### Yellow

In the paper on colour read by Mr. Strutt before the British Association (NATURE, Jan. 19) two things are stated as requiring explanation (p. 238), both of which, it seems to me, are explained by one of the results furnished by such experiments as his own.

The first is the difficulty usually found in recognising the demonstrated fact that yellow is a compound colour. The other is that we generally distinguish different kinds of yellow more strictly than of other colours. "A dark yellow or orange . . . . suggests its colour so little as to be called by a new name (brown), while a dark blue is blue still;" upon which I must observe that we thus distinguish degrees of impurity rather than degrees of darkness, and that an impure yellow is called brown when it is dark, and drab when it is light.

Both things, however, are explained if it is true that *natural yellows differ less from the nearest colours of the spectrum than other natural colours do.* For, in the first place, the consequence will be that there will be many yellows in nature which we could not compound by our ordinary reds and greens, and we therefore find it difficult to imagine it could be compounded by any red and green. Secondly, there will be a greater relative range, so to speak, of yellowness, which we shall naturally subdivide according to degrees of purity and brightness. It may be added that, so far as brightness is concerned, the greater maximum brightness of yellow would act in the way last described.

But is it true that our yellows differ less from the nearest colours of the spectrum than our other colours do? I certainly think this is the result of the experiments, but I will only show that it is the case with the pigments employed by Mr. Strutt. He says, indeed, that "the most saturated yellow can be compounded of red and green." So it may in the spectrum (Maxwell, *Phil. Trans.*, 1860, p. 57—84); but Mr. Strutt's yellow cannot be compounded of Mr. Strutt's red and green. On the contrary, we see from his last "calculated" equation but one, that his yellow had to be diluted with nearly two-thirds as much of his white (the brighter of the two, I presume) before it could be matched by his red and green.

We can test the matter more closely. Denoting Mr. Strutt's red, green, and blue by $r$, $g$, $b$, and the "primary" red, green, and blue of the spectrum by $R$, $G$, $B$ (Maxwell, *ubi supra*, p. 74), we may thus express the former in terms of the latter:—

$$\left.\begin{aligned} r &= LR + mG + n'B \\ g &= l R + MG + nB \\ b &= l R + m'G + NB \end{aligned}\right\} (1);$$

where we know thus much about $L$, $m$, &c.; first that they are all positive, or else extremely small; secondly that, among them, the large letters must denote comparatively large quantities, and the small letters small quantities. Now, by the second "calculated" equation of the second batch, we find that Mr. Strutt's yellow is

$$\frac{1}{57}(128{\cdot}4\, r + 63{\cdot}5\, g - 49\, b);$$

and, if we substitute in this expression the expressions given above (1) for $r, g, b$, we shall have, for the coefficient of $B$,

$$\frac{1}{57}(128{\cdot}4\, n' + 63{\cdot}5\, n - 49\, N)$$

Now this must not be negative, or else must be very small in comparison with the coefficients of $R$ and $G$ (Maxwell, *ubi supra*, Tables VI. and IX.). Therefore $N$ cannot be greater than $2{\cdot}6\, n' + 1{\cdot}3\, n$; that is to say, there is no more "primary" blue in Mr. Strutt's blue than about $2\frac{1}{2}$ as much as in his red, *plus* $1\frac{1}{3}$ as much as in his green. It is true that blue is rather a dark colour in pigments; but so it is in the spectrum; and $N$ measures, not a quantity of colour simply, but its ratio to the "primary" blue of the spectrum. Either the yellow was very pure, or the red and green very impure; and, if Mr. Strutt provided himself with good representatives of natural colours, this proves my point.

C. J. MONRO

Jan. 20

### The Primary Colours

I HAVE been greatly interested in reading Mr. Strutt's curious experiments on colour in the last number of NATURE. I am glad to see that he is able to assume as proved the theory that green and not yellow is the middle primary. The true position of green is well illustrated in Mr. W. Benson's "Principles of the Science of Colour," both by argument and by diagrams. There is, however, one piece of evidence which seems to me conclusive as against yellow, but which I have not seen noticed.

When a solid body is gradually heated to incandescence, the light given out is first *red*, then *orange*, afterwards *yellow*, and finally *white*. If yellow were a primary, it would be impossible for it to appear in this series, which is formed upon the basis of the first primary, red, by successive additions of more and more rapid vibrations. Every colour in the series except the first must be a compound. If the heat is not sufficient to generate the most rapid vibrations which the eye can appreciate, white light is not given off at all, the series terminates with the yellow. The light of a glowing coal, without flame, in an ordinary fire, rarely passes beyond the yellow stage, and such light yields to the prism abundance of red and green rays, but scarcely a trace of blue or violet.

But, if red is the first primary, and green the second, which is the third? Shall blue still sit upon the throne on which Newton placed him, when his brother yellow is deposed? I think his position has become extremely precarious, and that he would be wise to abdicate with dignity before he is ignominiously turned out as a usurper.

If the kingdom of light is really divided into three principalities, is not violet the rightful heir to the third throne? Violet is said to be a mixture of blue and red. But how should red make its appearance at the wrong end of the spectrum? If it has no definite limit, but gradually thins out from its own place to the other extremity of the spectrum, then the whole of the other colours must be more or less affected by it, and red must be the only true primary among them. If it is said that the red in violet is clearly recognised by the eye, I think it may be answered that this is only because we have been taught to think of it as a compound, and that we might just as truly say that we can see yellow in green or orange in red.

Leicester, Jan. 21 FREDK. T. MOTT

### Utilisation of Sewage

WHILE heartily thanking your reviewer for the very valuable suggestions which he has given me with regard to the second edition of my "Digest of Facts relating to the Treatment and Utilisation of Sewage," I wish to point out a slight oversight which he has made.

He says, "Mr. Menzies' name, however, has somehow or other slipped out of his pages (159, 169) where he treats of this improvement on the older plans for sewage."

The fact is that page 145 has somehow or other escaped the reviewer's critical eye. On that page the following sentence occurs:—"Some of these towns, then, it will be seen, are provided with sewers much upon the plan which Mr. Menzies has the credit of having first brought prominently forward; that is to say, with impervious pipes for the sewage properly so called, and brick drains for the surface and storm water, the former being laid deeply and the latter being superficial."

I should be very sorry to have it thought that I had forgotten "to emphasise the name of the Windsor Sanitarian."

W. H. CORFIELD

### Ocean Currents

THE differences of barometric pressure to which Mr. Keith Johnston refers (NATURE, Jan. 19, p. 227) have a well-ascertained geographical existence, but his suggestion that they may originate or direct the Ocean Currents is clearly inadmissible. The high pressure over a large patch of the North Atlantic to the south or south-west of the Azores—and similarly in each of the other oceanic basins—is there permanently; and whatever disturbance might be produced by it was produced once for all when the high pressure was first formed. It would then displace a certain quantity of the water over which it rested, would thrust it out, and keep that particular part of the ocean at a slightly lower level than that over which the pressure of the air was not so great. But having done this, the adjacent bodies of water would be in hydrostatic equilibrium, and the high pressure could not continue to thrust water out towards the place of low pressure. My meaning may be at once illustrated by putting one end of an open glass tube into a basin of water, and partially exhausting the air inside it. The adjacent surface is thus exposed to a higher pressure than the surface inside the tube, and a certain portion of the water is immediately thrust from the place of greater to the place of less pressure; the column of water inside the tube is raised until the weight of the excess