High Frequency Fatigue.[1]

MESSRS. G. F. Jenkin and G. D. Lehmann have prepared an important report on the subject of high frequency fatigue. These researches, the object of which was to determine the effect of the frequency of alternation of stress on the fatigue limits of various metals, were carried out in the Engineering Laboratories of the University of Oxford, and tests were made on rolled, normalised, and hardened steel; rolled aluminium, annealed copper, and normalised armco iron. The ordinary frequency employed in fatigue tests is 50 periods per second, though in 1924 Jenkin[2] carried out work up to 2000 periods per second, and in the research described in this paper frequencies up to 20,000 periods per second were used. In all the higher frequency tests the specimen consisted of a bar supported at the nodes, and vibrating freely.

Jenkin had previously used an electromagnetic method to produce the vibrations, but this will not work for very high frequencies and a new method had to be designed. On the experiments now described fluctuations of air pressure acting directly on the specimens were used to make them vibrate. The apparatus was essentially two blowers, each blower consisting of a small adjustable resonating chamber, into which air was admitted by a throttle valve in the back, while the front was closed by one face of the specimen. The position of the specimen was so arranged that as it vibrated to and fro it alternately released the air pressure or allowed it to mount up in the chamber.

The strains were calculated on the assumption that the bar vibrated freely and the only measurement necessary was the amplitude of vibration at the centre of the bar. Lord Rayleigh has shown how the strains may be calculated for a long, thin vibrating bar, but using the method of vibrating by air, the bars had to have a moderate width and, for the highest speeds, had to be short, with the result that Lord Rayleigh's theory was no longer sufficiently accurate. Prof. Love, however, has explained how the theory could be applied to bars of moderate width, such as were used in this apparatus.

The results obtained are of very great interest. In Jenkin's earlier experiments the largest increase of the fatigue limit observed was only 15 per cent, but, as he pointed out, much larger rises were to be expected at higher frequencies. In the present tests, the fatigue limit in all cases increases as the frequency of vibration is raised, and increases of fatigue limit up to 60 per cent have been recorded. It has also been found that the fatigue limit does not increase indefinitely with the frequency, but apparently reaches a maximum value at a certain critical frequency. In some tests it was actually shown to fall at the highest frequencies, the greatest drop obtained beyond the maximum fatigue limit being about 9 per cent of the maximum. This fall would probably have occurred for the other metals also, if they had been tested at still higher frequencies. The results obtained are summarised in the following table:

Material.	Critical Frequency (Approx.).	Maximum Fatigue Limit (Tons/sq. in.).	Ratio Maximum F.L. to Ultimate Tensile Stress.	Ratio F.L. at 50 ~ to Ultimate Tensile Stress.	Maximum Increase above F.L. at 50 ~ (Per cent).
Normalised 0·11 per cent carbon steel	20,000	>17·99	>0·799	0·631	>26·7
Rolled 0·11 per cent carbon steel	>20,000	>25·25	>0·588	0·528	>11·5
Annealed copper	10,000	5·59	0·385	0·324	18·8
Rolled aluminium	20,000	5·02	0·785	0·586	33·9
Normalised armco iron	10,000	18·1	0·903	0·685	31·6
Hardened 0·86 per cent carbon steel	10,000	32·4	0·658	0·400	62

[1] Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1222 (M. 62): High Frequency Fatigue. By G. F. Jenkin and G. D. Lehmann. (E.F. 219.) Pp. 34. (London: H.M. Stationery Office, 1930.) 1*s*. 6*d*. net.

[2] *Proc. Roy. Soc.*, A, vol. 109; 1925.

South African Vegetation.

DURING the recent meeting of the British Association in South Africa, the South African Association for the Advancement of Science may be said to have acted as scientific hosts to their visitors, and in that capacity they certainly spared no effort to provide information as to South African scientific activities which would interest their visitors from the northern hemisphere. As a result, the number of the *South African Journal of Science* issued in December 1929, which contains some of the papers read at the 1929 meeting, provides an exceptionally favourable means of gaining a comprehensive impression of South African science. The president, Dr. Jan H. Hofmeyr, in an eloquent address pointed out that, since the first visit of the British Association in 1905, there has been a great increase in the facilities for higher education throughout South Africa, and the 27 graduates of 1905 had increased to 314 in 1928. There has naturally, therefore, been a great amount of valuable scientific work carried out throughout the country since 1905, and Dr. Hofmeyr emphasises, as the outstanding feature of this period, that the bulk of this work is due to the activities of South Africans. Scientific data are no longer the result of the sporadic activity of visitors from older communities with a longer academic history; they result from the continuous labours of a number of South African investigators, many of whom have received their training in South Africa.

Biologically, South Africa is the product of its climate, its sunshine, its clear dry air, and its dependence upon rainfall. The remarkable vegetation of this great continent is very much influenced by the very characteristic physical and climatic features of the country, and this report, describing pioneer work in many fields, naturally has to give great space to the tentative generalisations that emerge as to the natural vegetation of the country and as to economic possibilities in agriculture and forestry. Prof. J. H. Wellington points out, however, that the three characteristic South African regions, as determined by seasonal precipitation, are equally important in determining human activities. These regions are:

(1) The western part of Cape Province, with a winter rainfall associated with westerly and north-westerly winds from the South Atlantic anticyclone. The visiting botanists obtained a slight impression of the possibilities of this type of weather on the occasion of their excursion to the Kirstenbosch Botanic Garden.

(2) The vast central and eastern area of the sub-

continent, with a summer rainfall, carried to it by the east and north-east winds from the anticyclone over the South Indian Ocean.

(3) The intermediate region, mainly a coastal strip, on the south and east, where, as a result of its intermediate position, the rains are fairly evenly distributed throughout the year.

The high tableland that fills the interior of the continent means that the rain-laden winds usually lose their moisture at the mountain barriers near the coast. As a result, over a great part of the interior of the continent the rainfall is very scanty, and the deficient moisture supply is the dominant factor determining both natural vegetation and possibilities of cultivation.

In the south-west of the Cape Province, with its adequate winter rainfall, cultivation is of the type associated with the Mediterranean seaboard. Provided there is enough potash, vines may be grown on the alluvial soil, and many visitors will have grateful recollections of the local vintages and the local liqueur Van der Hum. The olive, apparently, cannot compete with European conditions for economic rather than climatic reasons. But if cultivation problems are somewhat the same, the natural vegetation of the Cape Province is entirely different, for reasons that Dr. Marloth makes clear. We have in the Cape flora a remarkably diversified vegetation which, in an area about one-tenth of the country south of the Orange River, contains as many species as in the remaining nine-tenths. The bulk of these species are so remarkable in form and so new to the visitor that even the non-botanist is led to wonder and admire. Dr. Marloth lists 64 genera, containing 615 Cape species, which between them include only 19 species that are found outside the Cape region. These plants form part of the characteristic southern, sub-Antarctic flora, with affinities rather with other Antarctic land masses, and which has remained isolated and distinct by reason of the 'physiological isolation' imposed upon it by the arid tableland that intervenes between it and more northern floras, so that such invasion as does occur takes place either along the more richly endowed coastal strip, or by sea. Most of the familiar plants that the visitor first notices, the oaks, the weeds, etc., result from the long history of the Cape as a port of call upon the ocean route to India, before the making of the Suez Canal.

Most of the northern immigrants are also unfamiliar to British visitors, being elements identical with, or related to, the main African flora, Acanths, Asclepiads, Euphorbias, etc., and most of the native forest trees; comparatively few familiar northern genera, *Anemone*, *Rubus*, *Hieracium*, etc., are to be seen. As a result, the botanist from the northern hemisphere is at first swept off his feet by the vast assembly of striking forms of plants that are new to him; even in the Cape winter the Ericas and Proteas provide him with a wonderful array of flowers; in the spring, the numerous bulbous monocotyledons give sheets of colour on the hillside, and all the year round the flora is full of interest. The extraordinarily pronounced development of ericoid vegetation forms at the Cape also strikes the visitor; 21·4 per cent of the flora of French Hoek have ericoid leaves, according to Dr. E. P. Phillips; many of these plants being characteristic of an acid, if not a peaty, soil.

Northwards of the Cape, on the high inland plateaux, over many miles of ground, stretches the Karroo, with a rainfall averaging between 3 and 12 inches annually. This Karroo vegetation varies greatly in type: on the east with a summer rainfall we have a scanty grass veld, merging westwards into the 'Composite' Karroo, grazed by Persian black-faced sheep and goats; on the west, with a winter rainfall, the paradise of the succulents, where the more arborescent types predominate until the flora merges into the scrub areas of the coastal belt.

Prof. R. H. Compton has a brief note on this interesting vegetation. He points out that it is recruited from north and south. From the Cape come the leaf succulent Mesembryanths and Crassulas; from the north, stem succulent Euphorbias, Asclepiads, etc., and from the south, geophilous bulbous Monocotyledons, unpalatable Composites, the staple shrubs of the Composite Karroo, and from the igneous outcrops of the Transvaal and Rhodesia come curious plants with 'resurrectionist' habit, etc.

Where rainfall is slightly more favourable, the bush savannah or the high veld stretches over many miles of the Transvaal and Rhodesia. Dr. E. P. Phillips describes this interesting vegetation in the environs of Pretoria, where high veld and bush veld meet. He points out that the tropical element is conspicuous in the bush veld, which shows close affinities with the Kalahari flora.

South African Forestry.

Dr. H. M. Steven has written his impressions of the high forests of South Africa, gained during the British Association tour in 1929, in *Forestry*, vol. 3, 1929. The natural high forest in the region of Knysna and George, where rainfall may be expected throughout the year, is a mixed, temperate rain forest type, which in the past has been exploited regardless of the future. It is now under the care of a scientific forest service which studies its natural regeneration, but probably no skill could make this natural forest, with its superabundance of hardwood species, and relatively slow increment growth, an economic asset. It remains a national asset, and is well worth the care it receives, but South Africa is concerned with the fact that it exports its fruit in boxes made of imported timber and is rapidly introducing exotic softwoods to meet the needs of the industries of the Union. Messrs. G. A. Zahn and E. J. Neethling give an account of progress to date along these lines. *Pinus pinaster* has been planted most extensively in the past, but *P. insignis* and *P. canariensis* now stand higher in favour and are being planted very extensively. The yield of wood is already sufficient to enable Mr. M. H. Scott to give some preliminary notes upon the behaviour of the timber of such exotic conifers, whilst the high moisture contents recorded by Mr. Nils B. Eckbo (for example, 474 per cent on dry weight in the sapwood of *Cryptomeria japonica*) are a reminder that these studies deal as yet with very young-grown timber.

A new industry of considerable importance has sprung up around the cultivation of the introduced black wattle, *Acacia mollissima*, from which bark and tannin extract are exported annually to the value of about one million pounds. Mr. A. J. O'Connor and Dr. I. J. Craib deal with its sylviculture, whilst it would appear, from Mr. E. F. English's account, that most preliminary experiments on paper pulp production from South African hardwoods have been carried out upon the wood of the black wattle. With the tree grown especially for bark, a use for the timber is obviously an urgent economic problem.

It is interesting to note, with the distribution of the natural forest, and in the problem of plantation management, the dominant external factor in South African conditions is again the water supply. Indeed, Dr. I. J. Craib argues, on the basis of his experience gained at the Yale Forestry School, that the moisture content of the soil is in general of more importance than light in forest growth and in controlling the succession of events beneath the forest canopy, that go so far to determine the stability of forest conditions.

Dr. Craib's discussion of this problem has very general biological interest, as, indeed, do many of the contributions in this issue of *Forestry*, which seem primarily of economic interest.

Another very interesting ecological problem is the way in which the diversified native flora is sometimes superseded, as the result of fire or over-grazing, by almost pure stands of some particular plant. Mrs. Levyns gives a brief account of her extensive observations upon one such case, the extensive spread of the rhenoster bush, *Elytropappus rhinocerotis*, which has displaced pasture on the veld under such conditions. She shows that the seedlings of this plant flourish when germinating in completely exposed sites where many competitors wither and die, and that germination of the seeds may be better after exposure to a fire—observations which may explain the spread of this plant, which is useless as pasture. Sometimes the plants that oust the varied native flora are aliens, as several species of *Hakea* that cover the slopes of Table Mountain after fires.

GRASSLANDS.

South Africa is now grazed much more closely by the stock of the settlers than was previously the case, when wild game alone roamed in the veld. For many miles, in the dry South African winter, the only fruiting grass haulms seen from the railway will lie inside the wire fence that protects the rail track from the stock. Outside this fence, every palatable plant is grazed ruthlessly down to soil level, and only plants with conspicuous powers of regeneration are able to survive the onslaught. The control of grazing so that future resources are not needlessly impoverished, is probably the line of surest advance in many agricultural problems, and the doyen of American agrostologists, Prof. A. S. Hitchcock, of the Smithsonian Institution, has a brief paper upon the relation of grasses to man, which, whilst it emphasises the great importance of these plants, is full of wise counsel as to the conservation of grazing land based upon the experience of the United States, where over-grazing with the consequent depletion of the range has been a pressing problem, as indeed it has always been in the history of stock raising on open grassland since the days of Abraham.

The paper by Messrs. R. R. Staples and A. J. Taylor upon pasture management shows that South Africa is already attacking its own problems in this field. They show that frequent clipping on the veld, to simulate close grazing, materially affects the normal grass flora, both the dominant species, *Themeda triandra*, and the coarse pioneer grass, *Eragrostis alba*, succumbing very early under such treatment, whilst an introduced pasture grass, *Paspalum dilatatum*, survived the treatment much better. One of the most important results so far obtained in grassland management is undoubtedly the dominant significance of phosphate deficiency in most South African soils. Dr. I. de V. Malherbe states that phosphate treatment of arable soils practically always gives a large increase in yield, and Dr. P. J. du Toit emphasises the fact that phosphate manuring of grasslands in the form of bone meal has revolutionised the cattle industry in certain parts of South Africa. He suggests that, with a small daily ration of the missing mineral, it should be possible to raise improved breeds of cattle on the veld. A number of other very interesting contributions, dealing with both the native fauna, the stock and the economically important pests of the cultivator, are also included in this "Report of the 27th Annual Meeting of the South African Association"; in this review it has been possible to mention only very cursorily some of the many contributions that deal mainly with South African vegetation under both natural and cultivated conditions.

Weather and Climate of the Sahara.

OUTSIDE the polar regions there is no extensive area of land the weather and climate of which has been so little studied as that of the Sahara, with the possible exception of Central Asia. A certain romantic glamour seems to attach itself in the minds of most of us to that vast and little-known desert region, and this gives additional interest to a memoir published by the Meteorological Office, Air Ministry (Geophysical Memoir No. 48), which discusses in detail the meteorological observations made by Mr. Francis Rennell Rodd in 1922 and 1927 in various parts of the Southern Sahara ranging from Timbuktu in the west nearly to Lake Chad in the east, and in latitude from about 12° N. to 20° N.

This is a region that owes its rainfall to a brief monsoonal incursion of south-westerly winds from the southern Atlantic during the late summer. These winds penetrate underneath the prevailing easterly or north-easterly winds, probably to a height of about 1 kilometre, and the rainfall appears to be generally of a vigorous convectional type; the convection apparently mixes the opposing wind currents and often leaves the easterly wind in temporary occupation of even the lowest layers. Occasionally this process gives rise to 'tornadoes' of the African type, which are of the nature of line squalls, not destructive vortices like American tornadoes; they give severe gales of short duration. The rainy season appears to be a complicated affair, interrupted by various breaks. There was an important autumnal part until about fifteen years ago according to the natives, and Mr. Rodd experienced a cloudy spell in late November and early December that yielded a few drops of rain and lent colour to the local tradition. He was not of the opinion that any important general desiccation of this part of Africa has been in progress either recently or during past ages.

As in many other parts of Africa, the more mountainous districts tend to get abundant rain, while the relatively low-lying plains not only have, on an average, a very small annual fall, amounting locally to less than five inches, but also one that is capricious, and in large areas a scanty desert vegetation is only precariously maintained.

It is not in regard to rainfall, however, that the interior regions of the Sahara yield the most interesting weather, but in the matter of low relative humidity and the temperature contrasts that arise from it. Unfortunately, the degree of dryness experienced when easterly or north-easterly winds hold sway is too great for trustworthy treatment by normal hygrometry, and it would be necessary to make special direct absolute determinations to measure accurately the minute fraction of possible water-vapour pressure contained by the air on those days when temperature rises to 114°, as happened in June 1922 and September 1927. Some idea was obtained by assuming that the vapour pressure remained constant between the cool early morning, when measurements by ordinary means could be relied on, and the time of greatest heat at 3 P.M., so that the relative humidity was governed by air temperature alone. There was reason for believing such an assumption to be nearly true; more than one calculation