they lie in the rain-shadow of high mountains which separate them from the coastal rains. Moisture-laden clouds, sweeping landward from the Pacific, are forced to rise over two miles or more to get over the mountain barrier; at this altitude the clouds are chilled and cannot continue to carry their load of water further and it falls as rain on the windward side. Very little, if any, moisture gets to the desert side. But in the case of the Namib, there are no intervening mountains along the coast. We find two other desert areas without high land barriers between them and the sea: the peninsula of Baja California in Mexico and the famous Atacama Desert of northern Chile. Both of these deserts, like the Namib, are situated right on the flat coast itself.

Is there a common factor besides aridity in these three widely separated regions? They are all located adjacent to quite cold offshore water. In the case of the Namib it is a north-flowing arm of the South Equatorial Current, an eastward continuation of the Brazil Current. This is called the Benguela Current, with an average temperature of 60° F., that cools the air above it to such an extent that the current acts like a mountain barrier. Warmer rain-clouds sweeping shoreward from the Atlantic are cooled as they move over the chilled air above this cold water. Consequently, rain tends to fall at sea, just off shore. In addition, here as in Chile and Mexico, there is another very important factor involved: upwelling. This is caused by offshore winds or by winds that blow parallel to the coastline, as they do in South West Africa. The surface waters are literally blown away from the shore, creating what might be thought of as a "hollow" in the sea level along the coast. To compensate for this, water upwells from the deep to replace that blown away. Because this water comes from some

depth, it is much colder than the surface layer; it is this upwelling that makes the coastal water even colder. In addition, dissolved nutrients are also brought to the surface and this nourishes the microscopic plant life of the plankton to the extent that "blooms" occur irregularly. This in turn sets off an impetus in the food-web so that where upwelling does occur, excellent fishing is to be found. All of this cold offshore water also tends to cause a pronounced stability of the air above the land, forming an inversion layer several thousand feet thick. Unstable conditions are necessary for rain.

Still another determining factor in the aridity of the Namib Desert is its great width. If any storm clouds form in the interior and sweep westward over the escarpment, they are immediately met by a wall of warm uprising air from the desert floor, and what moisture they might still have is usually evaporated before they can get beyond the pro-Namib. This eastern hot wind is called the Berg Wind and it is a typical foehn like our local Santa Ana winds.

Strangely enough, like the Atacama and the Vizcaino, the Namib is a fog desert. Even though the annual rainfall at Swakopmund, for example, is only 0.6 inches, on the average, the humidity is generally well over 90% and often nearly 100%! This means that the air is literally saturated with dew. One has only to camp overnight in any of these deserts to become aware of this fact: next morning he will find his sleeping-bag or tent dripping wet. Desert fogs are also common, another anomaly, and they extend as much as 30 miles inland from the coast. It has been estimated that nearer the coast this fog may produce between 1.4 and 1.6 inches of moisture a year; twenty-five miles inland this may drop from 1.2 to 0.8 inches, not an inconsequential amount. It must be obvious that what few plants that are able to survive under these conditions must depend a great deal upon this dew as a source of water, as must also the many xeric animals of the Namib.

Near the beach live several small plants, such as an amaranth (Aerva leubnitziae) and an ice-plant (Mesembryanthemum salicornioides), both of which form so-called "elephant head" dunes to their leeward, exactly as do our creosote bushes (Larrea divaricata) and our burro-bushes (Franseria dumosa) in California's San Gorgonio Pass. These plants cause loose sand to accumulate around their bases; this gradually increasing pile tends to taper off away from the direction of the wind. Eventually the bush may be entirely covered with sand if it cannot keep growing above it.

After reaching Gobabeb, which is 70 miles by landrover southwest of Walvis Bay, I got settled at the Desert Research Station there. The Station was conceived and founded by the famous coleopterist Dr. Charles Koch, who originally camped-out here in a trailer, all by himself, for months at a time. Later the Transvaal Museum in Pretoria, Republic of South Africa, became interested in Dr. Koch's project and finally a Research Association was established. Funds were obtained to build the model research facilities, laboratory, library, accomodations, and complete weather station. It is located at 23° 34' south latitude and 15° 03' east at an elevation of 408 meters (1326 feet). At present there are but four on the permanent staff: Dr. Koch and his wife, and a student assistant Eric, and his wife.

Within twenty minutes of my arrival I walked down to the Kuiseb River bed which is immediately below the Station (it's built upon a rocky knoll overlooking the river, with the towering red dunes just beyond and the flat plains stretching endlessly in the other direction). My first impression in the arroyo (as we would call it) was that I was back in California in a dry wash on the Sonoran Desert.

There were trees that much resembled our mesquites (Prosopis) and others that superficially reminded me of our cottonwoods (Populus Fremontii). These new trees turned out to be two species of acacias: Acacia giraffae the Camel Thorn and Acacia albida the Anaboom. Also present were clumps of tamarisk (Tamarix austroafricana), quite similar to the introduced tamarisks so prevalent throughout our own Southwestern deserts. There were now dead stands of the thorn-apple Datura, sp. which are also so common along our desert washes. The Ebony Tree (Euclea pseudebenus), however, has no real counterpart in America; it reminded me a bit of the weeping willow. Wild tree-tobacco (Nicotiana) is an escape here.

One thing I did note (here, at least) was that there was practically no brush along the edge of the river course (which they term an "omuramba"). Along most of our arroyos much more brush growth than trees is usually to be found, and the bushes extend some distance away from the banks. Later on during my visit, I did see another section of the Kuiseb, further north, and there were great areas there of a low thorny bush, probably Lycium marlothii; so the lack of brush near the Station may not be typical.

Away from the river the Namib Desert becomes the more typical flat plain, dissected here and there by shallow ravines and miniature canyons, varying with the substrate. In these little side washes grows the peculiar leafless Narra (Acanthosicyos horrida) much resembling at a distance our Desert Tea (Ephedra, sp.) not only in its lack of leaves but in its form of growth, usually on little hillocks where water has washed away the intervening soil. The Nara produces a fairly large melonlike fruit much like our Coyote Melon (Curcubita). This melon is highly prized by the local Topnaar Hottentots and is one of their staple foods, the seeds being ground into a flour. A native beer is also made from it.

Near the bases of the sand dunes, where they rise from the plains, there are often large clumps of a tough yellow grass that looks much like our carrizo cane (Phragmites). This grass is Eragrostis spinescens and upon it may be found growing a fungus, upon which feeds a coccid scale insect which in turn is tended by large ants: an interesting and complicated symbiotic association. There are also several species of scattered short grasses, mostly of the genus Aristida, that appear only infrequently in the flat areas. This situation also is in contrast to our deserts where there are many species of arid grasses over most of our deserts at certain times of the year. Much of the central Australian deserts also contain vast fields of tall grasses and dense clumps of the notorious spinifex grass.

I was indeed lucky on my visit to see a "greenish" Namib. There had been the usual prolonged drought of some eight years, followed by unusual rain storms about a month previous. Now, almost like a film over the whole plain, was a light green grass, only about three inches high and in scattered clumps. Its seeds, like most xeric species, can withstand complete desiccation and remain dormant for years until conditions are just right.

That afternoon Dr. Koch kindly drove me in one of the Station's landrovers to some nearby washes. Here was growing a plant that had actually motivated me to visit South West Africa, for it grows only in this country, in very restricted areas, from here northward into neighboring Angola. Gobabeb is its southernmost known occurrence. This strange plant is the Welwitschia mirabilis (formerly W. bainesii), classified as a primitive gymnosperm in a group that includes our Desert Tea (Ephedra).

Whereas our ephedras have no leaves (only scale-like deciduous ones on new shoots) the Welwitschia has two broad strap-like ones that continue to elongate and grow for the lifetime of the plant (which in large specimens has been estimated to be several hundreds of years!). The two leaves arise from the top edge of the thick basal trunk; each extends half way around the circumference. At first the leaves are band-like in appearance, but as they grow outward, lying flat on the ground, the wind soon splits each leaf into narrow ribbons, which remain attached to the parent plant and continue to elongate. These leathery and often yellowish ribbons may reach a length of 8 or 10 feet as the trunk grows upward to a height of several feet. The sexes are separate in Welwitschia as they are in our ephedras. The male plant produces a series of small staminate cones on short stems which arise along the inner border where the leaves and trunk join. Pollen from these is wind-dispersed but Dr. Koch thinks that certain beetles may also aid in pollination. The female cones, also on short stems, are about four times larger and produce small winged seeds.

Our ephedras are not at all like the Welwitschia except perhaps in a similar cone shape, so this strange plant has no real counterpart in our desert. It is odd that two such primitive relatives of the conifers should both be now found in arid regions. Or perhaps they could only survive under these conditions where there is certainly less competition and fewer herbivores to eat them.

On the Namib plains here was a species of Parkinsonia (Parkinsonia africana), related to our Palo Verde (Cercidium). It has reduced leaves and small linear pods; its seeds are ground-up by the Hottentot as a coffee substitute. Here there is also a bush acacia (Acacia reficiens) and a shrub milkweed (Asclepias filiformis), neither of which reminded me of our only native acacia, the cats-claw (Acacia Greggii) or of any of our milkweeds in the same genus. Another familiar genus that occurs on our desert is Cleome, our bee-plant; the Namib species is Cleome diandra and has prominent yellow flowers. There is also a member of Burseraceae (which includes our Elephant Trees); the Namib representative is Commiphora saxicola and it has the typical swollen trunks but is a dwarf species (at least as I saw it there).

Another strange plant (to me) was the curious Dollar Bush (Zygophyllum stapfi) with large round succulent leaves. It was common the plains areas. A bush that grew in cushions on small isolated dunes was Trianthema; it somewhat resembled some of our daleas.

Dr. Richard Logan of UCLA in California has made a study of plant adaptation to the Namib Desert and for nearly every modification that he noted in South West Africa, there are parallel ones among our California and Arizona desert species. For example, the loss of leaves, as in the Narra occurs in our Smoke Tree (Dalea spinosa) and cacti; succulent forms to evade the drought are found in our echeverias (Sedum); poisonous or bad-tasting juices to minimize being eated by herbivores are in our Datura; halophytic or adapted to living in very salty soils occurs with our ink-weed Suaeda and the salt-bush Atriplex; development of spines has been attained in our cacti and mesquite; a great spreading root system to absorb water rapidly when it does fall, as in our creosote-bush; seeds that can endure long droughts and still remain viable, as in all of our annuals. But one adaptation that Dr. Logan listed has no real American counterpart: camouflage to "escape" detection, as in Lithops, the stone plants, which look so much like small rocks that in some cases you must feel them to be sure!

On the Namib, with no parallel adaptation on our deserts, are several grasshoppers in three families that have come to closely "mimic" stones. Some of these are truly wingless. An example of this is Lithidium which looks so much like a part of the gravelly plain that it defies detection until it moves.

Here and there on the Namib are isolated mountain ranges that rise from the desert plains like islands from the sea, hence their name "inselberg" or "mountain island". On one of these I visited, a few miles north of the Station, I noted an euphorbia which had the growth habit of our deerhorn cholla (Opuntia echincarpa). Here was also an aloe (Aloe asperifolia) with the form of our Agave. Like on our deserts, too, there were many brilliantly colored lichens to be seen on the outcrops and even on small rocks. I did see one, however, called Parmelia hottentotta, that grew in little isolated tufts, each about three inches long, scattered over the leeward surface of upright rocks on the slopes of this inselberg. Never have I seen anything quite like this lichen on our deserts.

When one walks out into the Namib, as I did along the Kuiseb, it is the animal life that the biologist is first aware. I must have seen hundreds of diurnal beetles, mostly black ones, nearly all swift runners, in the space of a square city block. Some of them fairly skimmed over the surface, never seeming to pause. This rapid motion is in vivid contrast to the common daytime beetles of our desert (mostly in the genus Eleodes), that move about singly in an erratic fashion and often as if in slow-motion. One would consider himself lucky on our Mohave or Sonoran Deserts to see six Eleodes in one whole day. Also, our Eleodes tend to be more active during the crepuscular hours and often hidden at mid-day. These Namib beetles were astir all day long, whether in the shade or in the direct sun. They were most abundant among the litter beneath the acacias. April, when I was there, was apparently their mating time, which may explain some of the hurrying? .... or is there a definite mating time? What I took to be males (they were smaller) were in "hot pursuit" of females and the two would race across the sand no more than an inch or so apart; when she stopped, so did he. I never once saw two in actual contact. Some of the longer-legged species could skim over the surface as fast as I could walk at a steady slow pace beside them; some on the open plains were even faster than this! Dr. Koch refers to these as heliotactic runners.

Eric, Dr. Koch's assistant, had set-out a long "trap line" across the Namib to a distance of several miles in order to study the habits and ranges of some of these ground beetles. One of his "traps" consisted of an open-topped empty gallon tin, sitting snugly in a second larger can which was buried so that the rim was just slightly below the surface of the soil. Anything crawling up to it day or night will tumble down and be trapped. I spent two enjoyable days with Eric as he made his weekly rounds of the thirty or more traps, each about 1 or 2 miles apart in all kinds of habitat. Each can was marked with a tall stake which bore a number. The numbers and kinds of creatures in each trap were recorded carefully. Dead specimens, if not rare, were thrown away at some distance (so the wind might not blow them back in); live ones were marked in red paint with the number of the trap and released at least 50 feet away, and in several directions if there was more than one beetle. As many as 50 or more beetles might be found in one week's time in one trap! ... as well as other ground-dwellers like scorpions and solfugids.

An interesting pattern seems to be emerging from Eric's studies. He has learned to predict just about what species will be caught in each area; one type may be found in only one or possibly two habitats and nowhere else. Some species occur in considerable numbers in one trap but not one will be seen in another can

just a half mile away. Also, the time of the year seems to be important. For several weeks he will catch only one particular species, then that one will "disappear" and later another different one will become common. Eric is trying to correlate this with which plants are available for food at the various periods of the year. It is far too early for any theories now.

But it is on and in the Namib dunes themselves that one sees the really unusual fauna. These dunes are so old, geologically, (over a million years), that there has been time enough for several species to vary and to adapt to the sand habitat. Other dune areas of the world have not yet had the advantage of such a long time, and most of their faunas are, for the most part, invaders from adjacent non-sandy areas; they usually do not spend their entire lifetimes IN the dunes.

Again, when you walk over the Namib dunes, it is the beetles that first catch your eye. They seem everywhere, scurrying over the surface or digging into it. The species here are different from those of the Kuiseb river bed, for these never leave the sand. They were born here, and here is where they will die. They are an integral part of the dune infauna, truly arenicolous and psammophilous. One evening, toward sunset, I had the great fortune to walk out among and to climb up some of the larger dunes, when the low sun had thrown every sand ripple into sharp relief and turned their color to a deep orange-red. This was the hour when the diurnal species were seeking shelter for the night. Beetles everywhere were excavating tiny burrows. I even saw a grasshopper that had somehow excavated a trough in which it lay, protected from nocturnal winds and predators. Somehow, I had never stopped to wonder what grasshoppers do at night; nor beetles, either, for that matter.

This was the time, too, when the night denizens were "awakening". I labored up the steep slope of the highest dune, sliding back with each step and hearing that odd singing-hum that all big dunes seem to emit when their surface is disturbed. On the crest I was astonished to see oval flat beetles rushing about in all directions, emerging from the sand ... dozens of them, some gray in color, some brown, and some whitish. White beetles are rare but they do occur on the Namib dunes; their color is due to tiny bubbles of air imprisoned in their exoskeleton, bubbles which reflect all light to create a white color. Of what advantage is a white color on red sand? Does it appear white to would-be predators? I certainly had no answer to that any more than I did for the deep black color of our desert Eleodes, unless it be a warning of bad-taste? or as protection against cosmic rays? And of course there doesn't HAVE to be a reason.

These beetles live their entire lifetime on or within the sands of the dunes. What do they eat? Bits of vegetation and pollen blown onto the sand? Or buried bushes and trees buried beneath from the past? Most of these species are herbivorous. Do they seek-out bits of plant material and carry it under to lay their eggs upon? No one yet knows the answers, not even Dr. Koch who is the world-authority on these beetles.

Most of the Namib beetles are wingless tenebrionids and are locally all called "toktokkies" by the Hottentot. Their arenicolous specializations include (1) color (2) rapid locomotion and (3) digging, with modifications of the digits to accomplish this: stiff hairs, spines, and flattened extensions. There are as many nocturnal species as there are diurnal ones. Not all are large and conspicuous; some are quite small.

Thirteen species of Tenebrionids are indigenous to the dunes: Lepidochora kahani, L. discoidalis, L. porti, L. eberlanzi parva; Onymacris laeviceps, O. unguicularis; Cardiosis fairmairei; Tarsosis damarensis; Cerosis hereroensis; Dactylocalcar caecus; Vernayella noctivaga, V. ephialtes, and V. delabati. Some of these are heliotactic runners. Lepidochora eberlanzi resembles our Dune Cockroach (Arenivaga); it is strictly nocturnal and has an ovoid flattened body.

On our California sand dunes we have only one common beetle that lives in the sand and that is the small black round Eusattus, one of the darkling beetles.

On the lower dunes I saw a few of the telltale craters made by ant-lion larvae or what we call doodle-bugs. These were not particularly large, about the size of our bigger species, so I was unprepared for the adult insect, which looks much like a good-sized dragonfly. The Namib variety is huge compared to ours, with a wingspread of nearly four inches; ours are about half that size. Also, our ant-lion adults are drab in color, grayish, and are strictly nocturnal. The Namib specimen I saw was flying about over the sand in broad daylight and was a striking whitish color with irregular black markings on the second pair of wings. I didn't get a chance to examine the larval stage.

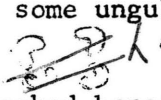
On one of the Narras I found a fairly large beetle, shiny black in color with three yellow bands across the body and red blotches at either end of the abdomen. It was a beautiful insect, one that reminded me of our desert soldier or blister beetles (Lytta magister) which are brilliantly red and black in color as a warning, for this beetle when irritated exudes a blistering fluid on contact with the skin. I only wondered if this Namib beetle might have its gaudy color for a similar reason, but decided not to experiment, and I later forgot to ask Dr. Koch about it.

One memorable night, Eric and I took a "tilly" (Coleman lantern) for me and a miner's head-lamp for him and we struck off after dark, across the Kuiseb and into the dunes. It was quite dark; there was no moon. The wind had fortunately died down earlier that afternoon. As we scrambled out of the river bed through a thicket of young tamarisk, Eric casually warned me to be on the lookout, for there were cobras about! Luckily or unluckily, I didn't encounter one that night. Around his waist Eric had strapped a wide belt with several pockets containing collecting bottles. He also carried small plastic bags for larger specimens.

By holding the lantern just above the surface, the low-angled light threw every track into sharp relief. One of the first psammophilous (sand-loving) creatures that we encountered was an inch-long tan-colored sand cricket. It went into a bottle and when I later photographed and examined it, I was amazed by its unique adaptations to digging. The ends of its "toes" were equipped with disc-like expansions and the jumping legs were covered with long hairy bristles. Odly enough, on our dunes (as at the Kelso Dunes on the Mohave Desert) I have found a similar sand cricket with quite analogous leg modifications. Ours belongs in the genus Macrobaenetes. These crickets are just one more in a series of remarkable parallel adaptations found in both the Namib and our American deserts.

Next we came upon a truly unusual creature, one that has no counterpart that I know of anywhere else in the world. It was the famous Dancing Spider (Leucorchestris arenicola). Dr. Koch first gave it its common name and when he described it to other biologists, they laughed at him. First of all, it is a large spider, with a body nearly an inch across and a legspread of about three inches. Second, it is pure white in color; until it moved, it blended in perfectly with the sand even though it was red! It stood on its long legs with the body

elevated off the ground and then, as I approached closer with the lantern held low, it leaped straight up off the sand about an inch or so, came down exactly where it had been, immediately leaped straight up again, and continued this unusual "dance" for several minutes as we watched, fascinated. No wonder people at first laughed at Dr. Koch's white spider that lived in the sand and danced! As to its prey, Dr. Koch believes it feeds upon small gecko lizards. The generic name Leucorchestris means a "white dancer". All Namib dune spiders belong in the family Sparassidae; there are 15 species in 4 genera.

Further on we saw what looked like a hoof-print of some ungulate. There was only one of these marks, however. It had this pattern  and was about two inches across. (see fig. 1) With a piece of grass-stem I carefully poked beneath the sand between the marks and brought to the surface a quarter-inch wide X-shaped "trap" of strong sticky web. This was the work of another kind of spider and somewhere beneath the trap was its maker, awaiting some prey, perhaps a hapless gecko again, to wander into it. This spider, which we couldn't locate even though we dug for it, is in the genus Seothyra.

Beyond this place I saw my first Web-footed Gecko, Palmatogecko rangei, a small translucent lizard about three inches long. This little lizard lives its entire lifetime in the sand, buried by day and active at night, seeking out small insects such as termites. It has the huge eyes that most nocturnal creatures have: these were black in color with prominent vertical slits in the light of my lantern. The body was a dark hue mottled with grayish white. But it is the reptile's feet that are unusual: both front and rear toes have an irregular ragged-looking webbing between them. These feet enable the gecko to literally swim beneath the sand in an instant. We captured a couple to take back to the laboratory.

On the sandy plains between the dunes there is another peculiar gecko, the Whistling or Barking Gecko, Ptenopus kochi, that lives in more or less permanent burrows that go down to a depth of 3 feet. The body of this lizard is reddish brown in color and has three darker bands across the body and three more across the tail. Its digits are fringed with long scales and the nostrils can be closed to the sand. Near sunset the males partly emerge from their holes (apparently each sex has its own private burrow), throw their heads back like a barking dog, and somehow emit a quick succession of loud sharp clicks that to me resembled the sounds one can make by sucking on the back of the hand. This is the so-called "whistling"; it is a loud sound and carries over half a mile. On the evening that I climbed to the top of the large dune to watch the sun set from that vantage point, I could easily hear far below me not only the quick series of 9 to 11 clicks of Koch's barking gecko, but also another species, (Ptenopus garrulus), which makes only 4 clicks. They were answered .. or challenged .. by other clicks in several directions, then all was repeated. It is believed the sounds are made by the gecko pressing its tongue against the roof of its mouth and then releasing it suddenly.

None of our desert geckos, of which we have several kinds including Coleonyx, can make as loud a call; ours make a sound more like a low squeaking. Nor do any of our geckos have webbed feet or live in the sand. Our species prefer rock slabs, cracks, crevices, fallen trees, and debris.

The Whistling Gecko does not have webbed feet; instead it has long fringe scales on its hind toes to aid in its fossorial habits. Another larger lizard of the Namib, which I did not get to see, is the Sand-shoveller or Shovel-snout Lizard (Aporosaura anchietae), which is a true dune dweller a foot or more in length. Its head is wedge-shaped to penetrate the sand when it literally plunges

in. In this regard, it closely parallels our Ocellated Sand-lizard (Uma notata), which is also called the Fringe-footed Lizard; both have a pointed head and long scales on the hind toes. Both are diurnal in habits, also, and both, if you approach too closely to where they lie buried just beneath the surface, will suddenly burst out in a shower of sand and skim rapidly away in an irregular course to plunge headfirst into the nearest sand, to "swim" out of view in a few seconds. Our genus is more brilliantly marked than the Namib sand-shoveller.

Our next find on the night with the lantern were some tracks that were familiar to me, yet not quite as they should be: the tracks left by our Sidewinder Rattlesnake (Crotalus cerastes). Of course there are no rattlers in the Old World, but here were those characteristic tracks: a series of parallel straight marks, each about a foot in length, unconnected with each other, and extending at an angle across the sloping side of a rather steep dune. No other animal leaves such a spoor. I had heard about this Namib snake, also called a Sidewinder or Dwarsloper (cross runner). It is an adder (Bitis peringueyi) and not at all closely related to the pit-vipers of the New World. Here was a most curious parallel adaptation. I examined the tracks at closer range. There were slight differences. For one thing, the Namib marks were pretty much just straight lines, without the marked hook at one end and the little cross bar across the other. In addition, there were faint "drag marks" between the lines here, whereas our sidewinder usually leaves the sand in between unmarred.

Eagerly we began tracking the snake, not being absolutely sure which way it was going except by the more prominent ridge on one side. The marks ran across the front of the dune, down a steep slope, across a broad flat area, up another dune and along its very abrupt crest (steeper in angle than I think our sidewinder could negotiate), down into a second basin and into a thick clump of grass, where the tracks seemed to terminate. I thought better of poking my hand into this thicket, so we abandoned the search.

At the laboratory they had a Namib sidewinder in a terrarium, so I was later able to examine it at close range. It was a little over twelve inches long and an orange tan color, like the sand (our sidewinder is whitish and of course our local dunes are also very light gray in color). It moves sideways in the same peculiar looping of the body that is so difficult to describe. By a continuous series of arches the body is raised a fraction off the sand (apparently dragging a bit in the Namib species) and laid down in a straight line about two inches from its former position. Two or three tracks can be in progress at the same time! This results in the series of unconnected lines and enables both snakes to move up a slope of loose sand. If either tried to climb such an angle in the conventional snake manner, they would keep slipping back.

The sand of the Namib may be looser or the dunes steeper to account for the drag-marks between the lines. The rattle at the end of the tail of our sidewinder may explain why the short crossing-mark is made last of all at one end, as the tail (with rattles held up) leaves that track to arch across to the next. Of course the Namib viper has no rattles.

Our sidewinder is also called the Horned Rattlesnake because over each eye there are prominent horn-like scales. The Namib Bitis does not have these, but there is another poisonous snake in South West Africa that does have "horns" and that is the Horned Viper, a much larger snake that is mottled gray in color like gravel and that lives in rockier areas and along the Kuiseb river bed. It does not move sideways. Its method of catching prey is to lie in a coil like our rattlesnakes, in the dark along rodent game trails and wait until the prey comes

by. Apparently it does not usually bury itself in the sand, which both our sidewinder and the Namib counterpart do.

Our American sidewinder rattlesnake thus combines some of the features of both of these Namib reptiles. Nor is sidewinding restricted to just these two snakes; the Saw-scaled Viper (Echis carinatus), a widespread desert species of North Africa, southwest Asia, India, and Ceylon also moves sideways; in addition it forms a figure-8 with its body and then rubs its sides together to produce a hissing warning sound.

Later in the laboratory at Goabeb I had a chance to observe other differences between the two sidewinders. I hooked the captive one to the surface of the sand in its cage and watched as it buried itself again, almost immediately. Our sidewinder always makes a tight coil of its body and in that position, by pushing down and out with its flattened sides, sinks lower and lower until it is out of sight except for the "horns". The sidewinder viper I was watching did not do this. It crawled about a few minutes and then, in a stretched-out position simply began to work its body under, starting at the tail-end first and with the head disappearing last. Now you could barely make out the outline; the head was completely concealed but once in a while I saw the tongue flick out.

This sidewinder hadn't been fed for about a week, so Eric decided to do so with one of the web-footed geckos we had captured. I hated to have him do this, but geckos are the natural food of this snake and I was anxious to see what happened. The lizard was dropped into the terrarium about a foot from the buried snake. Immediately the gecko became tense, standing upright on its legs, waving from side to side; it was obviously agitated. And there it stood, for perhaps a full five minutes, with nothing happening. Then a most curious thing did occur, a thing that I would not have believed had I not seen it myself. The end of the sidewinder's tail, which was whitish, was pushed to the surface of the sand, and there it writhed and wriggled like a little white grub! Instantly the gecko was alert, stopped its weaving, dropped down to the sand, and moved a few inches closer to investigate. Its instinctive response to movement had overcome the initial "fear". It moved an inch or so closer and then, so suddenly that it was blurred, the head of the viper had shot through the loose sand and grabbed the startled gecko by its body. It continued to hold firmly onto the gecko, quite unlike our rattlers that strike, inject venom, release their hold and recoil in case they have to strike again. The gecko did not seem overly nervous and struggled very little to escape. For a full ten minutes the viper retained its grip and then slowly proceded to swallow its prey in the usual snake fashion.

Here, then, were more differences: our sidewinder coils before striking its prey, it does not hold on to inject more venom, and of course it does not "lure" with the tip of its tail. When I returned to the States and visited the San Diego Zoo I noted in the reptile house that the Death Adder of Australia, which is really a cobra and not a viper, also uses its tail as a lure! Apparently all over the world there are subtle transitions between these various adaptations which appear so unique when isolated.

I had hoped to see the rarest of the Namib dune dwellers and the only mammal known to live entirely in sand: the Golden Mole (Eremitalpa granti namibensis), which by the way is a silvery gray color, not golden. Only a handful of specimens of this insectivore have ever been collected although it must be fairly abundant if one only knew where to look for it. An owl that perches around the Research Station often leaves pellets which contain the bones of this mole, so these birds,

at least, have discovered the secret of its whereabouts. We have no moles of any kind on our desert. There are gophers (Thomomys), which are rodents not insectivores, and which are herbivorous not carnivorous (what does the Golden Mole feed upon? the poor geckos?, beetle larvae?) and they are commonly seen out in very sandy stretches of our deserts.

In the river bed is a chameleon that is gray in color. It readily ate grasshoppers I caught for a captive specimen and apparently spends a lot of time on the ground. There are no true chameleons in America at all, so we have no counterpart to this reptile.

There are two limbless lizards around the Namib dunes: (1) the Legless Skink or Brains' Blindworm (Typhlosaurus braini) which lives under grass-tufts by day and comes out on the surface at night to catch its prey, termites and Lepisma (2) Fitzsimonsia brevipes which lives around narra and tamarisk clumps and dune grass, moving just beneath the surface like a mole (some of our burrowing snakes do this, as well as the dune cockroach and antlion larvae), only rarely coming out of the sand as it seeks its food: termites, ants, beetles, antlion larvae, cicadas, and plant-bugs. I didn't see either kind. We have limbless lizards on our deserts but none live in sand.

Of the two scorpions I saw on the Namib, one (Parabuthus villosus) was quite dark in color, nearly black. The other more slender specimen was yellowish, more like our common varieties; it's in the genus Uroplectes. How potent the venom of the Namib species is, I didn't find out.

There is probably to be found on the Namib more kinds of Solifuges (sun-spiders) than anywhere else in the world: over 80 species out of the total of 216 for all of South Africa (which is over one-fourth of the world's total of 800). The largest solifuge known occurs here; it reaches 75 mm (the female is usually larger than the male). The smallest variety ranges down to 7 mm. Their respiration consists not only of many very wide tracheae but the thorax is specially modified to move rhythmically to speed up the gaseous exchange. No doubt this explains the lightning-fast movements which, coupled with the profuse woolly hairs on the body and legs, results in a blurred image when it is glimpsed running. Some of the Namib solifuges are nocturnal, others are diurnal. Many are termitophagous. Some dig burrows and others can climb bushes.

We have only one common desert solfugid which we locally have misnamed "vinegaroon". It is harmless and is a yellowish color. One we caught in a beetle-can had the light yellow legs and body encircled by black bands and with a bright orange-red head and "jaws"; it was classified as Metasolpuga picta.

Another similarity to our deserts is the work of termites that may be seen on the surface. There were many dead branches in the side-washes that were completely covered with a thin layer of mud, which the "white ants" laboriously build over the edible wood at night so that they can continue to eat the cellulose by day without "fear" of the light and desiccating heat.

A common feature of the American deserts are ants, especially the Harvester Ants that accumulate large craters of seed-chaff around their entrance holes. I did not see any similar work here at Goabeb but later, far to the north at Etosha Pan, I did see such characteristic mounds. No doubt similar species live in the Namib as well. The common ant in the Kuiseb drainage was a large one, over half an inch long, stout bodied, dark brown in color with a bright yellow abdomen marked by two prominent brown saddles. We have no counterpart to this ant.

That night on the dunes we also scared-up a Gerbil that zigzagged across the dune in alarm, hopping like our Kangaroo Rat (Dipodomys deserti) on its two hind feet and using the tail as a balance. The Gerbil probably fills the same ecological niche on the Namib that our Kangaroo Rat does on our desert, but in a different way. Neither are strictly psammophilous.

One characteristic mammal of our deserts that one can nearly always expect to see on a desert trek is the ground squirrel, either the round-tailed (Citellus) or the antelope ground squirrel (Ammospermophilus). I saw no rodents on the Namib except for the nocturnal gerbil, but I understand there is also a ground squirrel (Geosciurus) here. Nor did I glimpse any rabbits which are so prevalent over most of our deserts; again I learned that there were lagomorphs here, both the Namib and Scrub Hares, both in the genus Lepus like our jack-rabbit.

There are several predators ranging over the Namib, including the Long-eared Fox (Otocyon megalotis) which probably fills a similar niche that the small huge-eared Fennec does further north on the Sahara and that our little Kit Fox (Vulpes velox) does on our deserts.

Dr. Logan in his monograph on the Namib Desert concludes with the statement that "The Namib is one of the emptiest, bleakest, most useless areas of the world"! I disagree with this statement even though I realize that Dr. Logan is a geographer and primarily interested in the human viewpoint. What does he mean by empty? Empty of what? Of human populations, yes, for there are only a few scattered Hottentot bands here. But in the all-too-short time that I was privileged to visit the area, I was impressed by how "empty" the Namib was NOT, especially the sand dunes themselves where I would have expected practically no life. And what does "bleak" mean? Without color, pale? The brilliant orange-red dunes alone belie this, and many of the canyons have colored stratigraphy that reminded me of some of our Arizona scenery. If by "bleak" is meant "exposed" or "wind-swept" then much of the Namib that I saw could be considered this, yet, aren't all arid regions exposed and wind-swept? And if by "bleak" was meant "depressing, cheerless", I would again have to disagree. To me, the Namib was most exciting, exhilerating, fascinating, mysterious. Every moment, there was something new to "discover", and this attraction is, of course, true not only of the Namib but of any wild area.

Finally, what did Dr. Logan mean by "useless"? Useless to whom? Again, he was probably thinking of economic use by man. The very fact that so many unusual plants and animals have been able to survive and reproduce there indicates that the Namib certainly is not useless to them.

To me, the casual observer, the most intriguing thing about the Namib is how its flora and fauna have adapted to such rigorous conditions and how these ways so closely parallel many of the adaptations of completely different plants and animals in our own deserts. Still, this is perhaps not so strange, either, for living organisms tend to respond to similar environments in similar ways no matter where in the world they occur and the more extreme the environment, apparently the greater are the similarities. Such parallelisms should really be expected and looked for.

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NOTES ON THE NAMIB DESERT OF COASTAL SOUTH WEST AFRICA

Quotes from Dr. Koch's papers: "The Namib is the least known but most remarkable faunistic area of the African continent. Its barren dune system and the vegetationless parts of the barchan dunes represent a most remarkable biotope of optimum conditions for certain xerophilous Tenebrionids and other macro-animals. The Namib is the only true desert in that part of Africa lying in the Southern Hemisphere. It has a roughly estimated area of 270,000 square kilometers, only 1/30 the size of the Sahara but it shows all the edaphic features of an ultra-desertic status (absence of macro-vegetation): massifs of barren dunes, sandy and gravelly plains without or with only very scattered desertic vegetation, and salty pans which correspond exactly to the Saharan terms of Erg (dunes), Reg (sand gravelly plains) and Sebkha (salt pan).

The Namib is characterized by irregular and very low rainfall, intense evaporation, and an additional factor of sea-mist which adds moisture and reduces evaporation and transpiration; it has a cool climate with great humidity. Of Meig's homoclimate classification of arid lands, the Namib would be EXTREMELY ARID (with at least one year without rain and no regular seasonal rhythm of rainfall), but it is also a MILD DESERT because of its temperature index of 22 (the Atacama is 23, the Sahara 24, and our Mohave and Sonoran deserts also 24).

The Namib is a coastal strip about 100 miles wide and some 1300 miles long, extending from the Olifante River in Little Namaqualand (Republic of South Africa) northwards along the entire coast of South West Africa (including the Skeleton Coast and prohibited diamond areas) to Mocamedes in southwest Angola. Its eastern boundary has been arbitrarily set at the 600 m contour (2000 foot) except where the dunes (as in Great Namaqualand) reach inland to the 4000 foot contour. The Namib is the extreme component of the arid Kalahari-Karroo-Namaqualand phyto-geographical system.

The Namib is the oldest desert in the world, remaining virtually unchanged since the Cretaceous when the Benguela current of cold water was deflected in close to the coast. It is this cold current plus cold upwelling that cause the aridity, just as similar conditions cause the Atacama Desert of Chile. Because of this long undisturbed duration, with no intervening wetter pluvial periods as with the Sahara, there is a great number of endemic species. All of the Namib tenebrionid beetles belong to two tribes with 35 genera and over 200 endemic species. Ninety-eight per cent of these beetles are apterous. Thirteen of the endemics are restricted to the dunes themselves, and never leave them (they belong to seven genera).

The exotic Kuiseb River divides the Namib into a southern and northern half. It is in the southern half that the great "sea of sand" occurs, with parallel dunes extending north-south for over 300 miles and inland up to 100 miles; individual crests reach a height of 1,000 feet, as high as any in the Sahara. The strange white tenebrionids and the curious Welwitschia plant occur only in the northern half, the latter only on consolidated soil faces but not in the dunes.

From the coast eastward, the Namib can be divided into three ecological areas: (1) the littoral sands (2) the barchan dunes themselves, getting redder in color as you travel inland (3) the consolidated sandy to rocky plains. On the dunes themselves Dr. Koch recognizes three beetle niches: (1) the scattered dune vegetation marginal to the dunes; here are plant-followers or plant satellite tenebrionids (Koch calls them "gravitators"; of these there are the errant plant-followers with a daily rhythm to the surface by day or by night and the stationary plant-followers that live in gregarious populations under the plants and surface only very rarely (2) the vegetationless barren dunes with optimum conditions for a highly specialized group of what Koch calls ultra-psammophilous beetles that are independent of active plant life.

Of the 800 species of Solifuges in the world, 1/4 (216) occur in South Africa, and 81 species of these occur in South West Africa in 12 endemic genera!

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