African bulbs and ground orchids than has yet been brought together in one place is already established in the nursery. Most of these were introduced here during the winter rains, which have been followed by an exceptionally wet summer. The results are such that any doubt that may have been entertained as to the possibility of establishing here a representative collection of South African—one may almost say African—plants is set at rest.

Most of those who have taken an active part in the foundation of these gardens will not be satisfied merely with the collection and cultivation of South African plants. The educational effect of such a collection will nevertheless not be small. The great extent of the country and the sharpness of its physical divisions militate against the slowly growing sense of national unity. The presentation, even on a small scale, of typical representatives of its regional floras to the view of many who of necessity are acquainted with but little of its area, must do something towards the obliteration of hard dividing lines.

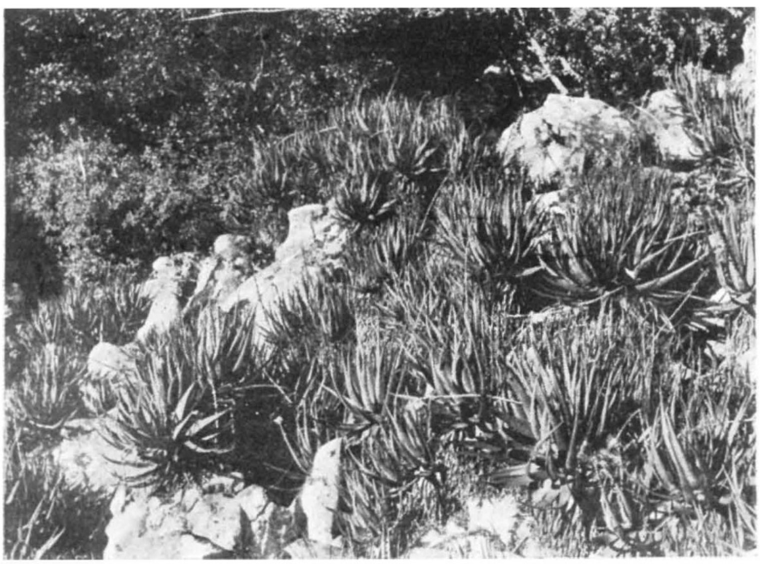

FIG. 3.—National Botanic Gardens. Group of *Aloe succotrina*. This is part of a very remarkable plant association about five acres in extent, on a steep slope strewn with large blocks of Table-mountain sandstone, 1500 ft. s.m. Associated with the aloes are lichen-covered trees of *Olea verrucosa*, *Cunonia capensis*, *Maurocenia frangularia*, *Plectronia* sp., etc., and a number of moisture-loving annuals, ferns and mosses.

From a purely scientific point of view, the importance of the National Botanic Gardens depends upon the use that is made of them for purposes of investigation. It is clearly realised that they will fall short of justifying their existence if they fail to make adequate provision for the proper study of the material they contain. Whether this provision will come through the much-needed university, or partly or entirely by private benefaction, or through some other channel, remains to be seen. The work at present in progress is ordered on the assumption that such provision will be made in the near future.

Since the publication of Pappe's "Floræ capensis Medicæ Prodromus" (1850), it has been known that a very large number of native species are, or have been, in use locally for medicinal or other domestic purposes. Plants yielding essential oils and other products of probable or possible economic value are numerous. While much of the work of acclimatisation, which in tropical countries has been done by the Botanic Garden, is here receiving adequate attention in the departments of agriculture and forestry, there are yet very many exotic plants worthy of attention, the possibilities of which await investigation. Among these the drug- and perfume-yielding species of the Mediterranean region are conspicuous. The economic garden, for which some twenty to thirty acres have been reserved, should therefore become an important part of the establishment.

The functions assigned to the National Botanic Gardens cover a wide range. At present much of the equipment which will make it possible to fulfil them is to seek. But the gardens exist in response to a popular demand, and popular support to make their future secure will not be wanting.

WAVES IN SAND AND SNOW.[1]

DR. VAUGHAN CORNISH has written a charming book, full of interesting observations. He starts with descriptions of waves and ripples in blown sand, and passes later to the similar forms produced under water, giving many good photographs to illustrate their various characteristics. Whether the waves are large or small, or whether formed by wind or water, it is obvious that the same causes are at work, and the author rightly distinguishes these waves from drifts and sand banks, the latter having their lengths parallel to the direction of the average stream, while the ridges of the waves are at right angles to it. The origin of the lateral drift which gives rise to sand-banks was first explained by W. Froude and independently by Prof. James Thomson about the same time.

Snow waves and snow drifts, and other forms of accumulations of snow, are described in chapters iii. and iv., and these also are well shown by photographs. The phenomena of snow are much more complex than those of sand, both on account of the variable size of the snow-flakes and particles and of the varying conditions as to moisture and temperature in which they are deposited. In some states snow particles cohere on contact; in others when the temperature is low they behave more like a dry powder, and it re-

1 "Waves of Sand and Snow and the Eddies which Make Them." By Dr. Vaughan Cornish. Pp. 383+plates. (London: T. Fisher Unwin, n.d.) Price 10*s*. net.

quires a pressure applied for some time to make them stick together. The resulting forms taken by accumulations near obstacles differ considerably in consequence.

One of the most interesting observations in the book relates to the natural sifting which sand undergoes whilst being blown hither and thither by the wind. One sample of desert sand was passed by the author through a series of wire gauze sieves of graduated mesh; a single sieve with a 1/48 in. mesh retained 94 per cent. of the total, the sieve above with a 1/24 in. mesh stopping 2 per cent. and the one below with a 1/96 in. mesh stopping 4 per cent. Practically, therefore, 94 per cent. of the sand grains had linear dimensions of between 0·02 and 0·01 in.

It would have been of interest if this sorting test had been carried further, for several phenomena of sand, notably "singing sand," and also the extraordinary roar which is sometimes heard when a slip occurs in a slope of blown sand, must depend on the uniformity of the size of the grains. Darwin in his voyage of the *Beagle* refers in chapter xvi. to a hill in Chile known as "El Bramante," on account of the roaring sound produced by the slipping of sand, and also states that the same circumstances are described in detail by Leetzen and Ehrenberg as the cause of the sounds which have been heard by many travellers on Mount Sinai. I have had a description from a friend who, with a party, was descending a slope of blown sand drifted against a cliff in the Nile valley. So far as could be seen, only a small surface flow of sand started by their footsteps appeared to be in motion, but the noise gradually increased to a loud roar, and the whole mass of the drift seemed to vibrate. This implies that each grain was doing the same thing at the same time for a considerable depth, which could scarcely happen were there not a fairly close uniformity in their size.

How the sorting is carried out by the wind does not clearly appear. Dr. Cornish's explanation is that the predominant size of grain is reached when mutual attrition ceases. If this is correct, it might be possible to determine the size in terms of the hardness of the material and the $\sqrt{\text{mean square}}$ velocity of impact. There is no doubt a definite size for which the whole work of impact could be taken up by elasticity and without rupture. The whole question, however, of the way in which dust is raised by the wind is rather obscure. Presumably the wind in contact with the ground must move parallel to its surface, and it seems probable that particles drifting along the surface can only be raised above it by impact more or less oblique with others which are stationary or moving with a different velocity. Once they are lifted into the eddying current their further distribution does not present the same sort of difficulty.

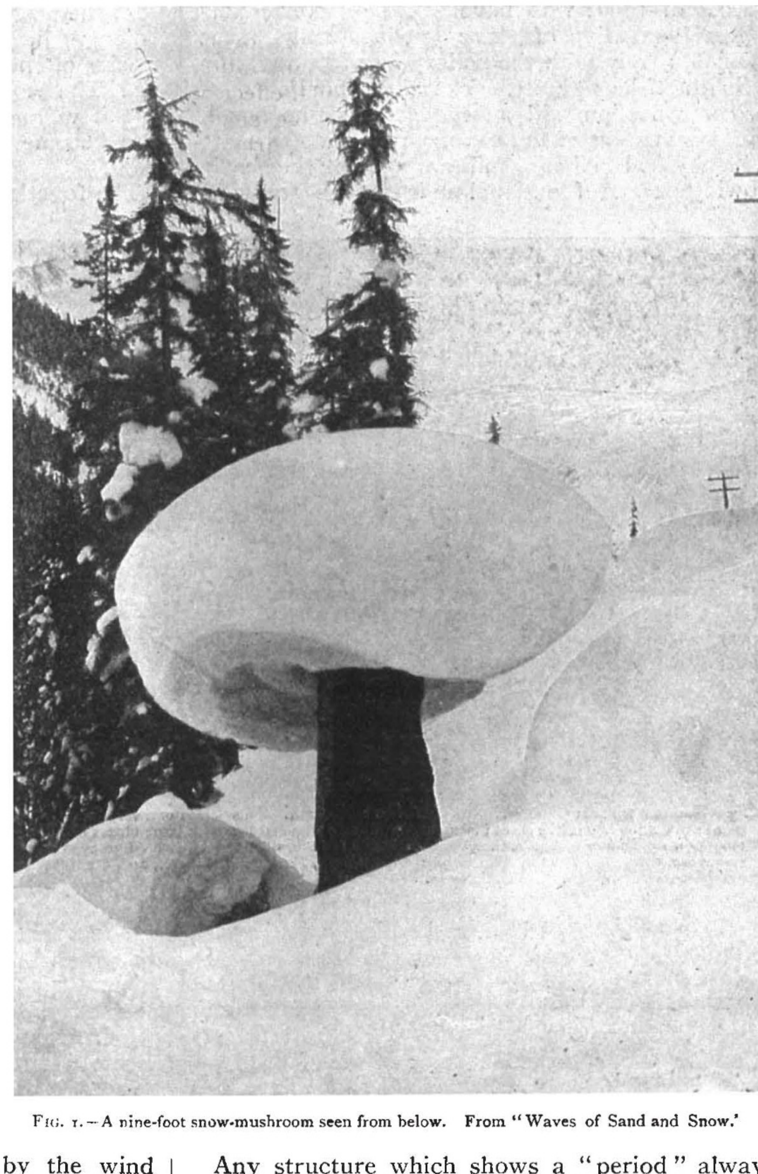

FIG. 1.—A nine-foot snow-mushroom seen from below. From "Waves of Sand and Snow."

Any structure which shows a "period" always presents interesting problems, but the periods and wave-lengths which Dr. Cornish deals with must not be confused with those belonging to stable systems, such as water waves, etc. The latter are definite in the same way and for the same reason as the period of a pendulum.

The sand waves are products of instability, and in all quasi-periodic structures which originate in this way the amplitude and wave-length are independent. In this they differ from stable systems which are isochronous. In the unstable systems a change, however small, tends to increase until a limit is reached at which a breakdown of some sort occurs. Instances might be given in great variety in which instability leads to a quasi-periodic motion or arrangement. Geysers which boil over at fairly constant intervals, the whistling of the wind (here the period is the rate of production of eddies round small obstacles), and the ladder-like shavings taken off various materials by cutting tools, are all cases in point, although drawn from such different quarters.

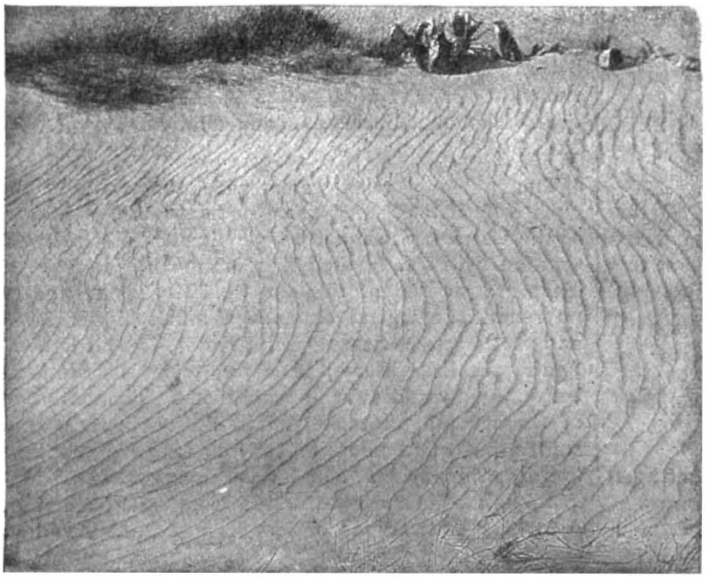

FIG. 2.—Aeolian sand-ripples at Southbour e. From "Waves of Sand and Snow."

Notice of many of the matters of which the author treats, such as snow mushrooms, and the ridges trodden out by cattle, must be omitted for want of space, and although it must be said that the explanations are not as good as the descriptions, the book is to be recommended as the most interesting collection of observations concerning the whole subject which has yet appeared.

A. MALLOCK.

MUTATIONS OF BACTERIA.

VARIOUS alterations in the morphology and in physiological characters of certain bacteria have been obtained by many observers. Thus *Bacillus coli*, the plague bacillus, and other organisms show considerable variation in the size of the cells on different culture media; the *Bacillus prodigiosus*, which forms a brilliant red pigment when grown at ordinary temperatures, completely loses the power of pigment production after cultivation at blood heat, at which temperature (98° F.) it grows as luxuriantly as at 65° F. Twort and Penfold have "educated" the typhoid bacillus to ferment sugars which ordinarily it does not attack, and Revis has obtained marked varieties of *Bacillus coli*, morphological and physiological, by prolonged culture in various media. Minchin holds that if there be no syngamy (sexual reproduction, *e.g.* conjugation) among bacteria, as seems to be the case, the so-called species of bacteria are to be regarded as mere races or strains, capable of modification in any direction.

A marked instance of the artificial production of mutations of *Bacillus anthracis*, a particularly well-defined and stable bacterial species (Fig. 1), is described by Mme. Victor Henri (*Compt. rend. Acad. Sci.*, vol. clviii., No. 14, 1914, p. 1032). The method employed was to expose an aqueous suspension of sporing anthrax in a quartz tube to ultra-violet radiations for times varying from one to forty minutes, and afterwards subculturing.

Whereas the majority of the organisms was killed by this treatment, the ultra-violet rays being markedly bactericidal, a few survived. Of the latter, while most presented a normal aspect, a few showed characters decidedly different from the typical anthrax bacillus. The principal of these were (*a*) coccoid forms (Fig. 2) which remained stable during a period of two months; (*b*) thin filamentous forms (Fig. 3), not taking Gram's stain, not liquefying gelatin, nor curdling milk, and producing an infection different from anthrax

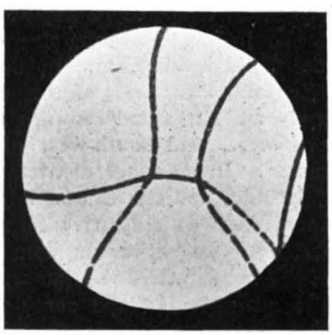

FIG. 1.

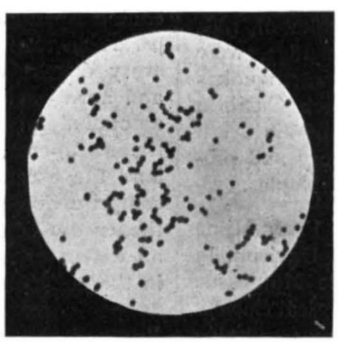

FIG. 2.

FIG. 3.