from what I have since seen on the large vacant orbs of aquarium cod-fishes, &c.

I have not yet seen the porpoises in the Brighton Aquarium, but suspect that if they contrive to "make themselves at home" there, a careful study of their habits will remove some of the difficulty which Prof. Huxley experiences in believing in their intelligence.

W. MATTIEU WILLIAMS

Instinct

A DIFFICULTY occurred to me on reading Mr. Lewes's interesting and instructive article on "Instinct" in NATURE of April 10—and as no satisfactory answer offers itself to me, I venture to trouble you with it.

Wherein lies the difference in kind between the actions performed instinctively by animals for the preservation of themselves or their young, and those actions performed by plants with the same result?

For instance; the Ivy Linaria grows on an old wall; its flowers and the flower-stalks stand out for the sun and insects to visit the little "snap-dragon." But no sooner does the corolla fall, than the peduncle begins to curve inwards to the wall, and usually contrives to tuck its seed-vessel well into the brickwork again. We cannot say of such an action that there is "no alternative open to it;" and even if we do, it does not explain it to call it "impulsive," and yet one is not prepared to accept it as an instance of instinct. I shall be grateful for any elucidation.

M.

Grus vipio

I OBSERVE that in your report of the meeting of the Zoological Society on the 6th ult., in your issue of the 15th, it is stated, with reference to *Grus vipio* (*seu leucauchen*), that "no example of this fine species, so far as was known, had previously been brought alive to Europe." Last autumn, when going over the Zoological Gardens at Amsterdam with the superintendent, Mr. Hegt, I saw there a splendid pair of these birds, which had been purchased for 140*l.*, and had bred the same spring, and reared successfully a fine young bird, about two-thirds grown when I saw it in September, destined, as I was informed by Mr. Hegt, for the Berlin Gardens. The collection of cranes at Amsterdam is exceedingly rich, far surpassing either London or Antwerp in this respect. It contained, when I saw it, fourteen out of the fifteen valid species of Grus, comprising, besides the above-mentioned, *G. vipio*, a splendid pair of *G. viridirostris*, a fine *G. leucogeranus*, *G. carunculatus*, *G. canadensis*, *G. Americana*, *G. torquata*, &c., the desideratum being *G. monacha*, of Japan.

W. A. FORBES

Culverlea, Winchester, June 2

ON THE SYNTHESIS OF MARSH-GAS AND FORMIC ACID, AND ON THE ELECTRIC DECOMPOSITION OF CARBONIC OXIDE *

IN connection with the investigation on the electric decomposition of carbonic-acid gas referred to in a previous communication to the Society, I was led to submit a mixture of hydrogen and carbonic-oxide gas to the action of electricity in the induction-tube, the mixed gases being circulated through the tube by means of an apparatus which I will not now describe. A contraction was soon observed to have taken place, which at the end of an hour amounted to 10 cub. centims. The rate of contraction steadily diminished, and during the fifth hour of the duration of the experiment amounted to only 2 cub. centims. The experiment was stopped, and the gas analyzed with the following results in two several analyses:—

I.		II.	
Carbonic oxide .	61·65	Carbonic oxide .	61·35
Hydrogen . . .	32·16	Hydrogen . . .	32·34
Marsh-gas . . .	6·14	Marsh-gas . . .	6·31
	100·00		100·00

A small quantity (about 2 per cent.) of nitrogen was also contained in the gas, together with a trace of oxygen, which have been omitted from the calculation.

The result of this reaction is expressed in the following equation:—

$$CO + 3H_2 = CH_4 + H_2O.$$

This fundamental experiment, which constitutes the basis of a new method of chemical synthesis, susceptible of the most varied applications, and of peculiar interest in reference to the explication of natural phenomena, was commenced by me on the 10th of January last at Oxford, in the laboratory of my friend and successor in the Chair of Chemistry, Prof. Odling; two analyses of the gas were completed, and the results attained in the course of a week from that date. In a similar experiment made with a mixture of hydrogen and carbonic-acid gas, a contraction also occurred, attended with the formation of water. The gas which resulted from the experiment was found to consist (after the absorption of carbonic acid) of hydrogen and carbonic oxide, together with a little marsh-gas. Traces of oxygen and nitrogen were also present. Minute drops, too, of an oily liquid appeared in the tube. This liquid, after the conclusion of the experiment, was dissolved in a small quantity of water. The solution was strongly acid and had a pungent taste. It reduced an alkaline solution of terchloride of gold and an ammoniacal solution of nitrate of silver. These reactions are the characteristic properties of formic acid, of which we may infer the synthesis to have been effected according to the equation

$$H_2 + CO_2 = H_2CO_2.$$

I may avail myself of the present opportunity to place on record the following important facts in reference to the action of electricity on carbonic-oxide gas.

When pure and dry carbonic oxide is circulated through the induction-tube, and there submitted to the action of electricity, a decomposition of the gas occurs, attended with a gradual and regular contraction, which, in the form assumed in my experiments, occurred at the regular rate of about 5 cub. centims. in an hour. Carbonic acid is formed, and simultaneously with its formation a solid deposit may be observed in the induction-tube. This deposit appears as a transparent film of a red-brown colour, lining the walls of the tube. It is perfectly soluble in water, which is strongly coloured by it. The solution has an intensely acid reaction.

The solid deposit in the tube, in the dry condition before it has been in contact with water, is an oxide of carbon. Samples, however, made in different experiments do not present precisely the same composition; but nevertheless they appear to belong to a certain limited number of forms which repeatedly occur, and may invariably be referred to the same general order or system. This system is, or appears to be, what I may term a homologous series of "oxycarbons," of which the unit of carbon with the weight 12 may be regarded as the first term, and of which the adjacent terms differ by an increment of carbonic oxide (CO) weighing 28, precisely as homologous series of hydrocarbons differ by the increment CH_2 with the weight 14. I have succeeded in identifying by analysis two at least of these substances, namely, the adjacent terms C_4O_3 and C_5O_4. From this point of view these peculiar bodies are members of a series of oxycarbons analogous in the oxycarbon system to the series of hydrocarbons of which the unit of carbon is the first and the unit of acetylene C_2H_2 is the second term, the oxycarbon C_4O_3 being represented in that series by the hydrocarbon crotonylene C_4H_6, and the oxycarbon C_5O_4 by the hydrocarbon valerylene C_5H_8.

* A paper read at the Royal Society by Sir B. C. Brodie, Bart., D.C.L., F.R.S., late Wayneflete Professor of Chemistry in the University of Oxford.

THE LAW OF STORMS DEVELOPED *

III.

FROM the Cape of Good Hope, in a straight line toward the projecting eastern coasts of Brazil, mariners have found a peculiar streak] of south-easterly winds.

* Continued from p. 148.

Between the island of Tristan da Cunha and the Cape, and northward and westward to the island of Fernando Noronha, this streak of powerful winds, with which nothing in the trade-wind region of the North Atlantic can compare, has its atmospheric current as sharply marked as the dark blue and rapid current of the Gulf Stream in the Narrows of Bemini. It is, doubtless, the region or band of most intensely acting south-east trades, and is probably due to the peculiar configuration of the shores of the South Atlantic, and to the wall of the South American Andes. It is a well-known fact that the volcanic cone of Teneriffe, which lies in the zone of north-east trades, intercepts the wind and gives it a lateral deflection; so that, while the trades are blowing strongly on the north-east side of the island, on the opposite side there is a distinctly-marked and carefully-measured calm shadow. Now, the chain of the Andes endeavours to exert on the south-eastern trades just such an influence as is exerted by the Canary Islands on the north-east trades. This influence, in the former case, suffices to throw off from the Continent of South America a large body of the south-east trades, and to deflect it to the eastward, giving it the character of a south-south-west wind, and, at the same time, by forcing a greater or more concentrated body of air into the regions north-east of Brazil, imparting an increased velocity and violence to the air-current. It is, therefore, in the air-current that the homeward-bound vessel from the Cape of Good Hope aims to steer, because she is sure of being wafted happily and swiftly to her destination.

It has long been demonstrated by meteorologic observations, taken both at sea and on land, that there is very much *less* atmosphere in the Southern Hemisphere than in the northern, and for a long time physicists were at a loss to account for the difference. It has been, however, very satisfactorily explained by the eminent American mathematician, Ferrel, in his work on the "Motions of Fluids and Solids, relative to the Earth's Surface," where he proves at length, and states in detail (p. 39): "As there is much more land, with higher mountain ranges, in the Northern Hemisphere than in the southern, the resistances are greater, and consequently the eastward motion of the air, upon which the deflecting force depends, is much less; and the consequence is, that the more rapid motions of the Southern Hemisphere cause a greater depression there, and a *greater part of the atmosphere to be thrown into the Northern Hemisphere.*" It is, doubtless, to this tendency of the Southern Hemisphere to throw off much of its atmosphere north of the equator that we may attribute in part the superior force and power of the south-east trades, and their well-known ability to battle with the north-east trades, and drive them from their own territory, at least all summer, and even in winter, as far back across the line as 3° or 4° north latitude. Mr. Ferrel, speaking of the principle just enunciated, well says: "This also accounts for the mean position of the equatorial calm-belt being, in general, a little north of the equator. But, in the Pacific Ocean, where there is nearly as much water north of the equator as south (and the resistances are usually equal), its position nearly coincides with the equator." In other words, just as a bucket full of water revolving on a perpendicular axis would show a depression in the centre, and the fluid be thrown from all sides of its rim, the Southern Hemisphere throws its water and its atmosphere into the Northern hemisphere, all along the equator.

It is, therefore, a mathematical and mechanical certainty that there is an invasion of the north-east trade-wind belt from the south-east trades, and observation powerfully bears out the deduction of the mathematician. Ansted states in his cautiously-written "Physical Geography:"—"The southern trade-wind region is much larger than the northern in the Atlantic Ocean. In this sea, the south-east trades are fresher, and blow stronger, than the others, and often reach to the 10th or 15th parallel of north latitude; whereas the northern trade-wind seldom gets south of the equator, and usually ranges from 9° to 29° north latitude" (p. 253). It is not difficult to see how easily it happens that a very small atmospheric eddy found in the tropical Atlantic by the conflictory north-east and overleaping south-east trade-winds may soon become a hurricane of wide extent and of tremendous energy. All that is necessary, as we have before seen, is that an initial impulse of gyration be given to a body of air. The moment that this takes place by mechanical influence, and centrifugal force creates the smallest eddy or vortex, the surrounding air, already highly charged with moisture, begins the process of convergence and ascensional motion, followed rapidly by condensation aloft.

The storm-cylinder—the nucleus of the hurricane—originally very small, is instantly enlarged and expanded by the evolution of latent heat stored away in the vesicles of aqueous vapour. For some hours, as all observations show to be actually the case, the incipient cyclone scarcely moves, while gathering in its energies and laying tributes upon all contiguous regions. The process continues with momentarily increasing intensity, and, before the sun has made his daily circuit, the meteor is formed.

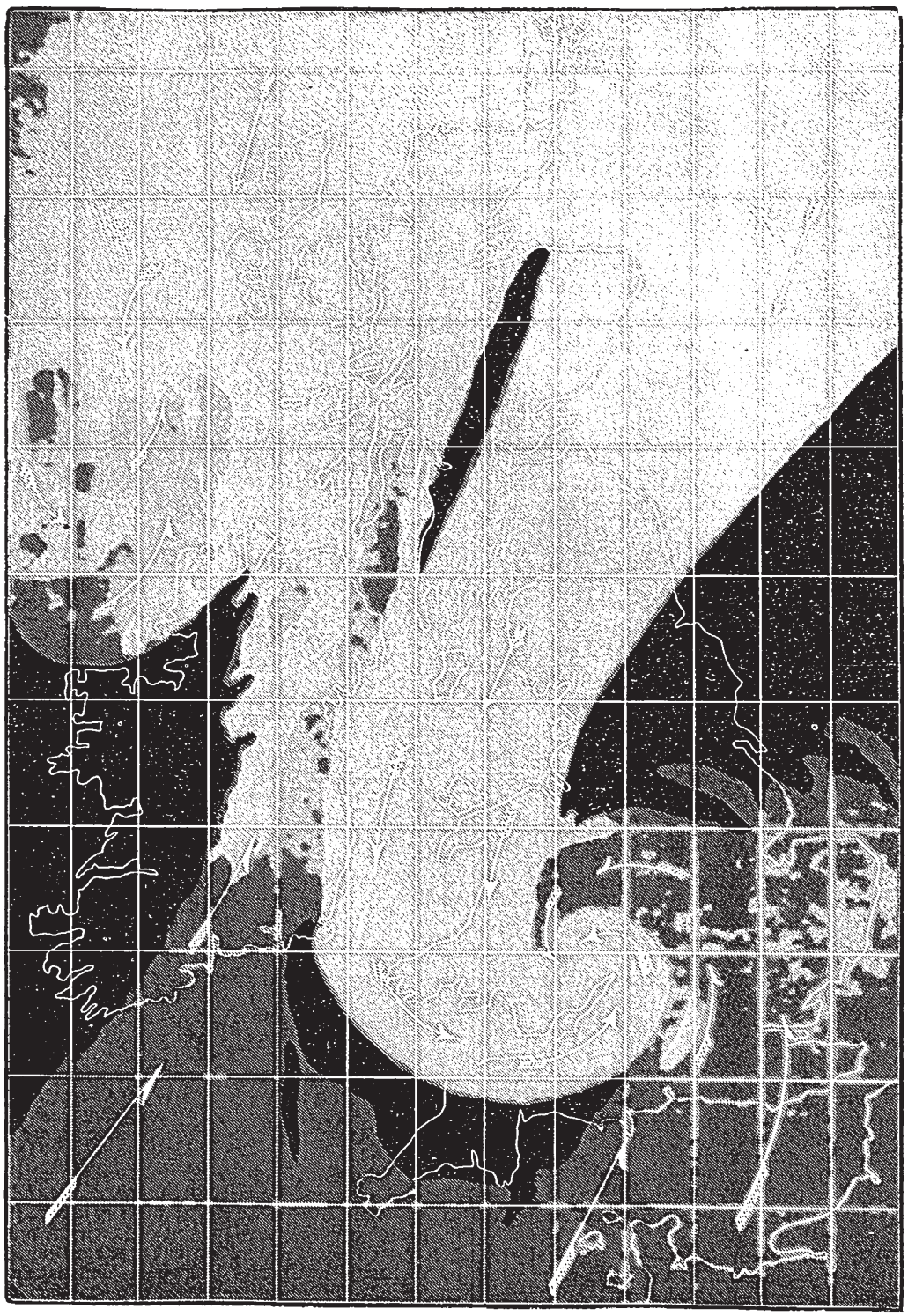
If it be asked along what parallels of latitude in our hemisphere this formation takes place, the intelligent reader will at once answer, Near the terrestrial circle of trade-wind interference. This, we have already seen, is in summer, from the 10th to the 12th parallels of north latitude.

This slender zone of debatable ground is the battle-field of the two opposing bands of the trades. There is really no need of observations to tell us as much. But millions of observations attest the fact. Every seaman knows it. Every meteorological writer tells the same story. You have only to examine physical charts from the time of Columbus and Magellan to this, to see the absolute unanimity of testimony, and to discover that the hypothesis now advanced, and the known facts of the case, are in perfect and minute accord.

If it be asked whether the origin and interest of the West-Indian gales is *solely* due to mechanical interference, the proper reply, it would appear, should be in the negative. As the south-east trade-wind comes laden with the vapour of the southern or water hemisphere, which Dové well called "the boiler" of the globe, it is met by the cold north-east trade from the northern, or land hemisphere. There must be a great difference in their temperatures, and consequently extensive condensation, which, by the reasoning of Mr. Clement Ley, would, of itself, explain the formation of the storm. That condensation greatly assists in producing or intensifying it, cannot be doubted. In the high latitudes, where the polar air-current is sometimes forced by barometric pressure into the southerly or equatorial current moving over the warm waters of the ocean, and thus heavily vapour-laden, the consequence is illustrated by such terrific and sudden tempests as that of the *Royal Charter*, distinctly proved by Admiral Fitzroy to have been generated between the opposite polar and equatorial currents off the coast of Wales.

But that the origin of great depression-systems is solely due to condensation can hardly be sustained, and seems entirely overthrown if we regard the single fact that, on the great equatorial belt—the belt of perennial precipitation—no hurricane or typhoon has ever been experienced by the mariner. It has long been, and is now, the almost universally accepted theory of meteorologists, that the reason no cyclones have ever been known to occur on the equator is, that there the earth's rotation exerts a deflecting influence on the winds, amounting to zero, and hence the formation of a whirl is impossible. This view is not satisfactory, because the nucleus of a depression

once formed on the equator, there would be intro-moving masses of air proportioned in violence to the amount of the depression and the steepness of the barometric gradient down which they rush to reach the point of



WEATHER-CHART OF GREAT BRITAIN, BEFORE "ROYAL CHARTER" STORM.
Full-feathered arrows show Polar current; half-feathered arrows show Equatorial current; dark-coloured surface not reported by vessels or land-observers.

lowest barometer. The true reason that no great cyclone has ever been formed nearer the equator than the third parallels of latitude appears to be, that the equatorial belt is a belt of *non-interference*.