useful things in a spirit of enlightenment which has nothing mean in it, but displays a fitness for cosmopolitan life of which we see the practical results. Besides the 'Realschule,' there are throughout Germany a number of 'high schools of commerce,' where young men enter to learn office-work and technicalities."

This German hits the right nail on the head, when he says that—

"The English Government would do well to establish such schools upon some definite plan as to unity of teaching. Young Englishmen are quite as well disposed as Germans; in many matters their character is even more stable, but you must give them the opportunity of learning what the Germans do. Proprietary schools will never succeed in this; and no breach of the liberty of the subject would be committed if your Government were intelligent and far-seeing enough to recognise the need of such a system of schools, supernatant on the elementary education."

As another *Times* correspondent says, the maintenance of our commercial prosperity is pretty much a schoolmasters' question. No "association for the promotion of scientific industry" will ever be able to remedy our shortcomings in this respect unless there be a career for men of Science, in which case it will be studied, and unless Science be properly taught. Unless this country is to be entirely outstripped by other nations in the very direction in which we have hitherto prided ourselves as being supreme, Government must take the matter up and see that there is put within the reach of all who are in any way to carry on our industries the means of making themselves thoroughly acquainted with the sciences and scientific principles upon which these industries rest. Let us also, like the Germans, have well-organised Realschule and technical training-schools; and for this purpose let Government take the advice of the deputation which waited on the Lord Chancellor last Saturday, and make haste to appoint a responsible Minister of Education, whose duty it will be to see that our educational machinery in all departments, both in extent and in efficiency, is kept up to the wants of the age. The establishment of mere technical schools is not sufficient; these will be of but little avail unless those who wish to take advantage of them have had a previous thorough training in the scientific principles on which the arts are founded. Thanks to Mr. Cole's wise foresight, there are now tens of thousands of our artisans who have had such a training.

No better instance could be afforded of the evil consequences which arise from the want of a responsible Minister of Education, than the disgraceful condition of the Patent Museum. In a dark rusty iron shed at South Kensington are huddled together so as to be practically inaccessible for purposes of study, the paltry collection which represents the genius of that nation which has been foremost in mechanical invention. Let us hope that the object of the Society of Arts' deputation will be granted, and that no time will be lost in arranging in a suitable building everything necessary for the comprehension of Science applied to our various industries, in such a manner that anyone who wishes may study historically all the improvements that have been made in any department; and that, as in the French "Conservatoire des Arts et Métiers," lectureships will be established, thus furnishing a most efficient means for training the men who are to carry on our industries. If this were done, and if local museums were established in suitable centres throughout the country, and if Government take steps to put within the reach of all a thorough general scientific education, and do besides, what no "society for promoting scientific industry" can do, provide means for carrying on unremunerative scientific research, England will soon regain her industrial supremacy, or at least be placed beyond any danger of being outrivalled.

## *BELT'S "NATURALIST IN NICARAGUA"*

*The Naturalist in Nicaragua:* a Narrative of a Residence at the Gold Mine of Chontales; Journeys in the Savannahs and Forests; with Observations on Animals and Plants in reference to the Theory of Evolution of Living Forms. By Thomas Belt, F.G.S., Author of "Mineral Veins," "The Glacial Period in North America," &c. With Maps and Illustrations. (London: Murray, 1874.)

MR. BELT is a close, an accurate, and an intelligent observer. He possesses the valuable faculty of wonder at whatever is new, or strange, or beautiful in nature; and the equally valuable habit of seeking a reason for all that he sees. Having found or imagined one, he goes on to make fresh observations and seeks out new facts, to see how they accord with his supposed cause of the phenomena. He is a man of wide experience; having travelled much in North and South America and in Australia, as well as in many parts of Europe—and always with his eyes open—before visiting Nicaragua. He is a geologist and an engineer, and knows how to overcome obstacles whether caused by the perversity of man or the forces of nature.

The book we are noticing has, therefore, a value and a charm quite independent of the particular district it describes. As a mere work of travel it is of little interest. The country and the people of Nicaragua are too much like other parts of Spanish tropical America, with their dull, lazy, sensual inhabitants, to possess any novelty. There is little that can be called adventure, and still less of geographical discovery; and the weakest and least interesting parts of the volume are the detailed descriptions of the daily route in the various journeys across the country. We have here and there good illustrations of Spanish American character, as when staying for the night at a ruinous farm-house, the proprietor, Don Filisberto, informed him that he was busy building a new residence. On asking to see it, "He took me outside and showed me four old posts used for tying the cows to, which had evidently been in the ground for many years. 'There,' he said, 'are the corner posts, and I shall roof it with tiles.' He was quite grave, but I could not help smiling at his faith. I have no doubt that, as long as he lives, he will lounge about all day, and in the evening, when his wife and children are milking the cows, will come out, smoke his cigarette, leaning against the door-post of his patched and propped up dwelling, and contemplate the four old posts with a proud feeling of satisfaction that he is building a new house. Such a picture is typical of Nicaragua."

Mr. Belt has done perhaps more than any other

traveller to support the theory originated by Mr. Bates of the purpose and cause of what is termed "mimicry" in the animal world, since it was he who first directly observed insectivorous birds reject the Heliconii and allies as food. In Nicaragua he found that a tame monkey, which was extremely fond of insects, and would greedily munch up any beetle or butterfly given to him, would never eat the Heliconii. He would sometimes smell them, but invariably rolled them up in his hand and dropped them quietly after a few moments. One large spider used to drop them out of its web when put into it, but another spider seemed to like them, showing that the smell and taste is not universally, although very generally, displeasing to their enemies. The Lampyridæ, among beetles, which are almost as frequently mimicked as the Heliconidæ, were rejected by monkeys and fowls, as they are known to be rejected by insectivorous birds. Among the new cases of mimicry observed by our author was a longicorn beetle, which most deceptively resembled a hairy caterpillar—a kind which it is well known are never eaten by insectivorous birds. More remarkable is the account of the behaviour of a green leaf-like locust among insect-eating ants. "This insect stood immovably amongst a host of ants, many of which ran over its legs without ever discovering that there was food within their reach. So fixed was its instinctive knowledge that its safety depended on its immovability, that it allowed me to pick it up and replace it among the ants, without making a single effort to escape. This species closely resembles a green leaf, and the other senses, which in the Ecitons appear to be more acute than that of sight, must have been completely deceived. It might easily have escaped from the ants by using its wings, but it would only have fallen into as great a danger, for the numerous birds that accompany the army of ants are always on the look-out for any insect that may fly up, and the heavy locusts, grasshopers, and cockroaches have no chance of escape."

The view that conspicuously coloured creatures, and those that seem to court observation, have some special protection, and that the gay colouring is a warning signal to their enemies not to touch them, was first applied by myself to explain the brilliant colours of many caterpillars. It is now, however, found to have a very wide application, and Mr. Belt is so convinced of its truth that he is able successfully to predict the behaviour of other animals towards an unusually conspicuous species. Most frogs are of more or less protective tints—green or brown according as they live among foliage or on the ground. They feed only at night, and they are all preyed upon by snakes and birds. One species, however, found by Mr. Belt, was of a bright red and blue colour, and hopped about in the day-time without any attempt at concealment. He was at once convinced, theoretically, that this frog must be uneatable. He accordingly took it home, but neither fowls nor ducks would touch it. At length one young duck was induced to pick it up, but instead of swallowing it, instantly threw it out of its mouth, and went about jerking its head as if trying to throw off some unpleasant taste. The skunk, whose offensive secretion is universally dreaded, is a similar instance among mammalia. Its white tail laid back on its black body makes it very conspicuous in the dusk, when it roams about, so that carnivora may not mistake it for other night-roaming animals. When we consider that such cases as these are probably very numerous; that instances of clearly protective colouring are still more so; that both these kinds of colouring may vary almost infinitely, and that there is certainly some unknown influence which tends to produce certain colours in certain localities; and when we further consider that all these causes have been in a continual state of change with changing conditions of existence, organic and inorganic, and have acted and combined with each other in countless ways for untold generations, we have some ground for concluding that colour in nature may have been produced with less assistance from sexual selection than Mr. Darwin thinks is due to that undoubtedly powerful agent.

A very full and interesting account is given of the leaf-cutting ants (Œcodoma sp.), and though these have been so often described, our author has much that is new to tell about them. In his mining operations he cut through some of their subterranean galleries, and from his examination of these he arrives at the conclusion that the ants do not feed on the leaves which they gather in such enormous quantities, but that they use them to form beds for the growth of a minute fungus on which they and their young live. These ants are so destructive to certain plants by entirely destroying their foliage, that many species cannot be cultivated without constant care and protection. It becomes an interesting point, therefore, to determine by what means many of the less vigorous or less abundant species are preserved. It has long been known that there is a very close connection between certain trees and ants. Many Melastomas have a kind of pouch at the base of each leaf, which serves as a habitation for small ants. These have been described by Mr. Spruce, as well as others on the leaves of species of Chrysobalaneæ and Rubiaceæ, &c., in a paper read before the Linnæan Society but not yet published; and he arrived at the conclusion that these structures had become hereditary through the adaptation of the plant to the constant parasitism of the insect, although he did not consider that the ants were of any actual service to the plant. Mr. Belt figures the leaf of a Melastoma possessing these pouches as well as a curious thorny Acacia, the thorns of which are very large and hollow, and are tenanted by ants. In this case the constant attendance of the ants is secured by a provision of food in the shape of little stalked fruit-like glands on the leaves, which the ant feeds on. The hollow stems of the Cecropias are also infested by ants, and they always abound on Passion-flowers, feeding on the honey glands of the flower. Now Mr. Belt believes, and apparently with good reason, that in all these cases the ants are protectors of the plant against herbivorous insects, such as caterpillars, cockroaches, earwigs, &c., but especially against the leaf-cutting ants; and that on account of this service the plants have in many cases become specially modified so as to supply food or shelter to the ants which are so useful to them. It is a suggestive fact that introduced trees and shrubs are more subject to the attacks of the leaf-cutting ants than native species. They do not possess either the disagreeable juices or the insect protectors that the latter have in the course of ages acquired. We have here an altogether new view of the inter-relations of plants and insects, which may, in

some cases, help botanists to account for the presence of the many curious and apparently useless glands and appendages plants often possess.

Among other natural history information in this work, we find some excellent observations on reasoning power in insects, a good description of the habits of a monkey, and some judicious remarks on the mode of action of

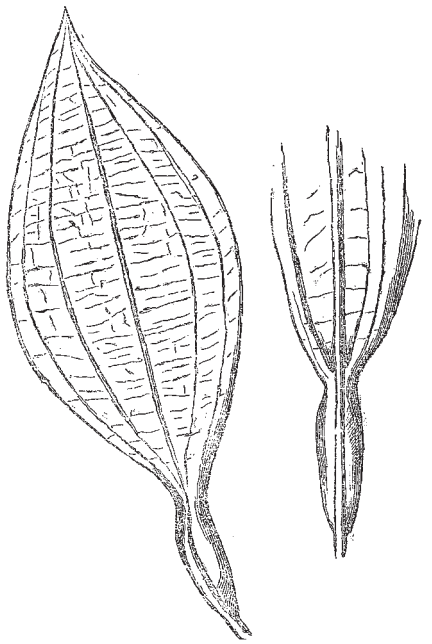

FIG. 1.—Leaf of Melastoma.

natural selection; although the idea that the hairless breed of dogs has been produced because hair favours the increase of *pediculi* and other parasites, is hardly one that will be accepted, seeing that hairless forms, of carnivora at all events, are quite unknown in a state of nature. On the subject of the fertilisation of flowers by insects Mr. Belt remarks, that besides the special adaptations for

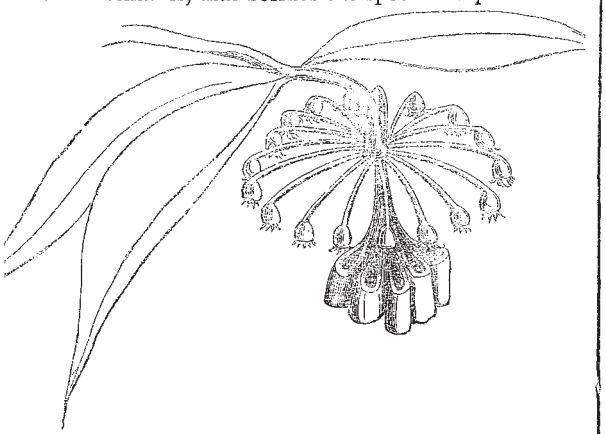

FIG. 2.—Flower of Marcgravia nepenthoides.

fertilisation by certain insects, there are often other adaptations for the express purpose of preventing useless insects from robbing the flowers of the attractive nectar, and he illustrates this by a description of our common foxglove. He also furnishes, what I believe are new and very curious cases of fertilisation by birds. In the *Marcgravia nepenthoides* (Fig. 2) there is a group of pitchers below the flowers, containing a sweet liquid which attracts insects; and numerous insectivorous birds come to feed upon these insects, and in doing so necessarily brush off the pollen and convey it to other flowers. In a species of Erythrina having a sword-shaped flower which will only admit very minute insects to the nectary, two species of long-billed humming birds probe the flowers in search after the insects, and in doing so get the pollen on their heads and carry it to other flowers. In this case the nectar is protected by a thick fleshy calyx, which effectually prevents bees and wasps from breaking in and stealing the attractive liquid.

As a geologist our author contributes some important facts on the great question of an intertropical glacial period. He found at from 2,000 to 3,000 feet above the sea, an extensive formation of boulder clay, full of great angular blocks, which he has not the slightest hesitation in pronouncing to be of glacial origin. He decides that this formation must be due to land glaciers and not to icebergs, because the latter would imply a depression of the country fully 3,000 feet, which would have produced a wide channel connecting the Atlantic and Pacific, and have caused more intermingling of the faunas of the two oceans than actually exists. It may, however, be argued, on the other hand, that if there has been no recent communication between the two oceans, then scarcely a single species of fish or mollusc should be common to the two. Yet no less than 48 species of fishes are absolutely identical; and as to the molluscs, Mr. P. P. Carpenter says that, besides those undoubtedly identical (about 40), more than 30 others may be identical, and that 40 more, although distinct, are very close representative species. We have, therefore, over 100 species of molluscs so nearly identical in the two oceans, that we cannot suppose their separation to date longer back than the Pliocene period. It may be fairly argued that this amount of community proves a connection between the oceans at a recent date, and that the number of species in common is quite as great as we can expect, when we consider—firstly, that migration into an already fully stocked area is by no means so easy and rapid a process as was once supposed; and secondly, that the presence of icebergs depositing their loads of clay and gravel in the straits themselves would, perhaps, destroy most forms of marine life, or drive them away to some distance. Mr. Belt further advocates, what seems a very untenable theory, that the glacial period of the northern and southern hemispheres was at its greatest severity at the same time, and that the glacial deposits of Central America and Brazil are synchronous. To get over the enormous difficulty as to what became of the exclusively tropical forms of insect and bird life that abound in such overpowering luxuriance in tropical America, he has recourse to the increased area of low land caused by the lowering of the ocean owing to the vast amount of water abstracted in the form of ice. But Mr. Andrew Murray's map of the 100 fathoms line of soundings shows that the tropical part of South America would not be materially increased in area by a depression of 600 ft., and another 600 ft. would add proportionately less. Besides, if astronomical causes have produced glacial epochs, it is certain that they would occur alternately in each hemisphere;

and this would enable us far better to understand how the tropical forms of life continued to flourish by migrating north or south away from the colder pole. The subject of glacial periods is rendered vastly more difficult by the discovery of signs of glaciation so far within the tropics, and all facts proving such glaciation are of the greatest importance. It seems most probable that the solution of the problem will be only possible by admitting a succession of glacial periods of unequal intensity; so that while in the tropics we have the traces of one of the more ancient and intense period of cold, in the more northern regions we see the results of successive glaciations and intervening denudations.

Much more satisfactory as well as more original, is Mr. Belt's theory of the cause of whirlwinds and cyclones. He well remarks that there is a complete gradation, from the little eddy which whirls up the dry leaves, through the moderate whirlwind, up to the most destructive hurricane; and that a great philosophical mistake has been committed in forming theories to explain the larger phenomena without ever having studied the smaller. The few pages devoted to this subject are well worth reading, and would alone stamp the author as an acute observer in physics as well as in natural history. He gives good reasons why all the received theories of the cause of cyclones are incorrect, and substitutes one founded on observation of the smaller and more easily observed phenomena which is very ingenious, and which appears to have received the provisional approval of the Astronomer Royal, but which would occupy too much space to give an account of here.

We have now sufficiently shown that most of the readers of NATURE will find matter of interest in this volume; and we sincerely trust that the author may soon find himself in a position to work more systematically at some of those branches of science which he has here touched upon. So clear-sighted and intelligent a student will probably make important discoveries.

ALFRED R. WALLACE

## *PETTIGREW'S ANIMAL LOCOMOTION*

*Animal Locomotion; or, Walking, Swimming, and Flying.* By J. Bell Pettigrew, M.D., F.R.S. (London: Henry S. King and Co., 1873.)

PROGRESSION on land, in water, and in air, are phenomena so intimately connected with everyday life, that all of a thoughtful and observant turn of mind cannot help becoming acquainted, unassisted, with most of the details and much of the principle of their production. Many will therefore open a new work on the subject with a wish to have explained to them some of the more difficult and obscure problems connected with it, which are too intricate or uncommon to be within the limits of ordinary powers of observation; and to have the fundamental principles on which the subject is based, fully expounded. With such a feeling we took up the book under consideration, especially as Dr. Pettigrew's name has been always held up as that of the British exponent of the phenomena of flight, and the combatant of the French school. Imagine our disappointment on finding that, instead of the work being by the hand of a master, its author is deficient in the knowledge of the first principles of physics, and of the undoubted meaning of some of the most simple terms employed in the science; his argument, if it may be so called, being but little more than a long series of vague and fanciful analogies, incorrectly stated physical facts, and untenable theories.

In the introduction, and more minutely in a special chapter, the subject of aëronautics is discussed, and the false hope perpetuated that it is quite within the range of human possibility to construct a flying machine, capable of sustained suspension; for we are told that "in order to construct a successful flying machine . . . all that is required is to distinguish the properties, form, extent, and manner of application of the several flying surfaces;" no mention being made of the true difficulty of the problem, which is, that it is at present impossible to obtain from any form of fuel, a sufficient percentage of the potentiality which it possesses for doing work, to work an engine sufficiently compact and light for the wings which it has to drive. In the chapter on progression through the air, one of the paragraphs commences with the astonishing title, "Weight, Momentum, and Power, to a certain extent synonymous in flight," which follows an equally extraordinary and oft-repeated statement that "weight, when acting upon wings, or what is the same thing, upon elastic twisted inclined planes, must be regarded as an independent moving power." After such indications of imperfect knowledge, nothing in the way of mechanical theories could cause surprise, and we are therefore not astonished to find it laid down as the fundamental principle of flight, that the up-stroke of the wing aids in propulsion, and that in the down-stroke the inferior surface of the wing is directed *downwards* and *forwards*. "I repeat downwards and forwards; for a careful examination of the relations of the wing in the dead bird, and a close observation of its action in the living one, supplemented by a large number of experiments with natural and artificial wings, have fully convinced me that the stroke is invariably delivered in this direction," the wings being said to act like a boy's kite during both the down and up stroke. Who can see any close relation between the flight of birds and that of a kite? Dr. Pettigrew seems to forget that a kite needs a string, and yet, backed by his false analogy, he has the presumption to quote the experimental verifications and opinions of such able and ingenious thinkers as Borelli and Marey, the authors of the true theory of flight, only to reject them; bringing forward in opposition such evidence as "from accurate examination, I am fully convinced," and the like, against the sound mathematical arguments and superbly conducted experiments of the two above-named physicists.

Another favourite notion which Dr. Pettigrew reiterates is that "the efficiency of the wings is greatly increased by the fact that when it ascends it draws a current of air up after it, which current, being met by the wing during its descent, greatly augments the power of the down-stroke. In like manner, when the wing descends, it draws a current of air down after it, which, being met by the wing during its ascent, greatly augments the power of the up-stroke. . . . The wing is endowed with this remarkable property, that it creates the currents on which it rises and progresses." This would