accept the Greek MSS. attributed to Zozimus, Pelagius, Olympiodorus, Democritus, Mary the Jewess, and Synesius, as exact evidences of date or knowledge. In regard to more modern matters we regret to find no account of Robert Hooke's important theory of combustion. We are glad to observe that M. Hoefler does not echo the Wurtzian aphorism: "La chimie est une science Française, elle fut instituée par Lavoisier d'immortelle mémoire." More liberally our author says, "Tout en suivant chacun une route différente, trois chimistes ont fondé, vers la fin du dix-huitième siècle, la chimie moderne: Priestley, Scheele, et Lavoisier, un Anglais, un Suédois, et un Français."

We should be glad to see in our own country the history of matter and of motion studied side by side with the history of languages and of numbers. Prof. Kopp lectures on the History of Chemistry in the University of Heidelberg, and no doubt his example is followed in other of the German universities. M. Hoefler's work is in many ways suitable for use as a text-book; it is cheap, it is anything but dull, and whatever the errors of arrangement may be, it contains a great deal of information.

G. F. RODWELL

OUR BOOK SHELF

An Essay on the Physiology of the Eye. By S. H. Salom. (Published by the Author.)

THAT the study of formal logic is not in itself conducive to sound reasoning will be acknowledged by many, but it is seldom that the truth of the statement is so fully illustrated as in the short work before us. The author has studied the writings of Hamilton, Mill, Bain, and others, and with a creditable enthusiasm endeavours to employ the new powers he thinks he has thereby acquired, in developing a hypothesis of his own to account for the phenomenon of vision more satisfactorily than those already accepted. An outline of the arrangement, which is partly disguised at first sight by the many technicalities and circumlocutions employed, will be almost, if not quite, sufficient for most of our readers. Commencing with a notion broached by Erasmus Darwin, that visual perception ensues from retinal motion derived through the motile force of light, the author hopes, "by turning the light of modern histological discovery on Darwin's theory of involuntary animal action, to succeed in convincing associational psychologists that this theory must henceforth be included in the creed of *a posteriori* thinkers." With this as a basis, the doctrine promulgated may be thus summarised. The eyeball being in a constant state of reflex action on account of the light acting dynamically on the retina, the motion thus produced exerts in the muscles surrounding the eye feelings of muscularity similar to those excited when we voluntarily determine ocular direction, and consequently without any voluntary effort, we are constantly aware of visual space properties. To prove this novel hypothesis the structure of the retina has to be fully entered into, and in a most ingenious manner solid fact is distorted to satisfy unsubstantial theory. Taking a single example of the reasoning employed, we find that it is necessary for the theory that the fovea centralis of the retina should be elastic; that it is so is evident from the following considerations:—"In the copious index of that exhaustive anatomical work, 'Quain's Anatomy,' under the heading 'yellow,' we find, in addition to 'yellow spot,' four substances *only*, namely—

Yellow cartilage,
" fibres of areolar tissue,
" ligaments of the vertebræ,
" tissue.

And on referring to the pages of the book in which these subjects are treated, we discover that *they have the common property of being elastic.*" From this on one of Newton's rules for philosophising "we are bound to frame the following physiological induction,—*all yellow anatomical substance is elastic.*" We can hardly think that the author is not attempting to fool us.

LETTERS TO THE EDITOR

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

Atoms and Ether

ATTEMPTS to dispense, in physics, with the ideas of direct attraction and repulsion, however interesting, lead generally to a *petitio principii*, and I fear Prof. Challis's view, to which attention is called in NATURE of August 7, cannot be received as an exception.

For an ether of which the density can be varied is a substance that can be compressed and expanded, and what idea is in our minds when we speak of compression and expansion in a really continuous substance? Continuity implies space, and space that is full. Can space be more than full? When we say that a fluid is compressible and elastic, do we mean anything else than that it is made of parts which can be pushed closer together, and which, being so pushed, will push each other back? But this is repulsion and action at a distance. We do not alter the fact by calling the substance ether, and relieving it from the influence of gravitation.

Is a continuous substance, which is capable of compression, conceivable? I think not; or if it is, the conception is at once more difficult and more opposed to sensible experience than that of attraction and repulsion.

The substance of a bar of iron is not continuous. If I draw one end of it towards me, why does the other end follow? What can be the relation between the movement of my end of the bar and the ethereal vibrations which must propel the other end and all intermediate parts in the same direction?

Liverpool, Aug. 9

ALBERT J. MOTT

Instinct

Sense of Direction

THE perusal of the correspondence published in the February and March numbers of NATURE now to hand, and also your article on "Perception and Instinct in the Lower Animals," in the number of March 20, has induced a belief in my mind, that I may perhaps be able to contribute some evidence bearing upon the question at issue; and also that it may have some value from having been obtained from a field of observation not generally accessible, and from the fact that cattle and horses in Australia are subject to very different conditions to those obtaining in England.

I may commence by stating that the question, whether animals have or have not a peculiar power of finding their way from place to place, suggested itself to my mind very shortly after I first went into the Australian bush, now more than twenty years ago. It was not long before I satisfied myself that in many horses this faculty was strongly developed, but yet unequally in different individuals. I afterwards ascertained that it also existed in cattle.

Not only did I find that horses had extensive memories for places, being enabled to recollect a track they had followed some time previously, but also to remember the way from one place to another where no track existed. I found that not only had horses this exact memory, but that they possessed another gift which at first appeared to me inexplicable. This was, that when ridden through the bush, many horses would never, for a moment, as it were, lose the recollection of home, but "bear away" in its direction. I remarked this not only in a district with which the horse might be acquainted from grazing in it, but also when travelling and absent for the day from my camp, and from the other horse or horses, the "mates" of the one I rode.

Further than this, I also found that as regarded myself, I never lost the distinct perception of the direction in which my home, or camp, or starting-point for the day was situated, and in endeavouring to trace out and analyse this feeling, I at last came to the clear perception that it depended upon an unconscious action of the memory thus recording the alterations of the courses I had followed, and which by an effort of the memory I could recall. On this point I feel quite clear, for from the practice of paying especial attention during constant explorations to the course travelled, both for the purpose of keeping a correct dead reckoning, as also for the delineation of the features of the country passed over, I have found the faculty intensified, and the process more evident to myself. I may say that during the course of those twenty years' experience, I have never found the faculty at fault.

I believe in this lies the explanation of the power possessed by cattle and horses of finding their way from one place to the other irrespective of the road they may have gone.

I now propose to record some instances showing how cattle and horses in this district have endeavoured to reach the places where they were reared, and the truth of which I do not in the least question. To show how frequently such cases are met with here, where horses and cattle are bred in a half wild state at large in the bush, I may note that on determining to make this communication, I spoke to the first persons I met with who were likely from their pursuits to have noticed instances of the nature I required; of these persons, four at once gave me the particulars I am about to relate. But before doing so I must further remark, as bearing perhaps not remotely upon the question, that I have not met with aboriginal natives, either as savages or as "tame blacks," who possessed any power of finding their way from place to place differing in its nature, though perhaps in its degree, from that to be found in every good "bushman" among the whites. Their knowledge of country is entirely local—special as regards the district belonging to their tribe or family—general as regards the country of the neighbouring tribes. They know it thoroughly because they have been born in it and have roamed over it ever since. Out of their own locality I have found them to be inferior to a good white "bushman," in so far that they are unable to reason out any problem relating to the features of the country, and my experience has shown that out of their local knowledge I could never rely upon one of them in preference to my own judgment. I have remarked also that very few could, even in their own districts, travel straight from one place to another, say at twenty miles' distance. I now refer especially to the aborigines of that part of the interior of the continent lying on each side, north and south, of Sturt's Desert and including Cooper's Creek. As a rule they would "give and take" some 30° on each side of the course, correcting the direction from time to time as they recognised the "lay of the country" from rising ground.

In order that the instances I shall now quote may be more clear, it will be necessary to say in the first place that all the localities mentioned below will be found named in the maps published by the Surveyor-General of Victoria, and no doubt also in others. The only exception is Deadcock Creek, which is however shown as a small stream falling into the Mitchell River, on the west side below Cobbannah Creek. All cattle and horses brought down from the Maneroo table-land in New South Wales to the Gippsland market, travel by one road *viz* the Black Mountain, Buchan, Bruthen, Bairusdale, and Stratford; the distance from the centre of Maneroo district, say where the 149th meridian crosses the Snowy River, to Stratford, is about 180 travelled miles, and the number of cattle brought down annually may be about 12,000; of these a certain percentage escape and make their way back to the place where they were bred unless recovered on the way or hindered by natural obstacles. There is no other way from Maneroo into Gippsland excepting the one mentioned, and the country northward between that road and the Great Dividing Range is occupied by high and rugged mountains, dense forests, and thick scrubs. The road from Maneroo crosses the rivers flowing from the Great Dividing Range.

1. About four months ago a mob of cattle was brought down from O'Rourke's Station, the Black Mountain, Snowy River, and sold at Stratford. After being two months on the Bushy Park run near Stratford, fourteen bullocks escaped from the paddocks, and on search being made were recovered at the junction of Deadcock Creek with the Mitchell River. The line they had taken if carried out would go near the Black Mountain.

2. A horse bred by Mr. Sheen of Omeo was taken down *viz* Bruthen, Bairusdale, and Stratford, and sold; was broken into harness, and worked by Mr. McFarlane, a contractor; was lost near Stratford, and on search being made was found at the junction of the Wentworth and Mitchell rivers. The line taken in this case is direct for Omeo.

3. Mr. Dougald McMillan of Stratford some little time back bought a mare from a Maneroo "mob." About a month ago she was lost from near Stratford in hobbles and was seen a day or two afterwards crossing "Iguana Creek still in hobbles and as fast as she could go." The people from the Glenalladale Station (Iguana Creek) being then engaged gathering some wild horses at Deadcock Creek, found her with them. This line taken was the usual one, and if carried out would cross the centre of Maneroo.

These three cases were related to me by the stock-keeper at Glenalladale Station.

4. A year or two back Mr. Kreymborg of Bairusdale purchased a mob of horses from O'Rourke Station, Black Mountain, and sold one, a black mare, broken to lead to a person named Gee, living at Cobbannah Creek. The mare remained with Gee's horses for some time, but was then missed from Lower Cobbannah Creek and next heard of at Tabberabberah, and was recovered on Pettersen's Station, at the foot of Mount Baldhead.

This line bears a little away from the Black Mountain, but the nature of the country is such that the Mount Baldhead and Notch Hill tier of mountains form the end of a *cul de sac*, of which the open country at the junction of the Wentworth and Mitchell rivers is the mouth. This tract of forest country fenced in by mountains a few years ago swarmed with stray cattle and their progeny; three hundred bulls were shot by the then proprietors in, I believe, about two years.

5. Mr. Freitag, who follows the occupation of packing up goods to the Crooked River gold-workings, tells me that he is in the habit of buying Maneroo horses at Stratford and breaking them in for use in his pack-train. He finds that for the first few trips they require watching carefully when camped at Iguana Creek, where the road to Crooked River turns northward, as they are very apt to make away at that place. When recovered they are usually found either at Deadcock Creek or up the river towards Tabberabberah, thus conforming strictly to the direction taken by cattle and horses in other instances.

6. Thomas Dowling, employed in the stations of Messrs. Degraives, at Omeo, bought a mare from Mr. McKeachie, of Delegete in Maneroo. The mare was kept in the Hinomungie paddock (Omeo) for two or three years. Being then taken to Bindj, about twelve miles distant, she escaped, and after being seen at Nannyong, was recovered at Gelantipy, on the Snowy River. Nannyong is a small open piece of country on the summit of the mountain east of Bindj, and the country crossed over, fifty miles, is very difficult, the mountains being some 4,000 to 5,000 ft. in altitude, and almost unknown even now except to stock-men. I came through, last summer, nearly in the line the mare must have taken. It is almost direct for Delegete.

7. A bullock-driver named Richardson purchased a working bullock which had been sent down from Maneroo by the usual road for sale. He sold the bullock at Omeo—going up there with loading—to Mr. Lewis, the manager of Messrs. Degraives' stations. The bullock was kept in the Hinomungie paddock, but got out two or three times, and in each case made away across country direct for Maneroo, being recovered by the Messrs. Pendergast, of Mt. Leinster, and sent back to Mr. Lewis.

These cases I have obtained from Mr. Lewis, and they are remarkable as showing the length of time during which cattle and horses retain the recollection of their native places, and also as showing, in even a more marked manner than those quoted first, that they return homewards without any regard to the track by which they have reached their place of departure. The cases from Stratford, on the other hand, illustrate the distances from which cattle will start for home.

8. Mr. Mackintosh, of Dargo, informs me that about two years ago, when gathering wild cattle on the Avon River, he got away from his men down that river for many miles before he ascertained that he was astray. Finding, then, that his horse persisted in going in a certain direction, he gave him his head, and the horse went in a straight line to the place where the camp was fixed, a distance of some ten miles through a scrubby country, and without a track.

I could continue quoting examples still further, but I fear that

I have already trespassed too much on the columns of *NATURE*, and I shall conclude by saying that these instances are not thought extraordinary here, and that the belief that cattle and horses can find their way "straight" is firmly held by all bushmen. I have heard similar instances at Lake Torrens, the Darling River, and Maneroo.

I am aware that they do not affect the question as to how a cat finds her way home when conveyed shut up in a bag, but I conceive that they bear out the view suggested by Mr. Darwin, and with which my own experience coincides.

A. W. HOWITT

Bairusdale, Gippsland, Victoria, May 21

Ingenuity in a Pigeon

THE following facts (having been witnessed by myself) may, perhaps, be considered worthy of insertion in your journal, as bearing on the subject of "Perception and Instinct in the Lower Animals," which has lately been brought into such prominent notice.

On the Richmond road (Surrey), at about a mile from the town, stands an old roadside inn, yclept "The Black Horse," owned by one R. Ketley. Attached to the house are a number of domestic pigeons of various breeds, chiefly "Pouters."

Having occasion to wait for my pony to be harnessed at this inn a few years since, my attention was directed by a gentleman (a resident of the neighbourhood) with whom I was acquainted, to the strange conduct of one of these birds.

A number of them were feeding on a few oats that had been accidentally let fall while fixing the nose-bag on a horse standing at bait. Having finished all the grain at hand, a large "Pouter" rose, and flapping its wings furiously, flew directly at the horse's eyes, causing that animal to toss his head, and in doing so, of course shake out more corn. I saw this several times repeated; in fact, whenever the supply on hand had been exhausted.

I leave it to your readers to consider the train of thought that must have passed through the pigeon's brain before it adopted the clever method above narrated, of stealing the horse's provender.

Was not this, indeed, something more than mere instinct?

RICHARD H. NAPIER

Upton Cottage, Bursledon, Southampton, Aug. 13

The Origin of Nerve Force

I NOTICE in *NATURE* for July 21 a paper by A. H. Garrod, suggesting that nervous force has its origin in thermo-electric currents due to the difference of temperature between the surface and interior of the body. Without presuming to any opinion from the physiological point of view, I venture to mention one or two obvious difficulties.

Although, as the writer observes, "in cold weather the impulse to act is much more powerfully felt than in summer, when the air is hot, and therefore the temperature of the surface is higher," yet even 98° F. (the internal temperature of a healthy body) is not uncommon for the air in tropical climates, where the natives can undergo great exertions. But, according to the thermo-electric hypothesis, the nerve force must in this case be *nil*. Again, temperatures of 140° to 160° F. are easily sustained for a considerable time in the Turkish Bath. Under these conditions the direction of the current should be reversed; and, even supposing that positive and negative currents both acted in the same sense on the muscles and nervous ganglia, it would seem that there must be an instant of transition when the two should be balanced, and nervous force at zero, and the powers both of sensation and motion lost with it.

The thermo-electric theory is not required to explain the cases to which Mr. Garrod alludes. We have only to consider that the body must be kept at a constant temperature of about 98° F., while heat is being continually evolved internally by nervous and muscular action, to see that the surface of the body must be cooler than the interior in order to get rid of the superfluous heat without consumption of work in increased perspiration and evaporation. At high external temperatures there will naturally be disinclination to muscular exertion; not only because it produces heat which tends to upset the equilibrium of temperature, but because the force that would have been expended in it is consumed in increased action to get rid of the heat. That the exhausting effect of hot water is much greater than that of hot air is accounted for both by its greater conductivity and specific

heat, and still more because it checks evaporation, which is one of the most powerful outlets for waste heat. It must be familiar to everyone that rapid exhaustion is produced by immersion not only in hot water but in that of almost any temperature. Taking 70° as an average external temperature, we shall find that immersion in water at 30° would be quite as rapidly destructive of nervous energy as in that of 110°; and that while air of the latter temperature could be sustained by the naked body for long without inconvenience, that of 30° would be rapidly fatal unless the temperature was kept up by violent exercise.

Supposing the brain to be really colder than the blood, I shall be glad if some physiologist will inform me if this is not due to the consumption of heat in building up the complicated and unstable matter of the brain from the comparatively stable and simple constituents of the blood, and in this case, if there is any difference of brain temperature between times of rest and nutrition (sleep) and those of active exertion.

Knowing as we do that chemical action is constantly going on in the body and that electrical disturbance is an almost constant result of such action, it seems hardly necessary to look further for the source of nerve force, though we are in almost complete ignorance of the details of its production.

HENRY R. PROCTER

The Flight of Birds

YOUR correspondent, J. Guthrie (vol. viii. p. 86), has struck a note which will, I think, echo. The question he raises is one which has exercised more minds than one. It has been present to me individually almost ever since I was able to reason. The opportunities enjoyed by exiles, especially in tropical countries, for the study of the phenomenon of a body, poised in mid-air, with no apparent support, is considerable, owing to the boldness and number of kites and birds of that class. I have watched them from the point of view—figuratively speaking—of your Cape correspondent, scores of times, and sometimes under peculiar conditions; but I am unable to add anything *certain* to the bare statement that birds of prey *can* maintain a position of absolute apparent rest.

It is some fourteen or fifteen years since I first watched an eagle in a telescope, with a view to test an explanation—the same as that suggested by Mr. Guthrie—hazarded as a conceivable possibility by my father, long before. Since that day I have had innumerable opportunities for close watch—some of which I will describe—and never have I seen anything to support it.

Not to go back too far, as I must trust to memory, I was, two or three years ago, on the summit of a long-backed solitary hill, 500 or 600 ft. high, in the Coimbatore plains of Southern India. There was a light breeze blowing, and I saw an eagle stemming it, on the leeward side of the hill, which was steep. Sometimes he was within (say) fifty yards, and having a good glass at hand, I rested it on a stone heap, and watched him. It was frequently possible to see him thus, stationary in a motionless field of view, at an apparent distance of 10 or 12 ft. Not a feather quivered: the head was turned from side to side as he scrutinised the hill-side: occasionally a foot was brought up to the beak: the roll of the eye was perceptible: but otherwise he was *at rest* to all appearance. Of course the tips of the wings came in for a share of my scrutiny. They may have been quivering, but they looked as steady as those of a stuffed specimen. And here I may observe, that for this appearance to be compatible with an unperceived vibration, the position of rest must have existed alternately with successive excursions, and the time occupied by the latter must have been insignificant as compared with the duration of rest. I find it impossible to accept this explanation, even as a first step, and need not inquire how it would produce the supporting effects. The tail, I should mention, was not at rest. It was frequently feeling, as it were, the passing breeze.

It is to be understood that in the course of frequent changes of general position, I had the bird under examination from different directions—not always of course so favourably.

On another occasion I spent a fortnight on the summit of a peculiar hill in this neighbourhood, with nothing to do but recruit as fast as possible. The hill resembles a dish-cover at top, and being the resort of fugitives from the dust and drought and heat of Bangalore in April and May, who occupy every available dwelling on a very restricted space, there is plenty to attract the kites from far and wide, to say nothing of vultures. There are two or three kinds of kite, but for the present subject they are all the same—fine, powerful, bold birds, with a stretch of