In a book, however, which must necessarily be intended for use by pupils of very different attainments, it would be difficult to avoid criticisms of this kind, and we think the experiments on the whole judiciously selected and clearly explained. We shall look with interest for the appearance of the second volume, and when finished "Physical Manipulation" will no doubt be considered the best and most complete text-book on the subjects of which it treats.

A. W. R.

OUR BOOK SHELF

Mineralogy. By F. Rutley, F.G.S. (Murby's Text Books.)

MR. RUTLEY'S little treatise on mineralogy has the merit of expressing in a clear and simple form the facts that are most wanted to be known by the general student of a science for which a small elementary English book is needed. The descriptions are concise, and the selection of the matter under each mineral generally good. Mr. Rutley, furthermore, gives some fifty pages of preliminary matter, which, though not always put in the most intelligible form, yet embodies a considerable amount of useful technical teaching in regard to the physical properties of minerals. Mr. Rutley even enters, and very rightly does so, on the subject of optical characters. But in these pages, as in the page on thermo-electricity, the author does not seem to have carefully revised what he wrote, or he would not have followed other authors in speaking of boracite as a uniaxial crystal, and would hardly have classed the dispersion of light by a diamond with the play of colour exhibited by an opal. Nor is an optic axis correctly described as the only direction by looking along which the doubly refracted images of a spot can be got to coincide, as Mr. Rutley will see if he looks at the spot through two opposite faces of the hexagonal prism of a calcite crystal. He ingeniously endeavours to indicate the nature of the faces of his crystals by a sort of heraldic hatching and marking. The use of small letters always indicating the character of the faces, as in Des Cloizeaux and other French treatises, might have done this usefully; Mr. Rutley's puzzling figures will probably only serve to scare away the English student, who needs every allurement to the study of the neglected science of crystallography—a science neglected merely because the rudiments of geometry and trigonometry are not made a necessary part of every scientific student's education. And it is a significant circumstance in connection with this neglect of scientific crystallography, that the geometrical methods and simple notation introduced forty years ago by our distinguished fellow-countryman, the first living crystallographer, Prof. Miller, are, we believe, untaught in any single lecture-room in London. Is England to be the last country to adopt a system made European by Sénarmont, Sella, Beer, and Grailich, and which is fast overcoming even in Germany itself a natural prejudice in favour of the more unwieldy, though in its time useful and ingenious, notation of the great Leipsig Professor?

Sanitary Arrangements for Dwellings, intended for the use of Officers of Health, Architects, Builders, and Household. By William Eassie, C.E., &c. (Smith, Elder and Co. 1874.)

THIS volume gives, in a collected form, a series of papers published originally in the *British Medical Journal*. Its object, the author states, is to give "an account of the most ordinary sanitary defects in dwelling-houses and public institutions, in respect to drainage, water-supply, ventilation, warming, and lighting;" and "to set forth, what he believes, 'the most simple and effective means of preventing or remedying such defects.'" He

thinks it necessary to say further:—"The purpose of this small work is to point out, in the plainest language, what ought to be done to render ancient and modern houses healthy. I will eschew all extraneous matter, as much as possible, and will not fall into the common practice, better honoured in the breach than the observance, of heading the chapters, or interlarding the matter, with lines from the poets." It is but due to the author to say that he has faithfully avoided this tendency "to drop into poetry" on the subject of house-drains, sewers, &c.; on the plainness of the language, however, we cannot speak very highly. Many householders, it is to be feared, will find some difficulty in recognising an S-shaped pipe under the name of a "sigmoid"; or in appreciating the beauty of a description in which the overflow sewage from a cesspool is said to "debouch into the fields."

The greater part of the book is occupied with a description of the various sanitary appliances for buildings which have from time to time been proposed, or which have been brought into actual use: such as drain-pipes, of which twenty-two different kinds are figured and described; traps, of which thirty-six are given; fire-grates and stoves, &c. In many places, indeed, it reminds us of nothing so much as a manufacturer's or tradesman's catalogue. On the whole, however, this work contains much useful information and many excellent suggestions. On the subject of house-drainage, we are glad to see that Mr. Eassie has adopted and advocates the principle of leading all house-drains into one collecting drain, outside the house if possible, and placing in this main drain an efficient trap, properly ventilated, so as to prevent any of the sewer gases finding their way into the house through the drains or pipes.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

Robert Brown and Sprengel

IN the notice of Mr. Darwin (vol. x. p. 80, bottom of 2nd col.) a mishap has somehow occurred which blunts the point intended to be made prominent and renders the statement untrue. I supposed that I had written "And we know from another source that he (Mr. Brown) looked upon Sprengel's ideas as *by no means* fantastic. Yet instead," &c. The object was to show how very near Mr. Brown came to reaching the principle that Nature abhors close-fertilisation in plants, and yet did not reach it at all. The authority for the statement I wished to make will be found in a footnote in Mr. Darwin's book on the "Fertilisation of Orchids," p. 340.

ASA GRAY

Cambridge, Mass., June 19

On the Physical Action taking place at the Mouth of Organ-pipes

THE most interesting, and perhaps the most important, fact disclosed in the experimental study of the organ-pipe on the air-reed theory is this—that the aeroplatic reed has a law of its own, unique amongst the phenomena heretofore observed in musical vibrations. It may be stated thus—*As its arcs of vibration are less, its speed is greater.* All our knowledge of rods and strings, of plates and membranes, would lead us to expect the usual manifestation of the law of isochronism, that in the air-reed considered as a free rod fixed at one end and vibrating transversely, the law would be observed, "though the amplitude may vary, the times of vibration will be the same." Yet here we meet with its absolute reversal, viz.—*the times vary with the amplitude.* This information does not rest on theory; every eye may verify it. A principle so strange, when first its action was observed, might well lead to disbelief in one's senses, although the mind had by its reasonings led up to the fact and sought for it as the one thing needed to give consistency to theory and make it a perfect whole. Familiar as the air-reed had been to me, the one secret had been hidden from my eyes; seeing, they saw not. Faith in the known mode of activity of the transversely

vibrating rod had blinded me, and it was only after long reasoning, forced upon me by the presence of independent harmonics, not upon any theory belonging to a reed (whose first harmonic would be higher than an octave twelfth), that my faith was shaken. Then, conceiving the idea of this principle of action, I looked, hoping to find my reasoning confirmed; yet, let me confess it, the first sight of the reality startled me not a little with self-confusion. Here was an every-day fact, constantly before me it had been, beautiful in its simplicity, waiting to be acknowledged, and I so stupidly blind as not to see it. Vary the experiment, repeat it again and again, and the fact will be confirmed beyond possibility of doubt, that, the length of reed remaining unaltered, if by extraneous influence the pitch of the note is lowered whilst the pipe is speaking, correspondingly with the changing sound the path of the air-reed will be lengthened; or conversely if the pitch be raised, simultaneously with the quickened velocity, the air-reed will be seen to shorten its stroke; no swelling of tone gaining power with gain of amplitude; not the counterpart of a metallic reed, nor acting as a tuning-fork. The creature of air, it times itself to the element that sustains it. This aero-rhythmic law provides the only way possible to the air-reed to work out the transmutations of energy essential to its functions; the constitution of air necessitates the conformity in mechanical relations.

Another remarkable demonstration falls to this theory—that the note of every open organ-pipe is not single but is a concord, always consists of a duality of tone; the two distinct tones of the air-reed and of the pipe may be separated and again blended at pleasure.

Also that the harmonics or over-tones may in favourable pipes be brought on at will without alteration of the pressure of blowing; that likewise, when a pipe, instead of continuing to sound its fundamental, is unsteady, and gives its harmonic, the pipe being said to “fly off to its octave,” the notion implied is erroneous; it can be rendered visible that the air-reed leaps back to its octave speed, and by its superior strength compels the pipe to follow in accord. The expression “leaps back,” is deliberately used, for the native pitch of the air-reed is far higher than the harmonics of the pipe.

Add to these the still more singular feature of three different velocities concurring to produce in an open organ-pipe the one fundamental tone, which we call its pitch, the super-nodal wave having one velocity, and the sub-nodal wave having for its course and recourse two differing rates of progression. *The motion of vibration is an activity tempered by rests.* In every wind-instrument we perceive intimations that the period of rest is originally governed by the special structure of each, and experiment shows that we can arbitrarily limit or prolong it; this variable ratio of rest to activity is to be taken into account in all calculated times and velocities. In forming a true conception of the behaviour of musical reeds, and in tracing out the process of tone-making in organ-pipes and other wind-instruments, the modifying influence of the “rest” between the vibrations announces itself as of vital importance. If the doctrine is strange, it is not unnatural. The action of the heart furnishes a parallel instance—contraction, dilatation, pause—the three making up the rhythmic period of the heart’s beat, and their relative duration varying with the individual organisation.

The foregoing affirmations are preparative. It will not be possible to condense into one letter the evidence and arguments supporting them, but if they are borne in mind during the progress of the exposition, the bearing of each new fact on theory will be more readily seen, and the aim and purpose of the reasoning be apprehended even in its incomplete stages.

There is one significant question which it occurs to me has never yet been asked; that the node is to be found in all longitudinal vibration of rod or pipe is undoubted; that there is a displacement of a node in an open organ-pipe is an accepted fact—but why, in rod or pipe, why is there a node at all? The question will wait.

Now to the experimental pipe. Suppose we have before us an open diapason organ-pipe, of section rectangular, length 7 ft. 6 in., interior breadth $4\frac{1}{2}$ in., depth 6 in., area of mouth $4\frac{1}{2}$ in. by 4 in., pitch C.C.—the half wave-length for this pitch is 8 ft. 8 in. in the atmosphere. The wind-way is a narrow fissure, barely the twenty-fourth of an inch wide; on the inner margin of this wind-way we place a card or plate, covering interiorly the whole area of the embouchure, and then we admit the wind-current at the foot of the pipe from the organ-bellows.

Premising that the swift sequence of action is delayed for convenience of our analysis, we notice that the stream of air,

and as yet it is nothing more, is directed slightly diverging from the vertical, and sufficiently to cause it to glide up the inclined plane of the lip. This stream is the life-force of the sound. “That everybody knows.” True they may. But how many ever think, if they know, that its force is that of a storm-wind driving along at the rate of sixty miles an hour. The anemometer or wind-gauge proves it to be so, and that moreover in some stops of large organs the pressure per foot given by the bellows is equal to that of a hurricane.

If now the plate be removed from the back of the embouchure, the stream is instantaneously transformed into an air-moulded reed. There is gradation in the change, the order of which may be worked out, leaving the sound as Shelley says “waiting to be born.”

The velocity of *passage* is to become endowed with a new power, the velocity of *vibration*. How is this investiture accomplished? How afterwards does the transversal vibration of the aeroplastic reed call into existence the longitudinal vibration of the air-column of the pipe?

The isolated reed, before any change takes place, has no innate tendency to swerve from uprightness, of itself it can neither blow in nor out, nor can the atmosphere influence it, for that is equal on both sides; the air-column within the pipe is at rest, it has no self-stimulating power of vibration, and to disturb its equilibrium some internal exciting cause is needed which shall produce, with determination of priority, condensation or rarefaction. It is obvious that the reed as it now stands has no power to produce a condensation, it does not strike against the sharp edge, it simply asserts its own upward-rushing force. The reed must be bent before it will vibrate. To cause this flexure the only alternative is rarefaction. The act of rarefying occupies time, it takes place within the pipe, is not spontaneous, but is induced by some previous act, therefore the provocation belongs to the reed. In velocious rush over the mouth, its dense stream making around itself a rarefied atmosphere, it causes the approach of the quiescent column, carries off all the particles of air lying in the nearest layers, and would go on abstracting indefinitely if there were no counterbalancing causes coming into operation, but it brings down upon itself the power that bends it; *suction by velocity* has created a partial vacuum; the air-column, pressing outwards with the impetus of expansion, begins to bend the reed over, the excited air-particles of the interior not only press forward to fill the places of the lost, but eagerly crowd out upon the top of the reed, irresistibly sucked into the zone of rarefaction around the mouth, a region where velocity has ensured least pressure, and through this same “law of least pressure,” there is a loss of support to the under surface of the reed, favouring the curve of flexure, the pressure varying and diminishing from the root upward.

As yet we have no vibration, for simultaneously with the exterior action the interior rarefaction is extending high upward, the air-particles are rallying from further distances, awakened by the agitation of those in advance, throughout the whole length and breadth of the pipe, uneasy as bees in a hive; whilst the particles are swarming toward the mouth, they are drawing away from the main body of their supports, their own elastic energy is diminishing, they are more and more thinned in numbers, and the new levies come up to the front exhausted of their early vigour. Now is the supreme moment of the reed’s advantage, its watchful ally, the external air, pierces the weakest line just under the sharp edge of the lip, and dashing in as a wave of condensation with cumulative pressure, drives back the outflowing wave, and would restore equilibrium but that the air-column, still advancing, and pressed forward in consequence by the in-road of the upper air, meets it in full shock ere it has reached midway; meanwhile the air-reed, rising with vigour to recover its upright position, and following after its ally in the wake of the retreating column, slightly overpasses its own line, enters the pipe momentarily to be cast out again, for the wave of rarefaction is returning and vibration is established. The invading wave has been repulsed at the spot hereafter memorable as *the node*, and the conflict renewed and continued will chronicle no victory to either unless other and foreign forces are brought in, for, as I shall show, we have resources within command enabling us to sway the equipoise and give supremacy to the reed.

“I do suppose,” as Dr. Hooke says in his talk on “springy bodies,” “I do suppose the particles” behave, and that the action takes place in the manner I have described; the analogy is not strained, nor have I used one phrase in association of ideas which I do not think fully justified by the physical relations of

the process. Therefore do not dismiss this as the sketch of a fancy battle. Watch for yourselves; place within the pipe at the back of the mouth some fine filaments of cotton, or fluff or down; advance them from the interior to the inner edge of the windway, and you will see them shot with energy not upward into the pipe, but outward full in your face with an unmistakable trajectory. Do we not bring into activity the same force, "suction by velocity," when we blow through one little tube over another tube leading down to a well of perfume and draw up thereby scent-laden globules caught in the belt of wind passing over the tube's orifice, dispersing fine odour-sprays into the atmosphere? When a train of carriages loosely coupled is starting out of a railway station, should the engine suddenly back a little we see the hindmost portion of the train with its acquired momentum meeting the foremost portion advancing to it with reversed direction of impetus, and the central carriages receive a double compression, a rude kind of node is thus formed starting a reaction of bufferage in opposite directions; so when trains come into collision or are suddenly stopped in career, the distribution of weight, the gradients and relative velocities determine which portion feels most the influence of the shock. Again an analogy. There is a country custom, when the bees swarm to dredge them with flour as a means of identification, if the flour *travels* you will know the bees have journeyed likewise. Take a piece of white tissue paper (a bank-note answers it admirably), fold it so that a portion will occupy very nearly the space of the embouchure of the diaphon pipe, by using a card it may be held level on the outer edge of the windway, it is in fact a paper reed but flaccid and inanimate; as you advance it to the windway no sooner is it caught in the current than it darts upright and becomes incorporated with the air-reed,

"Grows with its growth and strengthens with its strength."

This same crisp little bit of paper will reveal to your eyes the treasured secret of the organ-pipe, tell you how its wealth of varied tone is wrought, show you its fine arcs of flexure, how it bends less for its inward than for its outward stroke, and how its free curves are moulded to your will; listen, and you shall hear the domestic wrangle of the reed and pipe; look, and you shall witness how in its high caprice it transmutes in a flash to harmonic speed and leaps exultant to its octave. Truly an Ariel imprisoned, endowed with form, and clothed with a white vesture making it in all its motion visible as bees.

On the supposition that the theory herein advanced is justifiable, the work of the aeroplatic reed is to be considered, specifically, *to abstract*. By reason of abstraction rarefaction ensues, condensation correlates therewith, the latter springing out of the former, and the product is vibration. The reed is the generator of the power and the node is the fulcrum of vibration, the place of reaction, with this peculiarity that it affords an elastic fulcrum sensitive to the encroachments of the column of air above it; in the stopped pipe on the contrary there is a stable unyielding fulcrum, and the results of this difference are very remarkable, as will be seen in another paper necessary to complete this exposition, but at present I can only allude in passing to one of these results which it seems desirable not to omit here. Admitting my affirmations so far as they can be proved by other eyes, objections will be taken to the imaginary description of the action of air-particles and waves in the interior of the pipe, as opposed to received doctrine. Novelty is often held to be outrage. It is an essential feature of my hypothesis that the initial movement, or prelude to vibration in the pipe, is distinct from successive movements both in its course and character; it extends throughout the pipe, is continuous but diminishing in degree, and is without a node, which is only fully established at the second course. Without entering now into further details it is important to notice that this interval between the first effort or gasp of the pipe and the full possession of its power, is distinctly perceived by the ear. All musicians acquainted with organs are conscious of this, and it is matter of usual comment with them how that stopped pipes are on the contrary remarkably quick of speech, instantaneous in articulation. They feel this without reasoning of why or wherefore. As in stopped pipes there is no supernodal column, no requirement for an effort similar to that awakening motion to perfect vibration in open organ-pipes, the verdict of the ear is in both cases consistent with and corroborative of the hypothesis. Experiments with a very peculiar pipe called the "German Gamba" will throw invaluable light on the process of tone-making in organ-pipes.

HERMANN SMITH

The Degeneracy of Man

WITH regard to the culture of savages in Brazil the evidence of facts will be more esteemed by Mr. Tylor than the opinion of Dr. Martius, for Mr. Tylor has brought together a wealth of facts on the history and conditions of culture.

There is one class of facts which to my mind bears particularly on this question of the tribes of Brazil and the Amazons, and that is language.

The Kiriri and Sabuyah of Bahia as also the Ge have affinities with the Shoshoni and other dialects of the Rocky Mountains, and it is difficult to believe a language of this kind can belong to an epoch of high culture.

The dialects of the Tocautius have affinities of a like character with the Ankaras and Wun of Africa, and with that of the Akka pigmies just discovered in the Nile region.

The Purus, Coroado, and Corope of Rio Janeiro appear to belong to the Carib directly, and thereby also to Africa.

In the present state of our materials and information it is impossible to define exactly the members of each class. Thus the two groups last mentioned appear to be connected by the Baniwa and the Carib.

The main body of the population of Guarani, Tupi, Omagua, have by me been long since pointed out as having a language similar in roots and grammar to the Agaw of the Nile region. This is the highest development of language known to me in Brazil.

If the tribes of Brazil have fallen from a higher estate it is strange they should have become endowed with languages of the Prehistoric epoch.

HYDE CLARKE

June 29

THE gradual degeneracy of savage man from a higher type is a fact which an eminent author states in his letter in NATURE (vol. x. p. 146) to be difficult of belief. He wonders that Dr. Martius should say "the Americans are not a wild race, they are a race run wild and degraded."

The following facts seem to me to support the view held by Dr. Martius, Alex. von Humboldt, Abp. Whately, the Duke of Argyll, and others.

In the Ilium now laid bare by Cr. Schliemann, the lower strata contain more copper and fewer stone implements than the upper. "In other words, we have the very 'unscientific' fact of an 'age of stone' above an 'age of copper'" (Quart. Rev., April 1874). "The newly opened mound of Hissarlik stands as a lasting witness to a progressive decay of civilisation, industry, and wealth, among the successive races of its inhabitants" (Quart. Rev.).

Among the forest tribes of Brazil Dr. Martius found traces of the village community with its tribe-land common to all, while huts and patches of tilled ground were treated as acquired property, the recognised owners not being individuals but families. This may be well explained as a custom brought by Asiatic immigrants into the American continent. The Chinese anciently divided the land of a village into nine parts. The division was made by two perpendicular and two horizontal parallel lines. The middle square was common land. The eight remaining squares were assigned to eight heads of families, who cultivated the common square, giving the produce to the Government: they constituted a village. This principle of revenue collection based on land distribution existed for many centuries in ancient China, and was afterwards changed for a grain tax in kind about the time of the building of the Great Wall. Agricultural emigrants to America at any date before 200 B.C. would be familiar with this mode of doing things, and would naturally carry with them the knowledge of this and other customs existing at the time in eastern Asia. The appearance of a principle of land distribution resembling that of the old Teuons, among American tribes, cannot then be taken as proof that they were progressing and not degenerating, for it may, when our knowledge of ancient America becomes more accurate, be seen to be one of the lingering remains of an older civilisation which in a tropical climate favourable to indolence would easily decline. The religious beliefs and social customs of Asiatic and American races are in many respects so similar that there is abundant ground for questioning the originality of any civilised custom found among American tribes. Why should not comparative ethnology one day find the key to solve all such questions?

This fact, looked at from the eastern Asiatic point of view, is so far then from supporting the theory of progressive development, that it may rather be used as an additional buttress for the theory of degeneracy.