But I think the analogy still holds good, inasmuch as the "gradual variation, &c., of a few primary sounds," is not the result of an *intention* to originate a new language, any more than the origination of a new species of animal by natural selection is *intentional* on the part of the animals engaged in the struggle for life.

S. J.'s "impression is that the dialects which run wild are much more variable than those under man's care, which is the reverse of the case with wild and domestic animals and plants." But it must be remembered that it is the object of the "host of schoolmasters, lexicons, and grammars," who "watch over the Queen's English" to make that language uniform, to check its variations. If breeders of cattle made an effort to obtain perfect uniformity in a certain species of animal, I have no doubt that the wild herds of that animal, if allowed to exist under different conditions, would show much more variation "than those under man's care." But I question whether, in spite of the conservative influences of "schoolmasters, lexicons, and grammars" languages do not undergo as much variation through the *artificial selection* of writers, whose aim it is to make language more and more expressive, as animals and plants undergo through the artificial selection of breeders and agriculturists.

King's Lynn, May 28 ARTHUR RANSOM

STONE IMPLEMENTS FROM BURMA

SOME notes on the stone implements of Burma, by W. Theobald, jun., of the Geological Survey of India, contained in the number of the Proceedings of the Asiatic Society of Bengal for July, 1869, seem worthy of notice in these pages. "The implements are curious as differing in form and type, not only from anything found in India, but from anything hitherto described from any part of Europe, though any implement yet found in India has its precise analogue in Europe." According to Mr. Theobald, not only is the form but the material remarkable, as these Burmese implements are fashioned either of basalt or some schistose rock, quite unlike anything to be met with in the district where the implements themselves occur; a fact which he thinks points to their having been brought down from Upper Burma (where such implements are common) by the original settlers of the country.

That curious superstition which prevails over almost the whole of the globe, and connects the origin of these stone implements with the "thunderbolt," is found also in Burma. They are there called *mo-gio*, or thunderbolts, and are believed to accompany the lightning. If a flash of lightning is seen to strike the ground, and an earthen vessel is inverted over the spot, in the course of a year or so the *mo-gio* will be found in it, having worked its way back again to the surface by its own recoil.

The classical, or rather Plinian, view of this subject has been well given by Bishop Marbodæus, who wrote his Book "De Gemmis" early in the 12th century, and who thus speaks of the Ceraunius :—

> Ventorum rabie cum turbidus æstuat aër,
> Cum tonat horrendum, cum fulgurat igneus æther,
> Nubibus elisus cælo cadit ille lapillus,
> Cujus apud Græcos extat de fulmine nomen.

Its virtues were great in Europe as preserving from injury by lightning or shipwreck, and they had even aggressive as well as prophylactic powers, enabling the possessors to take beleaguered cities and to destroy hostile fleets.

In Burma they are also highly valued, but are put to crucial tests to prove them to be the genuine article, before a purchaser pins his faith to them. One test is that if wrapped in cloth and fired at with a gun, no effect will be produced either on the cloth or its contents, however near the aim may be taken, and it is from its presence producing invulnerability in its wearer that the *mo-gio* is mainly valued. It may be observed that it is not stated whether it is the seller who is entrusted to take aim with the gun. Another test of its celestial origin is placing it on a mat with a quantity of rice. If genuine, no fowl or other creature will venture near it. Again, a plaintain tree cut down with it ought to die, and not, as is usual, to send up a new shoot. If genuine, it preserves from fire, but it has also great medicinal virtues, and a small chip administered internally is considered a cure for inflammation of the liver or other internal organs, and is also a specific for ophthalmia. The virtues of stone axes in Germany, as summarised by Preusker in his "Blicke in die vaterländische Vorzeit," are curiously similar to those of the Burmese *mo-gios*. They preserve the house in which they are from lightning, they perspire when a storm is approaching, they are good for diseases of man and beast, they increase the milk of cows, they assist the birth of children, and powder scraped from them may be taken with advantage internally as a remedy for certain diseases.

The types of these Burmese instruments described by Mr. Theobald seem susceptible of arrangement under four heads.

1. "A rough, stout, wedge-shaped instrument," which, to judge from the figure, resembles closely the better finished specimens of flint hatchets, of the type which occurs in the Danish Kjökkenmöddings.

This form is very rare.

2. A hatchet with flat sides converging towards the base, which is square, and with a segmental edge, much like a common German form.

This type is common.

3. A long adze, with square, slightly converging sides, and a bevelled segmental edge, in character much resembling some of the implements discovered in Java, Borneo, and Sumatra, and also a New Zealand form; and—

4. Implements of the same character so far as the edge and sides are concerned, but having the butt end reduced in width so as to produce a square shoulder on each side of the blade. In some this reduction in width extends more than half the length of the blade, so as to produce a T-shaped form. These shorter specimens are the most common. This form appears to be peculiar to Burma. One of them has been figured by the Society of Antiquaries (Proc. N.S. vol. ii. 96).

In some cases the lashings used to fasten them to their hafts have left traces on the stone. The implements are usually picked up on the surface of the hills, in the fields, or clearings made for cultivation, and not in the plains. Mr. Theobald seems inclined to doubt whether, without the use of iron also, those who made these implements could have effected clearances in the gigantic forests of Pegu; but it may be urged against this view that by calling in the aid of fire the efficiency of such tools is almost as great as if they had been formed of metal, and it is difficult to conceive a people in possession either of bronze or iron bestowing the necessary time and trouble on the fashioning of stone tools, when those of metal were at their command, which, whether fire were employed in the clearance or no, were for general purposes so much more effective. If the makers of these stone tools had been in possession of other means for clearing the hill sides, then Mr. Theobald would be inclined to regard the stone relics as agricultural implements used in hand agriculture, at the end of sticks, as a kind of spade, to form the shallow holes for the cultivation of "hill rice." If not explained in this manner, he argues, we must regard them as weapons of the chase and war, though this use is, he thinks, negatived by their thoroughly inefficient character for such purposes. To this may be objected, first, that the material of which they are usually formed is basalt, a stone constantly used as a material for cutting tools; secondly, that the presence of the square shoulders, so like those on the horn sockets for hatchets of the Swiss Lake-dwellers, seems to testify to the tools having been used as adzes or axes, or possibly chisels; and thirdly, that if they had been required merely for hoeing or digging, the trouble of grinding and polishing might and would have been saved. We will only add

that the paper is a valuable contribution to our knowledge of Eastern Neolithic implements, and that our present remarks are, like those of Mr. Theobald, "merely tentative, and designed to elicit additional information."

J. EVANS

M. FIZEAU'S EXPERIMENTS ON "NEWTON'S RINGS"

A COMPARISON of the values given by Professor Ångström (in his magnificent *Recherches sur le spectre solaire*) for the wave-lengths corresponding to the two principal components of Fraunhofer's line D, with some observations made eight or nine years ago by M. Fizeau, not only reveals a remarkable agreement between the results of these two distinguished investigators, but yields one of the most striking confirmations of the truth of the undulatory theory of light that recent optical research has afforded.

The experiments of M. Fizeau to which we refer were, essentially, the following. He produced the phenomenon of "Newton's rings," by laying a convex lens of very long focus upon a piece of glass with plane parallel surfaces, and illuminating the combination by the yellow flame of spirit of wine containing a little common salt. The lens was so arranged that it could either be made to touch the glass plate or be separated a short distance from it, its position being regulated by a micrometer screw. On gradually separating the lens from the glass plate, the rings were seen to contract and move in towards the centre of the lens, where they successively disappeared, while their place was supplied by fresh rings which made their appearance at the circumference of the lens. So far, all was in accordance with what was well-known before. But M. Fizeau found that when the phenomenon was observed with sufficient care, nearly 500 rings could be counted, flowing inwards one after another, but that after about this number the rings ceased to be visible, the surface of the glass showing a nearly uniform illumination all over instead of a sharply defined alternation of light and dark bands. When, however, the distance between the lens and the glass plate was further increased the rings re-appeared, getting gradually more and more distinct, until when nearly another 500 had passed they had become as sharp as at first; but a still further increase of distance caused them again to become confused, and they ceased a second time to be discernible at about the 1,500th. With a still greater separation of the glasses, however, they reappeared again, and became quite sharp at about the 2,000th, after which they for a third time got gradually confused and became indistinguishable at about the 2,500th.

So the phenomenon went on, the stream of rings inwards towards the centre of the lens, followed by fresh ones from the circumference, continuing as the lens was moved further and further away from the glass plate; but the succession of rings was not uniform, but broken up into batches of about 1,000 each, separated by short intervals of confusion in the way that has been described. The rings did not finally cease to be distinguishable until *fifty-two* such batches had been counted, and the two glasses were at a distance of about fifteen millimetres (more than half an inch) from each other.

This remarkable phenomenon of the alternate periods of distinctness and confusion of the rings is easily explained, as M. Fizeau points out, when we remember that the light employed was not strictly homogeneous, but consisted of two portions of nearly, but not quite, equal degrees of refrangibility. If either of these two constituent parts of the light had been used by itself, it would have produced a set of rings, but the rings of one set would have been a very little larger than the corresponding rings of the other. Hence if the two sets of rings are put together (as they were in Fizeau's experiment), they will nearly, but not quite, fit each other. If we examine a few rings at the centre, when the two glasses are in contact, they will appear to coincide precisely; but if they are traced to a sufficient distance from the centre, the coincidence is seen not to be exact. For although the *twentieth* ring (say) of one set is not perceptibly bigger than the twentieth ring of the other set, the *five-hundredth* of one set is perceptibly bigger than the five-hundredth of the other, and, when put upon it, falls almost exactly halfway between the five-hundredth and five-hundred-and-first of this set. Consequently, at about this part of the phenomenon, the bright spaces of one set of rings will occupy the same position as the dark spaces of the other set, and they will mutually obliterate each other. But since the *thousandth* ring of one set is nearly the same size as the thousand-and-first of the other, the two sets of rings will appear to fit each other again about this point; the *fifteen-hundredth* of the first set, however, is larger than the fifteen-hundred-and-first of the second set, but not so large as the fifteen-hundred-and-second; and hence, at about the position of this ring, the rings of the two sets will overlap each other, and mutually efface each other's outlines. And, carrying such considerations further, it is evident that the apparent coincidence and overlapping of the two systems of rings would recur alternately at regular intervals.

In order to simplify this explanation, we have tacitly assumed the lens to be so large that several thousand rings could be seen between its centre and its circumference. Practically, this would be impossible; but, by gradually separating the lens from the plane glass, we can, as it were, draw in towards the middle the rings which, with a larger lens, would be formed at a great distance from the centre.

Now, according to the explanation which the undulatory theory gives of the formation of "Newton's rings," the distance by which the interval between the glasses must be increased, in order that a given ring may come into the position previously occupied by the next smaller ring, must be equal to half the wave-length of the kind of light used for the experiment; and the distance of 0·28945 millimetres, through which, as M. Fizeau found by actual measurement, it was necessary to vary the space between the glasses, in order to make the rings go through one of the recurrent periods above described, that is to say, pass from sharpness to confusion and become sharp again, must contain just one more half wave-length of one portion of the light by which the rings were formed than it does of the other.

This brings us to the point of contact between M. Fizeau's observations and those of Prof. Ångström, to which we referred at the beginning. According to the latter, the wave-lengths of the two principal constituents of the light emitted by a flame containing the vapour of sodium (such as the flame employed by M. Fizeau) are respectively—

Millimetres
0·00058951 3
and 0·00058891 2.

Now, if we divide 0·28945 by half the former of these numbers, we get as the quotient 982; and if we divide it by half the second, we get as the quotient 983. That is to say, we find, precisely as the undulatory theory requires, that the distance measured by M. Fizeau contains exactly one more half wave-length of the more refrangible constituent of the light of a sodium-flame than it does of the less refrangible part. And, moreover, if we calculate, from Ångström's determination of the wave-lengths, the number of rings which must intervene between the positions of greatest confusion and greatest distinctness, we find 491 of the one set and 491½ of the other, which agrees entirely with M. Fizeau's estimated round number 500.

G. C. FOSTER