wīlehs, Beha'is, and Ismailis, were also encountered by the way.

In northern Syria two of the most interesting places visited by Miss Bell are the castle of Kala'at el-Ḥusn, near Homs, and the church of Kala'at Sim'ân, between Aleppo and the Bailan Pass. Kala'at el-Ḥusn is the northern Kerak, the "Crac des Chevaliers" of Crusading times, and is one of the finest examples of the military architecture of the Crusaders in existence. Fig. 1, a photograph by Miss Bell, gives an idea of the walls with their French round towers and Saracenic sloping walls. The castle belonged to the Hospitallers, and the Grand Master of the Order lived there, until it was taken by the Egyptian Sultan Malek edh-Dhaher. This, then, was the first stronghold of the Order of St. John, to be succeeded by Rhodes, always associated with the name of de l'Isle Adam, and by Malta, the scene of the heroism of la Valette and the cowardice of Hompesch.

Kala'at Sim'ân (Fig. 2), the scene of the fakir-life of St. Simon Stylites on his pillar, is a fine example of a Byzantine church of the sixth century. Kalb Lōzeh (p. 302) is just such another. Many of these splendid specimens of Syrian stone architecture have been studied by the recent archæological expedition of Princeton University.

At beautiful Antioch and Seleucia Miss Bell's Syrian journey ended.

It is a pity that her map is not better than it is. It is based on Kiepert's map in Oppenheim's "Vom Mittelmeer zum Persischen Golf," with additions and Miss Bell's route marked in red. All the German spellings of Arabic names seem to be retained unaltered, with the result that the British reader is confronted with such words as "Meschetta," "'Ijun," "il-Kreje," "Riat," "Dimaschk Ischscham," and so on, which he will hardly recognise as the "Mshitta," "Ayun," "el-Kreyeh," "Ghiath," and Damascus "Esh-Shām" of Miss Bell's text. This is a bad fault, but one often committed when German maps are copied in England. By the average British reader "Ijun" and "Kreje" will be pronounced "Eye-jŭn" (Germ. "Eidschan") and "Kreege" (Germ. "Kridsch"). It is too often forgotten that the German pronunciation of consonants and vowels is not yet the world-standard, and that the English pronounce the letters "j," "sch," "ch," quite differently from the Germans. We certainly will not have the German "j" thrust down our throats, at any rate. Miss Bell and her publishers must share the blame for this serious blot on her otherwise admirable book.

H. R. HALL.

HAVE ALL EYES THE POWER OF FORMING IMAGES?[1]

SOME animals, such as the earthworm, have no eyes, and yet they are phototropic either in a positive or negative sense, according as they move towards or away from light. Others, such as planarians, have remarkably simple eyes, consisting of one or several sense elements, behind which is a pigmented cup, composed of one or more cells. Such eyes cannot form an image, and they have been called "direction eyes" because light from only one direction can affect such an eye at a given time. Higher in the scale we find the "compound" or "mosaic" eye, as in insects and other animals. The question arises, To what extent is an image or images formed by such an eye composed of many ocelli? There can be no doubt that the compound eye forms an image or images. Exner has taken a photograph through the eye of a fire-fly, and Parker has shown that the compound eyes of Astacus form a single image. Lastly, we find in vertebrates the "simple" eye, the optical construction of which leads to the formation of an image on the retina. The image of a distant object can readily be seen on the retina of a fresh eye removed after death from an albino rabbit, and if a lighted candle be placed in front of the isolated eye of a frog, a beautiful little inverted image of the flame may be visible on the sclerotic.

Mr. Leon Cole recently investigated the question as to the formation of images by different kinds of eyes by a new and ingenious method. It is obvious that it would be almost impossible to make a direct observation on the formation of an image by certain kinds of eyes, especially mosaic eyes of very small size. Mr. Cole's "aim has been, rather, to treat the formation of images from the point of view of their relation to the animal as a living organism—to determine in what way the ability to form a more or less perfect image affects the responses of the animal to light, and what relation, if any, this result has to the normal habits of the creature, and to its behaviour under experimental conditions" (p. 337).

For phototropic observations, Mr. Cole devised an arrangement by which two sources of illumination were so placed as to cause one or other to illuminate the eyes. The animal was placed with its long axis at right angles to a line joining the two lights. One light was so much larger than the other that the ratio of the two areas illuminated was as 10,000 to 1. The intensity of the light from either source was about 1·25 candle metres. The qualities of the two lights were also compared and tested, and the differences in the spectral components were so slight as to be negligible. The experimenter wished to ascertain "to what extent complexity in the organisation of eyes is correlated with the reactions to luminous areas of different size but of equal total luminosity" (p. 347). The character and relative percentage of phototropic responses as movements to or from lights were used as measures of the reactions. Suppose an animal positive in its reactions to directive light is so placed as to be midway between two luminous areas of the same shape, size, and intensity, the one acting on the right eye and the other on the left. Assume that each luminous area is 1 cm. square, has an intensity of 100 candle-power, and is 2 metres from the animal. The measure of the light falling on each eye would be 25 candle metres. Thus simultaneously stimulated on each side, the animal might go straight ahead without turning, or it might turn at random towards one light more than the other, and as the animal is positively phototropic it would continue to crawl towards this light. But as the chance of random movements in one direction is as great as in the other, in a large number of trials, we should find the number of times that the animal would go towards each light would be practically equal. Enlarge one of the areas to 100 cm. square, but keep the total amount of light the same. The area being 10,000 times as great, the intensity from 1 sq. cm. is now only 0·01 candle-power. The whole amount of light on each side is still the same, 25 candle metres. If the animal had no light-perceiving organs, the reactions would be the same as when the lights were of equal size; the animal would be indifferent. But if it had cells sensory to light distributed in its skin, as there is no apparatus for concentrating the light, the amount of light received at any point of the skin on either side of the animal would be equal to that received by any other. "This is evident from

[1] "An Experimental Study of the Image-forming Powers of Various Types of Eyes." By Leon J. Cole, Zoological Laboratory of the Museum of Comparative Zoology at Harvard College. (Proc. of American Academy of Arts and Sciences, vol. xlii., No. 16, January, 1907.)

the fact that light from every one of the 10,000 areas (each 1 cm. sq.) which make up the large area falls upon each point of the surface of the animal; the intensity of the light from any single square centimetre of the area is only 0.0025 candle metre, but since there are 10,000 such radiating squares the total intensity is 25 candle metres" (pp. 347–8).

In an animal having eyes that form a good image the case is different. The small light, only 1 cm. square, would form on the retina an image having a very small area (x), but the light would have considerable intensity (y). On the retina of the other eye there would be an image covering a larger area (10,000 x), but each area (x) would receive a light intensity of only $1/10,000\ y$. In all probability the difference between a very weak light and no light at all falling on a visual element would be more stimulating than the same or even a greater difference in the amount of the light at higher intensities. If so, we should expect an animal to react more strongly "to that stimulus which fell upon the larger number of visual elements—that an animal normally positive, for example, would be more strongly positive to the large light than to the small, and similarly that a negative animal would tend more often to move away from the larger than from the luminous area" (p. 349).

A large number of experiments was made on several animals, and the results, when discussed by methods now in use in biometrical work, on the whole bear out the line of reasoning just given. With the earthworm (*Allolobophora foetida*) the results showed that the *intensity* of the light is the controlling factor in its movements to right or left. This animal was negatively phototropic. It has no eyes, but it has cells in the skin sensitive to light. No image could possibly be formed. The largest of the land planarians (*Bipalium kewense*) has small *direction* eyes. Numerous experiments showed that animal has, to a slight extent, the power of appreciating differences of area, as it responded by turning away from the larger luminous area more often than from the smaller. It was negatively phototropic. The larva of the mealworm (*Tenebrio molitor*) has two or three ocelli on each side of the head, but nothing of the nature of lenses. It is negatively phototropic. When two lights, of different areas, acted simultaneously on both eyes, the responses right and left were equal in number, showing that "the ability of the eyes to form distinctive images of objects differing considerably in size is wholly lacking" (p. 371). The sow bug (*Oniscus asellus*), an active isopod, has small eyes consisting of a group of about thirty ocelli on the side of the head at the base of the antero-lateral lobe. It is negatively phototropic. The responses to light were of a less definite character than was observed in the larvæ of the mealworm. It has only unilateral illumination, and yet its eyes have greater efficiency for the formation of images than the larvæ of the meal bug. The cockroach (*Periplaneta americana*) has well-developed compound eyes, and it is very active and keenly sensitive to differences of light and shade. It was difficult to handle, and having more of what may be called a restless intelligence than the other animals already mentioned, the results do not seem quite so trustworthy. It reacts negatively to direct light in an excess of about 50 per cent. of its responses, but although it has relatively large eyes, Mr. Cole does not think the evidence bears out what one would have expected, namely, that the eyes were capable of forming better images than those of the animals already mentioned. The mourning-cloak butterfly (*Vanessa antiopa*) creeps and flies towards a source of light. It is positively phototropic for lights varying in intensity from 2 candle-power at 2 metres distance (0.5 candle metre) to 250 candle-power at 2 metres distance (62.5 candle metres). It can discriminate between lights of different area falling with equal intensity on the animal. Other animals, such as the water-scorpion (*Ranatra fusca*), the Pomace fly (*Drosophila ampelophila*), the European garden snail (*Helix pomatia*), the European garden slug (*Limax maximus*), were also examined. In the case of the garden snail, the inference from the experiments was "that the eyes of the snail do not aid greatly, if at all, in the discrimination of two lights differing in area as the two used" (p. 391).

The results with the cricket frog (*Acris gryllus*) are very instructive. It is, on the whole, positively phototropic. With luminous areas of different sizes but equal intensity, it turns in by far the greater number of trials towards the larger of the two areas. The result was the same when the skin was protected and the eyes alone were left uncovered. After section of the optic nerves, but having the skin exposed to the light, the animal is indifferent to the size of the luminous field. Still, even with the optic nerves severed, the frog is positively phototropic. Here light must be perceived by the skin, a result in keeping with the well-known experiments of Lord Lister made many years ago on the pigment cells in the skin of *Rana temporaria*. Similar results were found with the green frog (*Rana clamata*).

Mr. Cole concludes his paper with an interesting general discussion, showing that there is a correlation between the habits of the animals and the conditions under which they live. For example: "those are creeping forms whose movements towards the light take them in the direction of their food or else that other conditions prevent their phototropism from taking them into unfavourable surroundings" (p. 407). The following is very interesting:—"A query which Romanes found among Darwin's manuscript notes shows careful observation and puts the question very clearly. It is as follows: 'Query. Why do moths and certain gnats fly into candles, and why are they not all on their way to the moon—at least when the moon is on the horizon? I formerly observed that they fly very much less at candles on a moon-light night. Let a cloud pass over and they are again attracted to the candle.' Romanes thinks the answer is that 'the moon is a familiar object, the insects regard it as a matter of course, and so have no desire to examine it.'" Parker and Cole give a more reasonable explanation. The moths and gnats react to larger areas of light than to a point of more intense light. They therefore remain near the ground, on account of the bright patches of moonlight, instead of flying towards the moon; but if they come near a candle, the great intensity of the light at a short distance "overcomes the reactions of the moonlit areas," and the insects fly into the flame. Obscure the moonlight by a cloud so as to take away the patches of moonlit earth, and the insects fly more readily into the flame.

Mr. Cole gives at the close of his admirable and suggestive paper the following classification:—

Type A. Response of eyeless forms.—Usually negative; sometimes positive, and then usually to very weak light. Response to *intensity* only (earthworm).

Type B. Response of forms with "direction" eyes.—Usually negative (Bipalium, Periplaneta, Tenebrio larvæ); sometimes positive (larva of wood-borer). Response wholly to *intensity*.

Type C. Response to size of luminous field.—

Animals usually positive; may be temporarily negative, as in the frog.

Type D. Response to definite objects in the visual field.—Not simple reactions; responses involve psychical phenomena. Respond (1) to moving objects; (2) to stationary objects. This form of response usually inhibits ordinary phototropic reactions.

JOHN G. MCKENDRICK.

SIR W. H. PERKIN, F.R.S.

WITH deep regret the whole scientific world will hear of the death of Sir William Henry Perkin, F.R.S., the founder of the coal-tar colour industry, and one of the most distinguished of British chemists. Sir William Perkin passed away at his residence, Sudbury, on Sunday, July 14, after four days' illness, the cause of death being double pneumonia and appendicitis. Especially affecting will be the news to his London friends, among whom his bodily vigour and mental energy had, even up to the last, been the envy of many a younger man.

Born on March 12, 1838, William Henry Perkin was educated at the City of London School, and at fifteen commenced his studies under A. W. Hofmann at the Royal College of Chemistry. During the Easter vacation in 1856 he discovered mauve, and, supported by his father and brother, immediately began its manufacture under the name of "Tyrian Purple." The importance of this discovery, which has given birth to the extensive industry of coal-tar colours, was fully recognised at the Jubilee celebrations last year, when Dr. Perkin was presented with congratulatory addresses from all the important chemical societies of the world, and also received the honour of knighthood. Messrs. Perkin and Sons not only introduced the first aniline dye into commerce, but soon began to manufacture alizarin, in itself the first member of an important series of dyestuffs which are still to-day classed among the most valuable colouring matters used by dyers and printers. In 1873 the Greenford Green aniline-dye factory was sold, and the business finally transferred to Silvertown, where the manufacture of alizarin is still being carried on with success.

Perkin now devoted himself to laboratory work, and soon discovered the valuable method of synthesis of unsaturated aromatic acids, such as cinnamic acid, which bears his name. He also effected the synthesis of coumarin, the odorous principle of the Tonka bean. Later, he turned his attention to the magneto-optical properties of organic compounds, and enriched chemistry with a series of researches on this subject, of which the last account appeared in the Journal of the Chemical Society for May of the present year. In all he contributed about ninety original papers, published chiefly in the Journal of the Chemical Society.

The value of Perkin's work was not left unrecognised; the Royal Society made him a Fellow in 1866, he was awarded the Royal medal in 1879, the Davy medal in 1889, the Longstaff medal of the Chemical Society in 1888, the Albert medal of the Society of Arts in 1890, and the Birmingham medal of the Gas Institution in 1892. These were followed by the Hofmann medal of the German Chemical Society and the Lavoisier medal of the French Chemical Society in 1906. He held honorary degrees from Würzburg and Heidelberg (Ph.D.), St. Andrews (LL.D.), Manchester and Leeds (D.Sc.), and Munich (Dr.Ing.).

Sir W. Perkin married, in 1859, a daughter of the late Mr. John Lissett, and, some years after this lady's death, the daughter of Mr. Hermann Mollwo. Few fathers can have had the same happiness as he in seeing his three sons distinguish themselves in his favourite science.

Loved by his neighbours at Sudbury for his philanthropic work, respected and admired by his scientific friends the world through, all were instinctively attracted by Sir William Perkin's equable and amiable temperament, and unite in deploring the loss which they and the nation have sustained.

J. C. CAIN.

NOTES.

WE regret to see the announcement of the death of Dr. A. Dupré, F.R.S., on Monday, July 15, at seventy-one years of age.

WE learn with regret of the death, on July 13, of Prof. Heinrich Kreutz, who for many years acted as editor of the *Astronomische Nachrichten*.

THE eleventh International Navigation Congress is to be held at St. Petersburg in May, 1908.

THE American Academy of Arts and Sciences has awarded the Rumford premium to Mr. E. G. Acheson "for the application of heat in the electric furnace to the industrial production of carborundum, graphite and other new and useful substances."

DR. ARTHUR J. EVANS, F.R.S., describes in the *Times* of July 15 some further discoveries made by Dr. Mackenzie and himself, during the past two months, in the great prehistoric Palace of Knossos. The net result of these investigations is to show that an additional area of some three thousand square yards must be added to the palace. At a short distance from the actual "House of Minos," two beehive tombs have been found belonging to a period about 800 B.C., and their contents are of deep interest. If the accurate astronomical orientations have been measured of the structures now revealed, the results will be of great value.

A SMALL exhibition of science apparatus, mostly for chemistry and physics, is being arranged by Mr. R. E. Thwaites, of Wyggeston Grammar School, in connection with the forthcoming meeting of the British Association at Leicester.

THE Recorder of Section I (Physiology) of the British Association informs us that an important change has been made in the provisional programme for the Leicester meeting announced in last week's NATURE. On August 6 there will be no discussion on antitoxins, but instead one on the value of perfusion experiments. This will be opened by Prof. E. A. Schäfer, F.R.S., and will probably be of considerable interest to expert physiologists. To the list of those who will take part in the discussion on the physiological and therapeutical uses of alcohol has now been added the names of Prof. Cushny, and Drs. Dixon, Rivers, and Waller; Prof. Zuntz, Prof. Schäfer, Dr. Reid Hunt, and Prof. Sims Woodhead.

IN connection with the retirement of Prof. G. Lunge from the chair of technical chemistry at Zurich, of which mention was made in last week's issue of NATURE, an interesting farewell meeting was held on July 10 at Zurich Polytechnic. The occasion was the distinguished chemist's last lecture hour, and, in addition to the students, most of his fellow professors and some from the neighbouring university had assembled. On Prof. Lunge's entry into his lecture theatre all rose in silence. After an interval Prof. Treadwell, professor of analytical chemistry, made a short speech in which he eulogised Prof. Lunge's work, and afterwards read an address from the whole of the