

found that Java indigo can tolerate wide changes in reaction, growing in Bihar in soil at pH 8.7 and in Assam at pH 5.4. It, however, does much better in the latter for various reasons.

In the British Isles it has been found that the yellow stonecrop, *Sedum acre*, flourishes in soil from pH 7 to 8 or over, whereas the white *S. anglicum* may be growing at from pH 6.8 to 5.1, possibly slightly outside these limits. Plants which are by some regarded as typical species of limestone districts may be found elsewhere provided the soil reaction is suitable; thus *Salvia verbenaca* grows between pH 7 and 8, *Critium maritimum* around pH 8, and *Cochlearia danica* from pH 7.5 to 8, possibly over it, much the same range being occupied by *Linaria cymbalaria*; for *Centranthus ruber* values from pH 7.4 to 8.8 have been obtained. The common gorse, *Ulex europaeus* is usually found on acid soil; in seven cases where it was observed growing in abundance the reaction was pH 6.8 to 5.4, but one plant was found at pH 8.1, one at 8.2, and three or four at 8.6. In other cases the soil was probably alkaline, but was not tested.

The sea pink, *Armeria maritima*, may be found between pH 6.8 and 8.2, but the typical sand-dune plants, *Ammophila arenaria*, *Euphorbia Paralias*, *Sal-sola Kali*, are found only in the neighbourhood of pH 8.

Moorland plants, *Erica tetralix*, *Anagallis tenella*, *Drosera rotundifolia*, *Jasione montana*, etc., are commonly found at pH 5.5 to 5, or thereabout, but the limits are certainly wider.

The accumulation of data of this type is of necessity a slow process, but one cannot fail to be impressed by the fact that the presence or absence of a plant in a given locality stands in close relation to the hydrogen-ion concentration of the soil. Plants may survive, or even do well, in cultivation outside their normal limits, but in free competition with their neighbours the soil reaction is often the deciding factor—always, in fact, if the divergence from the normal pH value for the species is sufficiently great.

Considerable changes in the soil reaction may be met with in quite a short distance. Thus on crossing a road at Youghal, Co. Cork, one passes from a soil of about pH 7.5, with *Salvia verbenaca* and *Ononis arvensis*, to an acid soil, pH 6.8 to 6.4, with gorse, and in the wet parts *Iris pseudacorus* and bog-cotton. This, in turn, passes into sandy pasture and sand dune, the latter giving about pH 8. Again, near Cawsand, in Cornwall, gorse is plentiful on the felsite soil at pH 6.4 to 5.4, but absent from the adjacent, and similarly situated, soil of the Staddon Grits, which normally gives pH 7 to 7.8.

It appears as if corresponding differences are shown by water-plants and fresh-water algæ, the upland waters which are very slightly acid or almost neutral favouring the desmids. There is much room for further work along these lines.

W. R. G. ATKINS.

August 30.

#### "Smoky" Quartz.

THE deeply tinted varieties of quartz, such as "smoky" quartz and the yellow or Madagascar variety, are generally transparent in the infra-red region of the spectrum to the same extent as clear rock-crystal, as may easily be demonstrated with the aid of a thermopile and galvanometer. I wish to suggest that a very simple physical explanation of this property may be offered. As has been emphasised in a paper by Prof. R. J. Strutt (now Lord Rayleigh) in the Proceedings of the Royal Society for 1919, these varieties of quartz are really optically turbid media, the opacity arising from the scattering of the

radiations in their passage through the crystal by a cloud of small particles present as inclusions. Since scattering of this kind is effective in inverse proportion to the fourth power of the wave-length, it can easily be seen why the longer heat-waves can traverse the crystal without appreciable loss. Some photometric observations which I have made of the relative transparency of the yellow and colourless varieties in different parts of the spectrum support this explanation.

In the paper just quoted Rayleigh has described the very beautiful and striking effects that arise owing to optical rotatory dispersion when a strong beam of polarised light is sent through a block of smoky or yellow quartz in the direction of the optic axis; the track of the beam, as made visible by the scattering particles and observed in a transverse direction, shows bright and dark bands if monochromatic light be used, and alternations of colour if the incident beam is of white light, the effect being due to the fact that the scattering particles themselves act as analysers of the light incident on them. I find that the phenomenon discovered by Lord Rayleigh can be very prettily shown in another way which is also instructive. A thin, flat sheet of unpolarised white light may be sent through the crystal in a direction transverse to the optic axis, and the track of the beam observed in a direction parallel to the optic axis through a Nicol. In this case the scattering particles act as polarisers, and the scattered light suffers a rotatory dispersion of its plane of polarisation in traversing the quartz along the optic axis before reaching the observer's eye. Hence the whole track of the beam as seen through the observing Nicol appears coloured, the tint fluctuating periodically with the thickness traversed as the block is moved to and fro in the line of sight or when the analysing Nicol is rotated.

Rayleigh has shown in his paper that the track of a beam of light traversing a beam of transparent colourless quartz can be successfully photographed. I find that by using a concentrated beam of sunlight it is possible visually to detect the Tyndall blue cone even in this case. Its intensity, however, is exceedingly small.

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September 4.

#### Brown Bast and the Rubber Plant.

IN NATURE of June 16 (p. 499), in a paragraph which announces the discovery by the Botany Department of the Imperial College of Science and Technology that "brown bast" (the most serious disease of *Hevea brasiliensis*) is essentially a question of phloem necrosis, it is stated that Sanderson and Sutcliffe have shown that "burrs result from the inclusion of areas of diseased laticiferous tissue in stone-cell 'pockets' formed by the activities of wound cambiums."

It should be pointed out that the presence of latex vessels in the core of nodules (burrs) was first recorded by Bateson (Agric. Bulletin Fed. Malay States, August, 1913, p. 24), and later corroborated by Richards and Sutcliffe ("*Hevea brasiliensis*," 1914, Malay Peninsula Agric. Assoc.), and by myself (Bulletin 28, Dept. of Agric., Ceylon, October, 1916, and Annals Roy. Bot. Gdn., Peradeniya, vol. 6, p. 257, 1917).

Workers in Java have further confirmed this inclusion of laticiferous tissue as regards the nodules which follow brown bast, and the fact that nodules in the most general case result from the inclusion of areas of diseased laticiferous tissue has been common knowledge in the East for the last five years. That the formation of nodules after brown bast is a secondary

symptom has also been generally recognised. Nodule-formation, however, occurs in many cases other than those in which it is merely a secondary symptom of brown bast.

The occurrence of diseased sieve-tubes in brown bast tissue, prior to the appearance of the disease in or adjacent to the latex vessels, has not been previously recorded, and if this is corroborated it may lead to further advance in our knowledge of this disease.

The statement that the diseased laticiferous tissue is enclosed in "stone-cell pockets" formed by the activities of wound cambiums is at variance with the results obtained by workers in the East generally. Occasionally stone-cell groups, which are abundant in normal cortex, are fortuitously enclosed within the nodule cambium at the time of its inception. The nodule cambium by its subsequent division lays down wood elements on the inside and cortical elements on the outside. It is a striking characteristic of cortex overlying old nodules, and presumably entirely derived from the nodule cambium, that stone-cells are completely absent.

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July 21.

MR. BRYCE is quite correct in his reference to the work of Bateson and others. In a brief note, however, historical reference to the bibliography of "brown bast" and related phenomena was not contemplated for a moment. The work of Sanderson and Sutcliffe was mentioned in consequence of the recent publication of their book on "Brown Bast." With the Editor's permission, it is proposed to deal further with the subject of this disease in a future issue of NATURE.

THE WRITER OF THE NOTE.

### The Nature of Vowel Sounds.

IF you will permit me to refer at this late date to Prof. Scripture's articles in NATURE of January 13 and 20 last on the nature of vowel sounds, I should like to emphasise the great service that the writer has done in pointing out that the ordinary methods of harmonic analysis are not necessarily adequate for the determination of the composition of a given tone, and may, indeed, give quite a false representation of the facts, because the sound may have inharmonic components. At the same time, it is doubtful whether his note in NATURE of March 3 (p. 12) in reply to another correspondent, interpreting some of Prof. Miller's results in this field, are justifiable. Prof. Miller's curves are evidently harmonic, from the fact that they repeat themselves very faithfully at regular intervals and establish without much doubt that vowel sounds (and some others) at least *can be* so produced that they are susceptible of harmonic analysis, whether they are always of such nature or not. The fact that Prof. Scripture finds the quality of the voice constantly changing in speech is not a matter of surprise, any more than that the human face and form rarely remain exactly the same for two seconds at a time in waking hours; it need not preclude us, however, from seeking to maintain a given quality for a time for purposes of analysis and record, any more than the latter fact prevents us from sitting for portraits.

There is, however, a point in the first article that is open to distinct criticism. The author says (p. 633):—"In the analyses of vowel waves the fundamental is indicated as weak, or often almost lacking. . . . We all know that this is the strongest tone of all." It takes all the point out of scientific research if we are going to discard its plain results for what "we all know," especially if the fact of "knowledge" stands on such weak grounds as does the one here referred

to. All that we are justified in saying is that a complex note is by common judgment considered as having the pitch of its fundamental; this may happen in cases in which the fundamental is known to be weaker than the upper partial or partials—a fact for which we have the authority of Ohm, Helmholtz, and the late Lord Rayleigh ("Theory of Sound," vol. 1, sec. 26). When Prof. Scripture states that fundamentals are "not of the nature of sine vibrations," he deprives us of any rational definition of the term; we could build up his type of fundamental vibration from a number of sine vibrations of shorter period, and thus produce a sound of low pitch from a number of high-pitched ones.

What I believe to be the true interpretation of Prof. Scripture's results and those of others in this field—in fact, the inescapable conclusion—is that the fundamental is, indeed, extremely weak in many of the tones produced by the voice and other musical instruments, and that it is further masked in the records by the comparative lack of sensitiveness of the ordinary recording apparatus in the lower ranges. We must then also conclude that there is something in the physiology or psychology of hearing, or in both combined, whereby the lowest component of a complex tone, the fundamental, fixes for the hearer the pitch of the whole tone, while the presence or absence of certain upper partials and their relative strength determines its quality.

The glottal puff theory is not inconsistent with the harmonic theory. Helmholtz accepted it and stated it very clearly, as seen in the following extract from his "Tonempfindungen" (Ellis's translation, p. 103):—"In order to understand the composition of vowel tones we must, in the first place, bear in mind that the source of their sound lies in the vocal chords, and that when the voice is heard these chords act as membranous tongues, and, like all tongues, produce a series of decidedly discontinuous and sharply separated pulses of air (*Luftstösse*), which, on being represented as a sum of simple vibrations, must consist of a very large number of them, and hence be received by the ear as a very long series of partials belonging to a compound musical tone." There remains to be applied a positive test, which, as Prof. Scripture points out, should not be dependent on the harmonic analysis of curves to determine whether or not Helmholtz was right in concluding that the partials of the voice tones are harmonic.

With reference to another point in the articles, it seems to me to be no more justifiable to say that the difference between the voice of a Caruso and that of a costermonger lies solely in the vocal chords than it would be to say that the tone of a reed instrument depends only on the reed, without reference to the size, shape, material, etc., of the rest of the instrument, e.g. that the difference between a bassoon and an oboe is only a difference of reeds.

PRESTON EDWARDS.

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THE first essential point of the interesting communication of Mr. Preston Edwards lies in the question of the weakness of the fundamental in the tone of a vowel. This tone is that of the larynx, or the voice tone. To the ear this is always the predominating tone. We may not be able to distinguish what vowel a singer is producing, but if we can hear him at all we hear the tone he is singing—that is, the tone from his larynx. When a larynx from a freshly killed animal is subjected to a blast of air and the vocal chords are brought together, a strong tone is produced.