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The residents of our South West African coast the giant barren sand dunes are quite as familiar as are the sea, the desert and the fog—surroundings to which they have been accustomed since childhood. Nevertheless they may be unaware that these dunes are not merely unique in appearance for the whole of the Sub-Saharan continent, but abound in curious and beautiful animals found nowhere else in the world.

The great Southern Sand Sea of the Namib is a detached world of silent inorganic grandeur — South West Africa's "Empty World" — spreading under a cloudless sky of continual sunshine, a waterless, dry, erosion desert of extraordinary simplicity, with gigantic complexes of sand dunes stretching, as far as the eye can reach, from horizon to horizon for hundreds of miles and completely devoid of any active vegetation.

From the point of view of origin the Sand Sea is the lowland depository for water-borne alluvium from the disintegrated primary rock of the uplands, which ulti-

Above: One of the barren sand dunes of the southern Sand Sea. When a certain angle of inclination of the leeward slope is reached, the "slip-face" of the dune is born (see centre of the photo). This slip-face may be compared to the pulsating heart of the dune because it creates its own field of wind shadow within which the foreward drag of the dune movement occurs. Sand grains pour in from the avalanche of sand breaking from the upper edge of the face. The ratio in the relationship between wind force and wind direction exerts a continuously changing influence on the shape and movement of the dune.

The slip-face also forms the "ball-room" where many of the dune-dwellers congregate and where their outdoor activities are performed. At sunset a dramatic change in the composition of visitors occurs: the sun-loving sand-runners dive into the sand for their night rest, while the nocturnal dune-dwellers emerge from the depth, often in great numbers. There is a similar departure and arrival of large numbers of predatory animals of strictly diurnal or strictly nocturnal habits, often moving rapidly from slip-face to slip-face in order to check on the availability of their prey.

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The Namib Desert Research Station at the time of its foundation (1963), with the Erich Übert House on the right and the weather station on the left. It commands the two main landscapes of the desert, namely the Sand Sea (background) to the south and the gravel plains (foreground) to the north. These landscapes are sharply separated by the intrusion of the deeply embedded, dry river-bed of the Kuiseb, the underground water of which supports a dense riverine forest on its alluvial silt banks (visible on the extreme right of the photo).

It was in this way that the mobile landform of the sand dune was brought into existence. This must have occurred many millions and millions of years ago, when the Benguela Current drew close to the coast and permanently cut off the rain from the primeval lowlands, causing desertification. It can also be inferred with the greatest probability, that such a perfectly balanced indigenous fauna as that of a barren sand dune must have required countless ages of gradual evolutionary processes.

Throughout these ages milliards of tons of sand accumulated on the desert floor and were moulded into the typical dune configuration by the winds. It is the interaction between the freely movable sand grains and the wind which causes the deposition, shape, structure, and the peculiar movement of the dune. The pseudo-living force inherent in a dune is determined exclusively by the physical laws of aerodynamics and gravity.

However in spite of the forbidding inorganic appearance of a barren sand dune, the almost fluid medium of sand is distinguished by the unique conditions of its inner structure. These are favourable to the evolution of organic life.

The wind brings in organic matter, alive and dead, animal and vegetable, which is mixed into the sand of the dunes. This detritus derives from the hinterland and, at the times of episodic rain showers in the desert, also from the corridors lying between the dunes, when the seed-laden soil explodes into ephemeral bloom. The detritus is stored in the dunes indefinitely and forms a store of ever-available food for the many primary dune dwellers such as certain desert beetles, fishtails, termites, etc. These curious beings populate the barren sand in their millions whether in larval or adult stages, and, as they have become specialized to manufacture their own water requirements by oxidation from even such a dessicated diet, they furnish the perfect “instant food/beverage” on which secondary and tertiary layers of fauna eagerly prey, such as highly specialized spiders, solifuges, scorpions, crickets, flies, wasps, reptiles and moles.

The wind also causes fog to roll in from the sea, the humidity creating a definite layer of moisture regime in the depth of sand, which, coupled with fairly constant and reduced depth temperatures, provides an optimal climate for the dune dwellers, allowing them to escape the outside conditions whenever these become unbearable. By virtue of their extremely modified locomotory organs the dune dwellers can readily penetrate into and freely move within the depth of the sand on account of the great permeability of the latter caused by the loose arrangement and subglobular shape of the sand grains.

In the natural state of undisturbed equilibrium the internal pressure in a dune appears to be considerably

"It is with regret that we have to record the unexpected death of Dr. Charles Koch at Windhoek on the 23rd of February, 1970, at the age of 65. Dr. Koch, who was born in Vienna, studied in Austria, Germany, Spain and Italy. Before coming to South Africa he undertook numerous expeditions to North Africa and the Middle East and became an internationally known scientist. He was famous for his study of beetles and was founder of the Namib Research Station at Gobabeb near Walvis Bay."
reduced through the presence of the empty intergranular spaces and channels. These are responsible for the vital process of oxygen circulation and are kept open and free from fine dust by wind action.

Along these lines organic life gradually gained access to the vacuum of the sand dune environment. The process of evolution into indigenous and sand-loving species culminated in a perplexing array of extraordinary adaptive features in body structures, body functions and behaviour. Ultimately a multi-ramified association of dune dwellers evolved which has become independent of any active vegetation and of regular rainfall by means of an intricate system of wind-imported alimentary and watery matter in the otherwise wholly unproductive medium of sand. It is sealed off from adverse outside conditions by the synchronisation of these conditions with all possible evading or resistant life-cycle and activity rhythms. The greater part of their life-cycle — in some extremely adapted species even the whole life — takes place in the mysterious depth of the sand, which so far nobody has succeeded in observing. In fact, adaptation has gone so far that it confines the dune dwellers exclusively to the dune element without which they can no longer exist — like fish which can live only in water. There is a well-balanced hierarchy of dune species which follows an established pattern of food and water chains, unequalled in any other desert of the world.

This over-specialized fauna cannot spread anywhere beyond the dunes and has to move inexorably together with the dunes wherever these may migrate.

Where the extremes meet . . . A giant barren sand dune, 80 metres high, towering above the exotic jungle of the riverine forest upon which it is encroaching at a scarcely noticeable but inexorable pace. Apparently in recent times no dune was able to cross the Kuiseb. It seems that an equilibrium exists between the dune movement and the flood potential, the almost annual floods removing the infiltrating dune sand in the river-bed.

In contrast to the short legs of the nocturnal saucer-beetles, the spider-like Namib sand runner (Stenocara phalangium) possesses legs of an extraordinary length.

It is a sun-loving beetle, racing across gravelly ground at a tremendous speed while carrying the body high above the heated surface. It is related to the famous “white” Onymacris beetles of the Northern Namib, viz. the only known beetles with white elytra (sheaths) in the world, while our spider-like sand-runner has the reputation of being the beetle with the longest legs in the world. Adaptive records such as these certainly attest to the uniqueness of our Namib Desert.
The slip-face of a dune is also the principal depository of the wind-imported food supply for the primary consumers. Organic fragments are hurled across the barren dunes by the wind and finally trapped within the wind shadow on the slip-face. Accumulations of this organic detritus are often found at the foot of the slip-face (see photo); these can also absorb water from night-fog condensation. Note on the photo a dense pattern of foot imprints left by the saucer-beetles after their nocturnal feeding session. The prevalent winds alternately expose and re-bury the detritus cushions in the depth of the sand, where they often form a compact and permanently preserved food substratum underlying the foot of the dunes.

The ornamental pattern on the dune surface after one of the rare local showers seems to be produced by the variable degrees in sand porosity, the laminal infrastructure of the dune, the boundary lines between firm and soft sand zones, and the run-off screen deriving from surface water not immediately absorbed. The considerable moisture content of the dunes is derived from such episodic torrents (averaging about 20 mm. annually) and also from the condensation of night-fog (about 40 mm. annually). Because of the fairly constant uniformity of the depth temperature in the dune—caused by the poor conductivity of sand—evaporation is prevented and the water retained for years underneath the surface at a depth of about 20 cm. This depth, offering optimal conditions for life, is readily reached by the dune-dweller.
Right: One of the saucer-beetles (*Lepidochora*) which inhabits the barren sand of the Namib dunes. These are peculiar, disc-shaped creatures covered with a dense layer of whitish scales of possibly moisture-storing or water-absorbing properties. They live in the depth of the sand from which they emerge only at night. When on the surface they “roll” on their short legs like a tortoise, but rapidly dive back into the sand when detecting the slightest disturbance of the dune. Their larvae are blind and permanently undersand swimmers; though known from experimental breeding, their life still remains a secret since nobody has so far been able to find them in their natural habitat.

The figured specimen belongs to a beautifully coloured species which has been named in honour of the late Mr. Moise Kahan, a great lover of the Sand Sea.

Left: Sand grains form the medium with which the dune-dwellers are in permanent contact during their whole life. To this they became adapted to such a great extent that they cannot exist without it.

The sand grains of the Namib dunes are usually of quartz, size-graded by wind action, ranging from 0.5 to 0.07 mm. in diameter, and are of a subglobular shape due to mechanical abrasion. While they are very firmly packed on the windward slopes, they are rather loosely deposited on the slip-faces of leeward slopes, along the “smoking” crests of the dune, and in pool-like patches elsewhere, forming dry quicksands. These soft areas are all very favourable to the activities of the dune-dwellers on account of the permeability of the sand and the intergranular air pockets. The latter makes possible the alternating process of suction and expulsion of the air, which depends on the differential tension built-up between the climates at depth and outside as well as the daily fluctuations in air pressure.

Into such an unstable and quasi-fluid medium even dune-dwellers of very small body size can readily dive and move freely in the depth. The photos show one of the smallest species, namely De la Bat’s nocturnal dune-runner, rapidly moving on the surface (top photo) and in the process of diving (middle photo). These are very tiny beetles of not more than 3 mm. in body length, camouflaged completely by the sand-coloured transparency of the skin. They escaped notice until only recently because of their very secretive way of life; during the day there is no trace of them, and during the night it needs the greatest concentration to detect them at all although they are common. During the same night and within the limited space of a slip-face measuring not more than one hundred meters square, we collected several hundred specimens of this species.
Photos above: The first step in the hierarchy of prey-predator relationship is occupied by some small predators preying exclusively on the primary consumers as well as on their youth stages. To these belongs also the "Namib Clown" (Comicus spec.), a nocturnal cricket of a colourless and almost transparent appearance. Its antennae are thin and extremely elongate, almost twice as long as the body, and function as a device for detecting dangers ahead. The legs have undergone the most spectacular transformation, in particular the flower-like feet (see photo below) which not only prevent sinking into the dry quicksands but also function as a perfect landing gear after the performance of jumps several feet high. However, in spite of all these precautions, our "Namib Clown" is eagerly hunted for by many predators of a higher echelon because of its soft body full of watery contents.

Above: The world famous Palmatogecko is exclusively a nocturnal predatory reptile of a very delicate, somewhat transparent appearance, able to place its webbed, "sand-shoe-like" feet on the loosest of dry quicksands. I have pleasant memories of meeting it under the starlit sky of the desert, after having followed its fig-leaf-like imprints over long distances of smooth sand. It was standing high up on its front legs and watching me with its big, beautiful night eyes—a silent ghostly apparition set in the vast solitude of the desert.

Although it belongs to a higher level of predators, it is preyed upon by the very aggressive white dancing spiders, solifuges and the sidewinder viper, all true children of the Namib dunes, indigenous to the Namib Desert.

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