

TRANSLATIONS AND NOTICES OF  
MEMOIRS.

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THE SAHARA AND ITS DIFFERENT TYPES OF DESERTS AND OASES.  
By E. DESOR, Professor of Geology, &c., Neufchâtel.\*

[Translated, with notes, by A. C. RAMSAY, F.R.S., F.G.S., &c.]

THE following memoir, by Professor E. Desor, of Neufchâtel, is only partly geological, but the greater portion of the remainder is so intimately connected with those questions of physical geography with which modern geologists are so much occupied, that I have thought it would be interesting to geologists in general, especially those parts that treat of the origin and nature of the Sahara, the Oases, and the underground sheets of water supplying the artesian wells. I have therefore translated the sketch in full. The Sahara, its salines, and other features, as well as the artesian borings, have formed the subject of several memoirs, by MM. Desvaux and Ville, in the *Annales des Mines*, 5<sup>m</sup>e Série, vols. xiv. and xv., 1858–59.—A. C. R.

I cannot pretend to describe all the aspects of the great Desert of Sahara. Such a district would require repeated journeys, and prolonged visits under conditions but little favourable to study, and necessitate a perseverance and devotion to science not often met with. Now, my travelling companions and myself have only seen a little corner of this strange country, in a rapid excursion as far as the limits of the French possessions. If, however, putting together our experiences as travellers and naturalists, we are able to present some new features of this unique country, interesting equally in a geographical, botanical, or geological point of view, our success is in a great measure owing to the protection and encouragement so kindly showed us by General Desvaux, Governor of the Province of Constantine, as well as to the enlightened solicitude of Captain Zickel, Director of the artesian borings in the desert.

Those parts of the desert which we visited are—the zone which borders the chain of the Aurès, comprising the Oases of Zibans, the route from Biskra to Tuggurt across the little desert, Wady Rir, and its oases, the Oases of Souf, and the route from Souf to Biskra, passing the Chott-Melrir.

In this itinerary the observing traveller will recognize three types of desert to which three types of oasis correspond: 1st. The desert of the plateau; 2nd. The desert of erosion; and 3rd. The desert of dunes.

*The Desert of the Plateaux*, between Biskra and Wady Rir, presents a plain stretching as far as eye can reach, strewn with pebbles

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\* *Le Sahara; ses différents types de Déserts et d'Oasis; par E. Desor.* (Extrait du Bulletin Soc. Scienc. Nat., Neufchâtel, 1864.)—Several paragraphs, not relating to the geological part of the memoir, have been omitted.—EDIT.

covering a crust of gypsum, which forms a true geological horizon. Some of these pebbles, small and well-rounded, are of chalcedony, others of limestone, and others of opaque silicates. They do not extend beyond the Chott, and are consequently limited to the neighbourhood of the mountain. This pebbly plain is not completely bare, for tufts of various plants grow here and there, which appear to accommodate themselves perfectly to the soil and the climate. Amongst these are *Ephedra fragilis*, the connecting link between the *Equisetaceæ* and the *Coniferae*, and which appear to play, in the desert, the part of the *Pinus mugho* in our Alps. As a common plant, robust and sturdy, its creeping roots, finding little vegetable soil, search for it at a distance by extending to an extraordinary length from the stem. Besides Brooms, Pistachios, and Tamarisks, we frequently observed a large Grass, a species of *Stypa*, several feet in height, known among the Arabs by the name of 'Alfa.' This is a useful plant, serving not only for food for horses and camels, but for the manufacture of besoms, mats, hats, bowls, and basins for holding milk, water, &c. For the traveller the Alfa is a wearisome vegetation at a distance; and, as M. Fromentin remarks, it looks like an immense harvest which does not ripen, and withers without turning to gold colour; while near, it is a maze of endless zig-zag meanderings where the traveller stumbles at every step. The soil is greyish, sandy, and averse to all other vegetation, except when refreshed by occasional rains; for we found on our return, after some days of rain, that the plateau between Wady Rir and Biskra was covered with a quantity of young plants; vegetable life was awakened, and, though it was December, the country wore the aspect of spring.

*Desert of Erosion.*—This phase of desert is characterized by enormous erosions, and a soil saturated with salt. I may cite as an evidence of these erosions, a river near Biskra, Wady Djeddi, the bed of which is many kilometres in width, though in ordinary circumstances the water is almost entirely wanting. But when the water is high, for want of a defined channel, it diverges and spreads to right and left over an immense surface, and produces the most extraordinary erosions. This is owing to a bed of gypsum, which near the surface forms a sort of flooring, and, being hard, prevents the water from scooping a deep bed. The ground has all the appearance of excellent arable land, but in fact it is absolutely barren. Nothing will grow on it, owing to the salt which is mixed with the soil to an extraordinary degree; and this is connected with the neighbourhood of the Lakes (*chotts*), which are themselves the remains of an ancient sea. The salt-lands can at once be recognized by the fact that the horses' hoofs raise no dust; and a numerous troop may trot over it as if it were the swept floor of a barn. This is especially striking after riding over a sandy district where the traveller has suffered from the dust: all at once it disappears, and he finds himself on the salt desert. The quantity of salt is so great, and it absorbs so much water during the night, that the soil retains its humidity the greater part of the day. In those spots where the salt is not in such excess as to exclude all vegetation, there is a

growth analogous to that of a salt-marsh—salsolas, salicornes, tamarrisks, brooms, &c.

*Desert of the Dunes.*—The soil of this desert is incoherent moving sand, without vegetation, and where the camel alone can walk with ease. A day's march to the west of Biskra there is a good specimen of this species of desert. There the dunes recall those of Holland; but it is between Tuggurt and Wady Souf that the desert of the dunes shows itself in all its aridity. It is the desert *par excellence*, which in all times has produced on all people an impression of awe and terror. The yellowish white plain is deeply undulated, these undulations being the dunes raised by the wind. Their height is very variable, sometimes attaining to 50 feet; and the two slopes are unequal, that which is opposed to the wind being steeper than the other, which is a gentle declivity. The sand is sufficiently firm to bear walking without sinking much. When the wind rises, the blown sand produces a kind of mist, which, of course, becomes thicker in proportion as the hurricane is severe. Consequently, as might be foreseen, these dunes are not permanent, for they change their places, though slowly; and in fact the sand does not move far from its starting point. It is not here as on the sea-shore, where the winds, being uninfluenced by local circumstances, are more constant and more intense, impelling the dunes always in the same direction. In the desert the wind frequently changes its direction, and the dunes change their forms, undergoing every kind of reconstruction. The general aspect preserves, nevertheless, its principal features so long that guides can still recognize their way. But guides being rare, and it being easy to lose one's self in this labyrinth of dunes, the French Government has established landmarks, to guide the caravans, like those planted in winter among the snows of the Alps and the Jura.

*Origin of the Sand of the Dunes.*—What is the origin of this sand? Does it come from the sea, as has been long supposed, or is it produced in place? M. Vatonne, mining engineer, in his journey to Rhadamis, has settled this question, having demonstrated that the dunes are the result of sandy formations decomposed in place. In Tunis, sands of the Cretaceous epoch generally provide the materials; and in Souf the Quaternary deposits. Between Guemar and Chott-Melrir, along the route followed by the caravans, relics of the original surface exist, unconcealed by the dunes; these surfaces being preserved by a crust of gypsum which prevents their destruction. These unburied relics consist of stratified friable sand, which, deprived of its protecting cover, easily disintegrates under the influence of atmospheric agencies and is driven along by the winds. Now, as this destructive action is carried on from year to year, and from age to age, it follows that the mass of the dunes is continually augmenting.

*Age of the Sahara.*—If the Sahara is the bottom of a vanished sea, it is interesting to inquire if this disappearance has been caused by a sudden upheaval or by gradual and successive elevations, and at what epoch this extraordinary phenomenon has changed the aspect

of the African continent, and consequently produced serious modifications of the climate of Europe. There was a general impression that the Desert of the Sahara was of recent formation; but the opinions of geologists were divided as to the period to which it should be assigned, some considering it of Tertiary and others of Quaternary age. Our observations resolve these doubts, and definitely fix the age of the Sahara, by the help of a little shell, the *Cardium edule*. This shell was known to exist in the neighbourhood of the Caravanserai of Om-Thiour, near Chott-Melrir, and it had been found at a depth of about 23 feet in the artesian wells of that place.\* From this it might have been supposed that it belonged to the Chott (or Lake) Melrir. But, on the other hand, we met along with it a species of *Buccinum*, from stage to stage, at a great distance from the Chott (even near Guemar in Souf), always in the same geological position, in a bed of sand distinctly stratified underneath the superficial gypsum. It thus became evident that the shells did not belong to the Chott, but to a lower stratum indicating a sea far more extensive and older than the salt lakes. These shells, therefore, not only attest the existence of a sea in those regions, but also that that sea belonged to our own epoch. Further the *Cardium edule* is, in the Mediterranean, a species inhabiting brackish waters at the mouths of rivers; and we may conclude that the Sahara, before being dried up, was an inland sea—a kind of brackish Baltic—and this amongst other things explains the small number of the species; for it is known that the faunas of inland seas are poor in number and debased.†

To sum up, when all communication with the ocean had ceased, and the gulf became a lake, the saltness of the waters would by evaporation increase so much as almost to destroy all animal life; the Chott-Melrir would become like the Dead Sea; and, in fact, it is affirmed that it is completely destitute of life.

This idea of a slow but recent elevation of the Sahara had already been mooted as a theory by M. Escher, and it was a source of lively satisfaction to him to find his hypothesis confirmed on the spot. The presence of this sea was referred to by M. Escher to explain certain phenomena in our country (Switzerland) connected with the Glacial period which ended when this sea disappeared. Is it possible to form an idea of the climatal conditions imposed on Europe by this vast extent of water? We may do so when we consider the influence exercised by the burning winds which come from the Sahara, and which are so justly called 'snow-eaters' and 'glacier-destroyers.' While the Sahara was covered with water our mountains never felt the burning breath of the 'foehn' and the 'sirocco'; the winters, never opposed by a lukewarm breeze, could accumulate their snows

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\* See Memoir by M. Ch. Laurent, *Bullet. Soc. Géol. France*, vol. xiv. p. 615, 1856-7.—A. C. R.

† See observations made by Rev. H. B. Tristram, M.A., F.L.S., &c., in his work on 'The Great Sahara' (1860, Murray); also Appendix to 3rd edition of Lyell's 'Antiquity of Man' (Dec. 1863), p. 28.—A. C. R.

and their ice and extend the borders of their empire.\* But when the desert was dry, what an effect must have been produced by the first visit of the 'föhn' to the enormous glaciers of our Alps! What torrents!—what deluges of water!—what ravages, especially on the southern slope! and now how easy to comprehend the erosion of the mountains and the levelling of the plain of Lombardy subjected to these rude assaults and covered with erratic débris! †

*The Oases.*—Wherever in the arid burning Sahara a thread of water appears, a precious tree, the Date-palm, grows and prospers. An Arab proverb says 'the Date must have its feet in water and its head in fire.' Wherever water moistens the soil the date-palms raise their graceful columns, waving in the wind their plume of verdure and promising to man shelter from the sun and food for his subsistence. These trees are the wealth of the desert, and the Oases are merely forests of palms rendered possible by the presence of water. This water may have a triple origin; it may be furnished either by springs or by artesian wells, or from having been dug out from a water-bearing stratum. Hence the three types of oases—1st. Those watered by streams from the mountains; 2nd. Those supplied with water from the artesian wells, the products of a very ancient industry; 3rd. The Oases without water, of which those of Souf are an example.

The oases of the first category are fed either by the streams from the mountains, or from subterranean springs, which are found in great and almost constant abundance, like the Reuss, the Noirague, and the Serrières, which are produced by the same cause, namely, the infiltration of the rain-water through the fissures of the limestone in the mountains. They are found at the foot of the Aurès, where they form the Oasis of Zibans; and some of them are warm, their temperature rising to 30° Centigrade.

*Oases of Artesian Wells.*—At a depth of about 160 feet, there is a sheet of water which springs to the surface when the intervening soil is pierced. Many of the oases, and particularly that of Tug-gurt, have no water but that of the wells; and these appear to be very ancient. It is indeed no light undertaking for the Arabs to dig a well. They club together, and employ forced labour; but notwithstanding, it often happens that years pass before they reach

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\* See Prof. E. Suess on the evidences of a post-pliocene sea on the site of the Sahara; Trans. Roy. Imp. Geol. Institute of Vienna, Jan. 1863.—A. C. R.

† In 1851 I published a paper in the Journal of the Geological Society on glacial phenomena, only part of which was printed, the remainder having been considered by the Council as too wild for publication in the Journal; and I therein stated, on the authority of the late Professor E. Forbes, that the Sahara 'formed an extension of the sea in which the Sicilian Pleistocene beds were formed;' but I am at this distance of time unable to recollect on what data he grounded this opinion. The diminution of the Alpine glaciers, both on the south and north sides of the chain, is however connected with phenomena of a much more general kind, which accompanied or caused the close of the 'Glacial Period' in both hemispheres, and we suspect of a kind not necessarily connected with any local phenomenon like the formation of the Sahara, however important that might have been in modifying part of the general result.—A. C. R.

their wished-for goal. The chief difficulty is the casing of the pit-walls. Having no other wood than palm, which is neither strong nor durable, it often happens that the frame-work gives way, and the sand falling in, overwhelms the work of years. Then, again, when they have arrived at the lowest bed, that which rests on the water, those who pierce it are exposed to extreme peril, for the water rushes upwards with such force that they cannot always get up in time.

The sand is at all times liable to drift in, and fill up the wells by degrees; and from time to time it is necessary to scour them out. This is a task devolving on certain families, and is hereditary. One can hardly believe the process they employ, it is so primitive and so dangerous. An unfortunate wretch, holding in his hands a basket or coffer, dives into the well, fills the coffer with sand, hastily returns to the surface, and the sand is drawn up by a cord. If any obstacle keeps the diver at the bottom of the water, a comrade is bound to jump in and disengage him. I have seen as many as three of these poor men drawn up by a fourth more fortunate than themselves. It is remarked that these divers seldom live long; the occupation is evidently too laborious; and they are usually attacked by complaints on the chest.

Notwithstanding the drawbacks to the Arab method of boring, nothing will induce the natives to change it; they cling with incredible obstinacy to their old customs. Some years ago, General Desvaux, visiting the Oasis of Sedi-Rached, was struck with the misery of the inhabitants; water was beginning to fail, the oasis was in a perishing state, and the Arabs resigned themselves to their fate with a fatalism truly Mahometan—'it was written.' But the General resolved to falsify the eastern proverb: he sent for an engineer, furnished by the house of Degousée and Co. of Paris, who brought with him the complete apparatus for the most approved style of boring, and wells were rapidly bored and proved an entire success. They yield 4,000 litres a minute; in fact an actual river. Captain Zickel has even profited by the jet of water so far as to make a fall and a water-mill, to the great admiration of the Arabs, who still crush their grain with the small hand-mills used from the time of the patriarchs. The abundance of the water would, it might be supposed, entirely renovate the oasis, and increase the extent of cultivated ground. Unfortunately that cannot be done without washing away the salt with which the soil is surcharged; and as the water itself is more or less brackish, it is easy to foresee this would be a work of time.

The water of these wells is rarely cold; at Tuggurt it is 30° Centigrade, and the inhabitants cool it by nocturnal evaporation, hanging out the pitchers in which it is contained on the top of the perches with which every house is furnished.

*Fish of the Artesian Wells.*—It is now three years since Captain Zickel, having bored a well at Ain-Tala, remarked some little fish struggling in the sand that had been thrown up with the water from the mouth of the well. This appeared to him so extraordinary,

that he resolved to wait till he saw it again before he published it. He had not long to wait, as the fish were by no means rare. The country being so devoid of water for a great distance, how came they there? M. Zickel communicated his discovery to some of his scientific friends, who treated it as fabulous. Now, however, it is a fact established beyond dispute. We have collected several specimens of these creatures from the Canal of Ain Tala. They are remarkable for the shortness of their ventral fins; so short, indeed, that some have adopted the erroneous idea that they are altogether wanting.\*

The eyes are well formed; and we assured ourselves of the fact that the fishes see perfectly. The largest did not exceed two inches in length. They are malacopterygious, resembling our *Bravan*, but differ in the absence of pharyngeal teeth, and the presence of fine tricuspid teeth in the jaw. They are of a clear colour; the under part of the body an iridescent blue. They belong to the family of the *Cyprinodontes*, and are probably identical with the *Cyprinodon cyanogaster* described by Dr. Guichenot, and coming from the fresh water of Biskra.†

These fish are, however, not confined to the streams from the artesian wells, but are found in neighbouring pools at Ourlana. Now these pools, from whence flow tolerably abundant streams, are probably only superficial vents of the great subterranean waters which lie beneath this country, and which are inhabited by strange creatures, and it is possible that from time to time these fish may stray into these pools.‡ This is the reason why they have such perfect eyes, which one cannot conceive that they would have had, if before their entrance to the upper world by the waters of the well, they had been condemned to live in total darkness. It is well known that the animals which pass their lives in complete darkness are devoid of vision, and only preserve the mere optic nerve, the last vestige of the eye, which itself has completely disappeared.

*Waterless Oasis of Souf*.—Here the culture of the palm is of the most simple description, but requires incessant labour. At a depth of eight or ten metres they reach a moist bed, and, planted in this, the dates, from ten to twenty in each hole, develop themselves perfectly. But these cavities, called *Ritans*, are frequently invaded by the sand, and they require constant attention. This compels the inhabitants of Souf to employ the utmost activity, which, giving

\* A little fish strongly resembling the above, if not identical with it, has been described by M. Gervais under the name of *Tellia apoda* (Annales des Sc. Nat. 1853, vol. xix. p. 14). It unites all the characteristics of our fish, with the exception of the ventral fins. It is said to be a native of Tell, south of Constantine.

† Revue et Magasin de Zoologie, 1859, tom. xi. p. 377.—E. D. See also Mr. Tristram's work on 'The Great Sahara' (already referred to). Mr. Tristram obtained specimens of *Cyprinodon dispar*, Lin., from the hot springs near Biskra; and Dr. Günther described them in a paper in the Zool. Proceed., 1859, p. 469.—A. C. R.

‡ But is it not possible that the fish, before rising in the waters of the wells, have been first carried down from the outer surface at a distance to the underground reservoirs that contain the waters underneath the surface of the Sahara?—A. C. R.

them habits of industry, has resulted in procuring them not only competence but wealth. All the houses were built of crystalline sulphate of lime, and were roofed with cupolas; from a distance a village looking like a collection of bee-hives. This singular custom is explained by the paucity of wood in that country: in the absence of beams to support the planking of a roof, they substitute a vault or a cupola, using the mid-rib of the palm-leaf for centreing.

It is a curious trait in the inhabitants of Souf, that having no other water than that of the wells, and this water never remaining on the sandy surface of the soil, they have no idea of a brook, or a river, or any other kind of running water.

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ABSTRACTS OF BRITISH AND FOREIGN GEOLOGICAL PAPERS.

ON THE ESKERS OF THE CENTRAL PLAIN OF IRELAND. By G. H. KINAHAN, Esq.  
(Read before the Geological Society of Dublin, Nov. 11, 1863.)

**A**TTEMPTS to determine the mode of formation of a deposit from intrinsic physical evidence have lately become much more numerous than they were formerly. It was in this way that Mr. Sorby determined, some years since, the mode of formation of the sand-beds of Hastings, Isle of Wight, Yorkshire, &c., and last year the origin of certain mica-schists, through the occurrence in them of the structure he has designated 'Ripple-drift;' and in a similar manner, Mr. G. H. Kinahan has recently discussed, in a paper read before the Geological Society of Dublin, the nature and origin of the Eskers of the Central Plain of Ireland. His paper is important, chiefly on account of its containing a proposed nomenclature of Eskers, which we cannot explain better than by saying that it is nearly parallel to that of Coral-reefs proposed many years ago by Mr. Darwin; we thus have Fringe-eskers, Barrier-eskers, and Shoal-eskers, as parallel terms to those of Fringing Reefs, Barrier Reefs, and Atolls; but the relation of the last-named terms in each series is less evident than that of the others, and partakes more of the nature of antagonism than parallelism.

Mr. Kinahan thus defines the three classes:—'The Fringe-eskers occur fringing high ground; the Barrier-eskers stretch from one high ground to another; or run out as a spit or bar from high ground; and the Shoal-eskers have been so called, as they seem to be similar to shoals and shifting banks of the present day.'

In case any of our readers may ask the question, What is an Esker? we may define it as a ridge, or rarely a mound, of sand or gravel, heaped up by the action of water, and derived from masses of the same material in close proximity to it. These masses, though they occur elsewhere, are most abundant in Ireland, where they have received the name of 'Esker;' they are analogous to the sand-banks, harbour-bars, shoals, &c., now in process of formation, through the antagonistic action of tides and currents causing the accumulation of bottom-material at particular points.—H. M. J.

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