

mottled with gold. The surface of the mirror is raised in low ridges, which radiate outwards from the centre in waving lines, like the sun's rays on the Japanese flag. After a few minutes' exposure to air or water a film of metallic green and blue invades the silver. But the tapetum does not line the whole of the back of the eye. It is bounded by a sharp irregular line which crosses the wall of the globe horizontally, about 1 mm. below the level of its equator. The lower portion of the retina, a little less than a quarter sphere, is backed, as it is everywhere in the human eye, by dense black pigment. Colonel Herschel observes that a man's eye does not gleam.

In a superbly illustrated monograph published in the Philosophical Transactions of the Royal Society Dr. Lindsay Johnson pictured the eyes of a great number of the animals in the Zoological Gardens as he saw them with an ophthalmoscope. With the exception of monkeys, the elephant, rhinoceros, and hyrax, all terrestrial mammals are provided with a tapetum. The exceptions are significant. In monkeys, as in ourselves, the retina shows a "yellow spot." They trust to direct vision with its minute discrimination of detail. They move their eyes with great rapidity towards the objects which they wish to examine. Such rapid movement is incompatible with extreme sensitiveness to the movements of external objects. A cat does not move its eyes. It moves its head. Of hyrax I have nothing to say, but the elephant and the rhinoceros stand alone amongst Herbivora. They alone are indifferent to the movements of lurking enemies—great cats and snakes. They do not need to sacrifice visual precision, as it must be sacrificed in animals in which the retina is backed by a mirror, in favour of a capacity of detecting movement.

I have examined the eyes of a considerable number of animals, and find that the disposition of the tapetum, considered in its relation to the habits of the animal, is in all cases in harmony with the view as to its purpose which I have here expressed. I am also prepared to give an explanation of the optics of its relation to the retina, but for this or for special illustrations I must not trespass upon your space.

ALEX. HILL.

COLONEL HERSHEY'S letter in NATURE of January 18, followed by that of Mr. Hunt, have no doubt interested others besides myself. I do not think that there is any reason to suppose that any animal's eyes are "autophanous," however general the belief to the contrary may be among those not given to accurate observation. I can add to the list of the apparently autophanous the springhaas in South Africa and the common English mouse. I generally encourage a few of the latter, and at the present time three have taken up their abode with me in Victoria Street. There is a regulator clock standing 1½ inches away from the wall, and about 6 feet high. I put a little food on the top of the clock, and sometimes behind the clock not quite so high, and in other awkward places. The mice jump on to the skirting board, and there spread themselves out sideways so as to stretch the 1½ inches, and then proceed to go up at an angle of about 40°, climbing, so to speak, a staircase that is not there, and then when this brings them to the side of the clock they turn over in a nimble way with a jump, not always successfully, and negotiate the next flight, and so zigzag to the goal. I often watch these quite close, holding a metallic filament electric light with shade, so that they are fully illuminated and I am in shade. So long as I am quiet or move slowly, doing nothing spasmodically, they take no notice. I have even prodded and moved the food they were eating with the slide of a long rule, which seemed to perplex rather than frighten them. They do not seem to hear loud noises or singing provided they do not contain S, K, or other sudden sounds, even though I am not a yard away. A few days ago while writing I heard one at work on some bread about 4 feet from the ground, when, to see him better without getting up, I focussed the filaments of the electric lamp upon him with a large reading-glass. The mouse did not seem in the least frightened, but stared at the lens a short time, and then I saw his eyes shining with a pale ruby, or rather spinel, colour, and was reminded of Colonel Herschel's letter.

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The same action which makes animals' eyes appear "autophanous" is seen in far greater perfection in that invaluable little instrument called the reflex light, now used in large numbers to protect the bicyclist from being run down by a motor-car at night. The bicyclist's lamp, of course, is useless, as its light in the road is outshone by that of the motor-lamps, and the lamp itself is generally not directly visible from behind. The bicycle and rider, too, are often by no means conspicuous objects, and the danger of being run down is a real one. To meet this, the reflex light has been invented. It may be considered to be a glorified cat's eye. All that is visible from the outside is a ruby bull's-eye lens, but inside, in the principal focus of this lens, there is placed a concave silvered reflector of half the focal length, i.e. the bull's-eye is at its centre of curvature. Any strong light shining upon the bull's eye is therefore brought to a focus on the surface of the mirror, and whether the light is directly in front of the lens, or on one side even to a surprising degree, the focussed light falls normally upon a portion of the reflector, which sends it back to the lens, and so in a parallel beam in the direction from which it came. The driver of the car and his lamps subtend so small an angle at a distance of, say, 200 yards, or very much less, that the reflected light is seen by the driver like a red lamp. The committee of the Associated Automobile Clubs were so impressed with the value of this device that the technical committee of the Royal Automobile Club, of which I am a member, examined and tested the reflex light, and they issued a certificate endorsing the claims made for it. There is a feeling that every cart in the country should carry one, which, unlike ordinary lamps, would entail no trouble or running expense, and would be free from all risk of fire. This reflex light beats any cat's eye or other animal's eye, but it is not autophanous.

C. V. BOYS.

THE experiments described by Colonel Herschel in NATURE of January 18 illustrate the reflecting power of animals' eyes, and give no support to the general view that the eyes of cats and dogs "shine in the dark," that is, in the absence of any external source of luminosity. The principle of the experiments is illustrated by the Reflex Lamp commonly fixed at the back of the frame of a bicycle in rural districts. This is not really a lamp, but a bull's-eye of ruby glass about 2 inches in diameter, fixed with the convex surface directed behind the bicycle. When a carriage or motor is approaching the bicycle from behind, its lamps illuminate the bull's-eye, and the reflection is so clear that the driver knows a cyclist is in front of him long before the rider or the machine can be seen. The candle-light used in ordinary carriage lamps enables the Reflex Lamp to be visible at a distance of a hundred yards or so on a dark night. The conditions are precisely similar to those described by Colonel Herschel, the only difference being that a glass convex lens takes the place of the animals' eyes.

R. A. G.

January 27.

Glazed Frost; a Reminiscence.

MR. HARDING'S letter (NATURE, January 25, p. 414) reminds me of an experience which, in view of the rarity of the phenomenon, may be of sufficient interest to place upon record in these columns, although the newspapers of the period—the sixties of last century—duly noted the occurrence. It must, I think, have been in 1866 or 1867 (date and year uncertain) that I had occasion to go from the West to the East End of London. Starting upon my journey about 10 p.m., it began to rain soon after I left the house in Bayswater, and I opened an umbrella, which, to my surprise, became stiffer and heavier every moment, and was found on examination to be so thickly glazed over with ice that it was impossible to close it. At the same time the pavements and roadway were also becoming uniformly glazed; pedestrian movement was most difficult, and all horse traffic was suspended. Although an experience of some forty-five years ago, the impression left upon my memory is still vivid—the ludicrous sight of people carrying ponderous and rigidly frozen umbrellas which they could not close, the stream of skaters down Oxford Street

and Holborn, and the silence due to the absence of vehicles, all came to mind on reading Mr. Harding's letter. It took me on that occasion more than four hours to perform a journey of about two miles, and progression was only made possible by encasing my boots in the folds of a woollen scarf which I was wearing at the time, which I took off and cut into two portions for the purpose. There was no viaduct at that time, and Holborn Hill interposed serious difficulties.

The explanation of the phenomenon is no doubt that given in "The Observer's Handbook" quoted by Mr. Harding, viz. the sudden freezing of supercooled water drops on shock. In connection with this explanation there naturally arises the question as to the particular conditions which admit of supercooling without actual conversion into hail. Clearly these conditions are but rarely complied with. The actual date could no doubt be found by hunting through newspaper files, but there must be many Londoners now living who can remember the occasion.

January 26.

R. MELDOLA.

The Radiating Power of Air.

It has been assumed in investigations of atmospheric radiation that the values of the radiating power obtained in laboratory experiments are comparable with the values obtained from meteorological observations, and agreement between values obtained by the two methods has been quoted as evidence of the accuracy of the determinations. In an investigation of the problem from the meteorological side, I discovered that the quantities used to represent the radiating power were different in the two cases, and the distinction is important.

In the meteorological method, if θ is the temperature of the air at time t during the night, values of α , θ_0 are found to satisfy approximately the equation

$$\frac{d\theta}{dt} = -\alpha(\theta - \theta_0) \quad \dots \dots \dots (1)$$

and apc is taken to represent the radiating power of the air, where c is specific heat, 0.239, and ρ is density.

If the radiation from a horizontal layer of air 1 cm. thick is $f(\theta)$ per unit area from each face, the absorption by it will be $2f(\theta')$ per unit volume if its surroundings are at temperature θ' . In that case

$$\begin{aligned} \rho c \frac{d\theta}{dt} &= -2[f(\theta) - f(\theta')] \\ &= -2(\theta - \theta') \frac{\partial f}{\partial \theta} - \text{higher powers of } (\theta - \theta') \quad \dots \quad (2) \end{aligned}$$

and by comparison with (1) it is seen that

$$apc = 2 \frac{\partial f}{\partial \theta}, \quad \theta_0 = \theta'.$$

Now, in laboratory experiments on the radiation of air, the quantity measured is the excess of the radiation per unit area from one face of a column or layer of hot air over the corresponding radiation from a column or layer of cold air, and this quantity, reduced to 1° C. difference of temperature for a layer 1 cm. thick, is denoted by h , and is used to represent the radiating power. Clearly $h = \frac{\partial f}{\partial \theta}$ and consequently $apc = 2h$, and not h , as hitherto assumed. If in the laboratory experiments the radiation emitted by the layer in a direction perpendicular to its face is compared with that emitted normally by a black surface, the value of h will be only $\frac{1}{2} \frac{\partial f}{\partial \theta}$ or $\frac{1}{4} apc$, since the ratio of the total radiation to the normal radiation is π for the black surface but 2π for a thin layer of air.

The confusion arose from the fact that h and apc were taken to represent the rate at which air is losing heat by radiation to surroundings 1° C. colder, but while in the case of apc the radiation in all directions was taken into account implicitly, in the case of h the necessary adjustment was not made.

E. GOLD.

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Microscope Stands.

A LENGTHENED experience in the use of the microscope impels me to ask you to allow me to take exception to one of the statements made by the writer of the article on microscope stands which appears in NATURE of January 11. Referring to the circular rotating and centring stage of the better class of Continental stands, the writer says, "the use of which for anything but petrology it is difficult to guess."

After working for upwards of thirty years with an English stand, and, especially during the latter part of that time, constantly feeling the desirability of a rotating stage, I decided three years ago upon the purchase of a new stand, and the circular rotating stage was the feature that led me to decide upon one of Continental manufacture, after carefully considering the merits of two of English manufacture. If well made, the rotating stage is of great utility. If one wishes to examine, and especially to draw, say, one of a number of scattered Ophiurid or Echinoid plutei, it is a great convenience to be able to bring its sagittal plane into a vertical position in the field of view, and, as I know from much irritating experience, this is seldom possible on a fixed rectangular stage provided with mechanical adjustments, or even a sliding bar.

What is really needed to make the rotating stage of the Continental microscope much more efficient is a removable sliding bar, upon which it would be possible to support a $3 \times 1\frac{1}{2}$ inch slip, so that a series of sections mounted upon it might be examined carefully with the microscope in an inclined position. The rotating stage of a high-class stand by one of the foremost English makers, now before me, is provided with such a bar, which slides in a groove cut in the stage; but its utility for the purpose indicated above is nullified by the projecting heads of two screws which hold together parts of the mechanical adjustments, and the whole instrument is little more than an ornament on my work-table.

I have never found any use for the excentric rotating movement below the Abbe condenser, and especially for the cylinder diaphragm, which, I suppose, is a sop thrown by Continental makers to those teachers who, in my student days, derided the use of any form of substage illuminator. In my opinion the expense incurred in the manufacture of these redundances might with great advantage to workers like myself be devoted to the improvement of the stage on the lines I have indicated.

H. C. CHADWICK.

The Biological Station, Port Erin, January 26.

Meteor-showers.

THE following meteor-showers become due in February. The epochs are arranged according to the times of the principal maxima:—

Epoch February 4, 3h. 30m. (G.M.T.), fifth order of magnitude. Principal maximum, February 3, 8h. 55m.; secondary maxima, February 3, 3h. 40m. and 20h. 20m.

Epoch February 3, 9h. 30m., nineteenth order of magnitude. Principal maximum, February 4, 21h. 15m.; secondary maxima, February 4, 11h. 25m., and February 6, 6h. 50m.

Epoch February 9, 4h., twenty-first order of magnitude. Principal maximum, February 10, 8h. 40m.; secondary maxima, February 10, 1h. 30m., and February 11, 8h. 25m.

Epoch February 13, 11h., fifteenth order of magnitude. Principal maximum, February 12, 13h. 45m.; secondary maxima, February 11, 22h. 30m., and February 13, 10h. 45m.

Epoch February 14, 11h. 30m., thirty-third order of magnitude. Principal maximum, February 15, 22h. 45m.; secondary maxima, February 14, 11h. 35m., February 15, 15h. 30m., and February 16, 7h.

Epoch February 16, 8h., approximately tenth order of magnitude. Principal maximum, February 17, 0h. 30m.; secondary maximum, February 17, 15h. 40m.

Epoch February 19, 1h., approximately thirteenth order of magnitude. Principal maximum, February 18, 5h. 40m.; secondary maxima, February 18h., 3h. 40m., and February 18, 18h. 55m.

Epoch February 20, 7h., fifteenth order of magnitude.