character and name to the mixed sensation. If any one fundamental sensation is so strong in predominance over all the others, that the latter are not distinguishable, it approaches the idea of purity, which, however, in reality can never exist.

When the visual organ has been for a long time protected from any external stimulus, it assumes, more or less perfectly, that neutral condition in which the assimilation and dissimilation, as well as the D-excitability and the A-excitability are equal for all the three visual substances.

In this state, in order that a mixed light should produce a colourless impression, it is necessary that this light should have an approximately equal assimilating and dissimilating moment, by which is meant the product of the stimulus and the excitability. Such mixed light may be called objectivcly colourless light.

But the same light will appear, say, greenish, if the red-green substance is no longer in the neutral condition, but has its green excitability greater than that of the red. For in this case the A and D-moments will not be equal, and a small difference will exist to the advantage of the green.

Now when a part of the previously neutrally tuned visual organ has been stimulated by coloured light, the condition of this part will become so altered that the excitability for the perceived colour diminishes and becomes less than the excitability for the opposite colour. Under these circumstances any mixed light which, in the neutral condition appeared colourless, will now appear coloured with the opposite colour. And if a part of the visual organ has been affected, say, by the action of green light, on looking at a blue or yellow surface, the blue or yellow will appear tinged with red.

The phenomena of simultaneous colour-contrast and of colour-induction are explained in the same manner as for the corresponding phenomena in black and white.

It has been seen that by the white illumination of any part of the visual organ, the other parts of it, and particularly those adjoining, are, by the indirect action of the stimulus, darkened; or the sensation of black is intensified; and in a similar way, under the action of coloured light on any part, the sensation of the opposite colour is strengthened in the adjoining parts.

As a consequence of this the relations of excitability are altered; for, according to this theory the sensation of any colour implies also a change of those relations to the disadvantage of this colour and to the advantage of its opposite. If, then, light be allowed to fall on the whole retina, which, under a neutral condition, would be colourless, it now appears coloured; the colour on the previously excited part will be the opposite colour (successive contrast), while that around it will be the same colour as that previously observed (successive induction). In fact, all the phenomena explained for white and black may be, in this way, transferred to the colour-sensation.

The author makes some further remarks on the Young-Helmholtz theory. He admits that the attempt of Young to reduce the great variety of colour-sensations to a small number of physiological variables was a most important step in advance, but he considers that if, as before explained, every psychical result must correspond to some physiological process, the number of fundamental colour-sensations ought, as has been often urged, to be increased to four, and that separate physiological sensations ought to be allotted to white and black. But he considers the great defect of the theory to lie in its only acknowledging *one* kind of excitability, excitation, and fatigue, namely, that which he denotes by D, and that it ignores entirely the antagonistic relations of certain rays to the visual organ; hence it regards the production of white out of "complementary colours" as a result of their mutual combinations, and not of their mutual extinction.

He also remarks on the difficulties of explanation of many phenomena, on this theory, and in particular on the inconsistencies it causes in the attempted explanation of colour-blindness, as shown in the most modern literature on the subject.

In conclusion he gives some remarks on the chief points of his theory, which it may be instructive to repeat here.

The theory, although immediately dictated by a free and unbiased analysis of the visual sensations, is essentially based on certain fundamental principles, taken from the acknowledged phenomena of organic and psychical life, and it is by these principles that the author's views are brought into connection with the doctrines of physiology generally.

With respect to the doctrine of light and colour, the first thing to mention is the natural system of visual sensations, founded on their internal similarity; and further, the grouping of the six fundamental sensations in three pairs of opposite colours.

Next comes, as of fundamental importance, the appreciation of the visual sensations as the psychical correlatives of the nutritive processes, or changes of matter in the visual substance, which leads to the separation of the D and A sensations, and further, to the principle that every D sensation implies a decrease, every A sensation an increase of the visual substance. Corresponding to the three pairs of simple or fundamental sensations are assumed three kinds of D and A processes in the visual substance and three kinds of specific D and A excitability. The colourlessness of mixed light formed out of "complementary" rays, is explained by their antagonistic relations.

Further, here, for the first time the proof is methodically and comprehensively produced that the separate parts of the nervous visual substance are in internal functional changing relationship (*Wechselbeziehung*), which is to be regarded as reciprocally connected with the change of matter; for when $\frac{D}{A}$ is greater on a stimulated part, it is less in the surrounding parts, and *vice versâ*; so that after the stimulus the excitabilities of both parts change in opposite directions.

These propositions and their consequences afford the means of explaining the various phenomena mentioned, but it often happens that several explanations are possible for one and the same phenomenon, and that the decision between them must be reserved for more detailed inquiry. What we immediately appreciate in a visual sensation is the ratio of the corresponding D and A processes to each other, for this determines the *quality* of the sensation. A change of sensation gives only an indication of the change of this ratio, and not of the changes of its two components. Then it is that we have so often the choice between an increase of assimilation and a stoppage or decrease of dissimilation, and *vice versâ*. But the theory itself gives means of determining these, by further and more detailed and intricate investigations; and the author promises future communications by which the details will further be supplied, without as he hopes, any material alteration of the principles he has laid down.

WILLIAM POLE

THE "PARASOL" ANTS OF TEXAS: HOW THEY CUT AND CARRY LEAVES: ORIGIN OF CASTES BY EVOLUTION

IN Mr. McCook's recent investigation (NATURE, vol. xx. p. 583, and *Proc.* Acad. Nat. Sci. Phil., 1879, p. 35) he stated that he observed carefully both the mode of cutting and the system of carrying cut portions of oak-leaves at Camp Wright, and at a vegetable garden near Austin, Texas.

To investigate successfully he found it best to thrust

small branches of live-oak into one of the mounds described, near the "gates." These were soon withdrawn, and seen to be covered with "cutters" busily occupied. It was thus possible to examine them at work by the light of a lantern, as it will doubtless be remembered that night is the busiest time with these active ants, supplying their minuteness with a most effective shelter.

The "cutter," usually an ant belonging to the caste next below the "soldier" in size, first grasps the leaf with outspread feet, and begins to cut into its edge by a scissors-like action of her sickle-shaped toothed mandibles. Thus she naturally proceeds, with steady motion, until the mandibles have clipped off a portion of the leaf, having a circular edge, clean cut. The feet turn as the head turns. The cutter sometimes drops, with the piece just cut, to the ground; but probably, if possible, retires when the piece has dropped, to continue her professional occupation. Mr. McCook found at the foot of one tree a pile of cut leaves, to which clippings were continually being added, dropped by the cutters. The carrier at the foot took them up and carried them to the nest. The loading of the cuttings is thus accomplished: the piece is seized by the curved mandibles, the head is raised, the piece is thrown back by a quick motion, seeming to be lodged on its edge within the deep furrow that runs along the entire median line of the head with the exception of the clypeus, and supported between prominent spines on the edge of this furrow and on the prothorax.

The young saplings near the mound at Camp Wright were found almost entirely stripped of leaves by these ants. The great tree (live-oak) near by was in parts stripped to the very top. In beginning work on a tree the cutters seem to aim first at the topmost leaves. They prefer trees with a smooth leaf; they eat grapes, radishes, &c., and can take celery, beet, young maize, and wheat, plum leaves, honeysuckle, and jessamine. Strangely enough, they do not like lettuce, paper-mulberry, figs, cedar, except the buds, when very hard up in winter. A nurseryman, on whose grounds Mr. McCook witnessed the ants at work and the scene of their former exploits, told him that they even entered his desk-drawers, and carried away part of his chewing-tobacco. At another plantation Mr. McCook saw an immense column of the ants engaged in plundering a granary of wheat.

One of the most interesting questions for evolutionists centres undoubtedly in the causes and mode of continuance of the castes or differentiated forms of species like this ant. The worker-castes are sterile, and produced from eggs laid at different periods by the female; and as to a blending of castes by intermediate forms, nothing has yet been seen or proved in the case of the cutting-ant, after careful examination by the microscope. The lowest castes of minims, in all individuals Mr. McCook examined, with special reference to the mouth-organs and eyes, had the same structure in equal definiteness and perfection, as the larger castes. Consequently, Mr. McCook again finds no way of comprehending how natural selection could have produced or preserved or improved these castes. May I suggest that we know as yet too little of the whole life-history of social animal communities, to say nothing of their past history in time, their conditions during long series of years, and the reaction of each community on its surroundings, to assert that any hypothesis of evolution admissible as a *vera causa* in one case is inadmissible in another? We are but on the threshold of the study of the influence of social laws and conditions upon human communities; how can we expect to understand the influence of society and common interests upon specialisation in ants? Yet there are even now several possible ways of imagining the influence of variation and changed conditions to have aided in producing castes. May it not be that the comparative study of *ant-communities* of the same species, or of different species of the same genus will at length furnish a key much more valuable than we yet know? How is it that nations of man rise and fall, increase or decrease? Are not all men of one species? Why are there so many castes? If we cannot answer these questions perfectly, why be dismayed if we quarrel about terms as to the intelligence or reason displayed by various animal forms? There is nothing to be done but for men to wait, study to comprehend the nature of proof, and then patiently investigate. The explanation of all difficult problems will, if we are to judge by the history of science, be very simple, much simpler and more illuminating than the acrobatic or the prejudiced intellects would have us believe.

G. T. BETTANY

NOTES

THE exhibition at Croydon, held in connection with the Congress of the Sanitary Institute of Great Britain, has a peculiarity attached to it which, though it has its advantages, is a disadvantage to the visitor. The peculiarity is that the awards of the judges will not be made known till the day of closing, viz., November 8. At most exhibitions visitors have their attention drawn to objects of high merit by the announcements of the honours the judges have awarded; but here, and this, too, on subjects often affecting their own health, visitors can, even if they care to take that trouble, only form their own opinions, guided by the skilled advocacy of the attendants at the different stalls. If all the objects announced in the catalogue as "essential," "indispensable," "infallibly safe," and "the only ones of the kind made," are really so, then the practical application of sanitary science in households is in a lamentably backward state, even in particulars where those who are our leaders in sanitation would least expect it. It can hardly be supposed, however, that all the exhibits shown have been admitted with the sanction of the Council as illustrations of the subjects discussed at the Institute. There are, for example, music stands, clocks, sausage mincers, billiard registers, weighing machines, mechanical toys, flower scissors, electric pens, nickel-plated goods, pantographs, bells, telephones, china cements, "lightning" knife sharpeners, &c. Some of the exhibits are made on principles that have been repeatedly denounced; for example, filters so closed that the filtering medium cannot be easily and frequently changed are now by our most experienced observers admitted to be unsafe, yet there are some in the exhibition. Traps of certain construction have been likewise denounced, yet they are shown. Ventilators of patterns generally regarded as practically useless, and so-called disinfectants which are only deodorisers, are shown. It might, perhaps, have been well had the exhibition been called one of "Sanitary and unsanitary appliances," and then the visitor would have been put on his guard not to believe in everything shown there. Mr. F. P. W. Essie, C.E., has contributed part of a collection of the materials on which his paper on the dangers of bad plumbing (read at the Congress) was based. It is intended as an unsanitary exhibition, and shows in an alarming manner how some so-called sanitary appliances may become a positive source of danger. Each specimen exhibited "has been associated with death and with disaster in some shape or other." It is a pity no handbook or any kind of guide other than the unclassified list of entries in the catalogue has been prepared. We may be able to return to the subject next week when noticing the list of awards.

AN article in the last number of the *Revue Scientifique* contains an interesting account of Mont Ventoux (1,928 metres high), and of the scheme for erecting a meteorological observatory thereon. The project, which has been prepared by M. Morard, under the direction of M. Bouvier, includes, first, the construction of a carriage road, which will render the summit accessible at all times. The total length will be 19 kilometres.