1821," ix. + 110 pp. 16mo. In the preface Mollweide says that von Prasse was his predecessor in the Chair of Mathematics, as stated by Prof. Virchl. This work is entered under both the title-names in Poggendorff's "Biographisch-literarisches Handwörterbuch," a circumstance that might have given a clue to the authorship of the "Demonstratio." Strangely enough, this is not the only instance in which von Prasse omitted his name in essays written by him for academical celebrations. I can only surmise that this was done with a view to republication in his "Commentationes Mathematicæ," and that the name was written on the copies distributed as invitations to the celebrations. Whatever the reason, it has in this instance obviously added greatly to the trouble ordinarily experienced when dealing with this class of academical essay, the bibliography of which is so complicated, and at the same time often so important.

RALPH COPELAND.

Lord Crawford's Observatory, Dun Echt, January 25.

A New Historic Comet?

AT a recent meeting of the Asiatic Society of Japan, a paper was read by Mr. W. G. Aston, H.B.M. Consular Service. This paper will certainly rank high amongst historic papers relating to Japan and Korea. Briefly described, it is a comparison between the ancient records of these two countries and China, and its aim is to establish the relative credibility of these various records. Mr. Aston has so far confined his attention to the period preceding A.D. 500; and his general conclusion is that, as historic writings, the Korean and Chinese chronicles are far superior to the Japanese of the same date.

In the Tongkan, as the ancient records of the Korean kingdoms are called, there is a notice, of which the following is a translation: "Summer, fourth month, Pèkché; comet visible; day-time." The fourth month began on May 14 or 15. At the request of Mr. Aston, I tried to find out if any such comet had been observed elsewhere. The only list of historic comets obtainable in Japan was the list given in Faye's "Astronomy"; and I am not sure if this is meant to be complete. According to Mr. Aston, the Pèkché comet appeared in May or June, A.D. 302. The nearest date in Faye's list is A.D. 295. If this is the same comet, then one *at least* of the dates must be wrong. It is quite possible, however, that both are correct; in which case we shall be indebted to Mr. Aston for having added one more to our list of historic comets. In coming to a conclusion, we must know to what source we owe the knowledge of the 295 comet, and whether this source has greater claims to chronological accuracy than have the Korean records. Not having the references at hand for studying these points, I have written this note to NATURE, in the hope that someone interested in the matter may be able to come to a decision on this question of a possibly new historic comet.

CARGILL G. KNOTT.

Imperial University, Tokio, Japan, December 19, 1887.

"Is Hail so formed?"

UNDER the above heading in NATURE of January 26 (p. 295) there is a short paper by Cecil Carus-Wilson, in which the writer assumes that under certain conditions, drops of water, whilst falling from the upper branches of a tree, become converted into ice before reaching the ground, whilst other drops falling from the same tree, but at 10 feet less altitude, came to the ground in a fluid state. There is, I think, a simpler solution of this question than the one given. Suppose the following conditions—namely, a frost sufficiently severe as to lower the temperature of the leaves and branches of a tree to a few degrees below the freezing-point; after which a very gradual thaw comes on, accompanied by a fine rain or Scotch mist which freezes on the tree.

Where the leaves and smaller branches hang downwards, small beads of ice would form on their points. As the air became warmer the ice would thaw, and fall to the ground either in the liquid form, or the beads at the ends of the leaves and twigs would become detached in their solid state, and reach the ground as ice-pellets.

Sometimes these ice pellets extend in length, and assume the form of small icicles.

J. RAE.

4 Addison Gardens, January 28.

MODERN VIEWS OF ELECTRICITY.[1]

PART III. (*continued*).

VII.

First Representation of the Field due to a Current.

RETURN now to the consideration of a simple circuit, or, say, a linear conductor, and start a current through it; how are we to picture the rise of the lines of force in the medium? how shall we represent the spread of magnetic induction? First think of the current as exciting the field (instead of the field as exciting the current, which may be the truer plan ultimately).

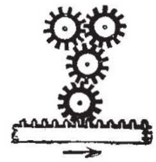

FIG. 34.

If we can think of electricity in the several molecules of the insulating medium connected like so many cog-wheels gearing into one another and also into those of the metal, it is easy to picture a sideways spread of rotation brought about by the current, just as a moving rack will rotate a set of pinions gearing into it and into each other (Fig. 34). But then half the wheels will be rotating one way and half the other way, which is not exactly right.

How is it possible for a set of parallel whirls to be all rotating in the same direction?

FIG. 35.

If there is any sort of connection between them they will stop each other, because they are moving in opposite directions at their nearest points; and yet, if there is no connection, how can the whirl spread through the field?

Well, return to the old models by which we endeavoured to explain electrostatics, and think whether they will help us if we proceed to superpose upon them a magnetic whirl in addition to the properties they already

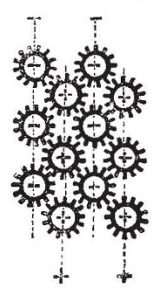

FIG. 36.—Rows of cells alternately positive and negative, geared together; free to turn about fixed axles.

possess. Looking at Figs. 5, 6, and 13, we remember we were led to picture atoms and electricity like beads threaded on a cord. And these cords had to represent, alternately, positive and negative electricity, which always got displaced in different directions.

We are forced to a similar sort of notion in respect of the wheels at present under discussion: in order that

[1] Continued from p. 323.

they may co-operate properly, they must represent positive and negative electricity alternately. If they *then* rotate alternately in opposite directions, all is well, and the electrical circulation or rotation in the field is all in one direction. Each wheel gears into and turns the next, and so the spin gets propagated right away through the medium, at a speed depending on the elasticity and density concerned in such disturbances.

It is not convenient at the present stage to ask the question whether the wheels represent atoms of matter or merely electricity. It may be that each atom is electrostatically charged and itself rotates, in which case it would carry its charge round with it, and thereby constitute the desired molecular current.

The apparent inertia of electricity would thus be explained simply enough, as really the inertia of the spinning atoms themselves; and the absence of any moment of momentum in an electro-magnet as tested mechanically would be equally explained by the simultaneous opposite rotation of adjacent atoms. A question may arise as to why the opposite molecules should have exactly equal opposite inertiæ, as they have, else a fluid magnetized medium would bodily rotate; and there may be other difficulties connected with a bodily rotation of electrostatically charged molecules: it is merely a possibility upon which stress must not be laid till it has been proved able to bear it. For our present purpose a spin of the electricity inside each atom, or even independently

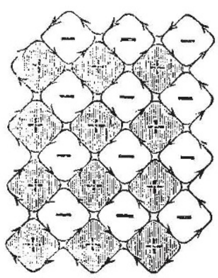

FIG. 37.—Portion of a magnetic field. Another mode of drawing Fig. 36.

of any atoms, is quite sufficient. Besides, since magnetic induction can spread through a vacuum quite easily, the wheel-work has to be largely independent of material atoms.

If any difficulty is felt concerning the void spaces in Fig. 36 it is only necessary to draw it like Fig. 37, which does every bit as well, and reduces the difficulty to any desired minimum.

Representation of an Electric Current.

Now notice that in a medium so constituted and magnetized—that is, with all the wheel-work revolving properly—there is nothing of the nature of an electric current proceeding in any direction whatever. For, at every point of contact of two wheels the positive and negative electricities are going at the same rate in the same direction; and this is no current at all. Only when positive is going one way and negative going the opposite way, or standing still, or at least going at a different rate, can there be any advance of electricity or anything of the nature of a current.

A current is nevertheless easily able to be represented: for it only needs the wheels to gear imperfectly and to work with slip. At any such slipping-place the positive is going faster than the negative, or *vice versâ*, and so there is a current there. A line of slip among the wheels corresponds therefore to a linear current; and, if one thinks of it, it is quite plain that such a line of slip must always have a closed contour. For, if only one wheel slip, then the circuit is limited to its circumference; if a row slip, then the direct and return circuit are on opposite sides of the row. But a large area of any shape with no slip inside it may be inclosed by a line of slip, and this gives us a circuit of any shape, but always closed. Understand: one is not here thinking of a current as analogous to a *locomotion* of the wheels—their axes may be quite stationary,—the slip contemplated is that of one *rim* on another.

Imagine all the wheels inside the empty contour of Fig. 38 to be rotating, the positive clockwise, the negative counter clockwise, and let all those outside the contour be either stationary or rotating at a different rate or in

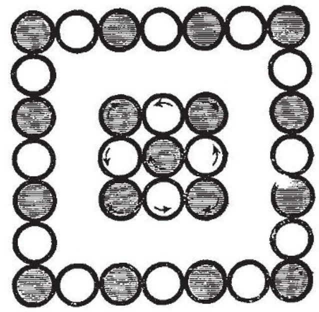

FIG. 38.—Diagram of a peripheral current partitioned off from surrounding medium by a perfect conductor, which transmits no motion, and therefore acts as a perfect magnetic screen.

an opposite direction; then the boundary of the inside region is a line of slip along which the positive rims are all travelling clockwise, and the negative rims the other way, and hence it represents a clockwise positive current.

But it may be said that the spin inside the contour, if maintained, must sooner or later rotate the wheels outside as fast as themselves, and then all slip will cease. Yes, that is so, unless there is a complete breach of connection at the contour, as in Fig. 38 there is. If the outer region has any sort of connection with the inner one the slip at its boundary can only be temporary, lasting during the era of acceleration.

Distinction between a Dielectric and a Metal, as affected by a spreading Magnetic Field.

In a dielectric the connection between the atoms is definite and perfect. If one rotates, the next must rotate too; there is no slip between the geared surfaces; it is a case of cogged wheels. A conduction-current is impossible.

But in a metallic conductor the gearing is imperfect; it is a case of friction-gearing with more or less lubrication and slip, so that turning one wheel only starts the next gradually—it may be very quickly, but not instantaneously—and there is a motion of a positive rim incompletely compensated by an equal similar motion of a negative rim while getting up speed; in other words, there is a momentary electric current, lasting till the wheels have fairly started.

In a perfect conductor the gearing is absent; the lubrication is so perfect that all the atoms are quite free of one another, and accordingly a spin ceases to be transmitted into such a medium at all. The only possible current in a perfect conductor is a skin-deep phenomenon.

A magnetized medium of whatever sort is thus to be regarded as full of spinning wheels, the positive rotating one way and the negative the other way. If the medium is not magnetized, but only magnetic—*i.e.* capable of being magnetized—it may be thought of either as having its wheels stationary, or as having them facing all ways at random; the latter being probably the truer, the former the easier, representation, at least to begin with.

Whether the medium be conducting or insulating makes no difference to the general fact of spinning wheels inside it wherever lines of force penetrate it; but the wheels of a conductor are imperfectly cogged together, and accordingly in the variable stages of a magnetic field, while its spin is either increasing or decreasing, there is a very important distinction to be drawn between insulating and conducting matter. During the accelerating era conducting matter is full of slip, and a certain time elapses before a steady state is reached. A certain time may be necessary for the propagation of spin in a dielectric, but it is excessively short, and the process is unaccompanied by slip, only by slight distortion and recovery. As for a strongly magnetic substance like iron, nickel, or cobalt, one must regard them as constituted in the same sort of way, but with wheels greatly more massive, or very much more numerous, or both.

Phenomena connected with a varying Current. Nature of Self-induction.

Proceed now to think what happens in the region round a conductor in which a current is rising. Without attempting a complete and satisfactory representation of what is going on, we can think of some mechanical arrangements which have some analogy with electrical processes, but do not pretend to imitate them exactly.

Take first a system of wheel-work connected together and moved at some point by a rack. Attend to alternate

FIG. 39.—A provisional representation of a current surrounded by dielectric medium, either propelling or being propelled.

wheels more especially, as representing positive electricity. The intermediate negative wheels are necessary for the transmission of the motion, and they also serve to neutralize all systematic advance of positive electricity in any one direction, except where slip occurs, but they need not otherwise be specially attended to.

Remember that every wheel is endowed with inertia, like a fly-wheel.

Directly the rack begins to move, the wheels begin to rotate, and in a short time they will all be going full speed. Until they are so moving, the motion of the rack is opposed, not by friction or ordinary résistance, but by the inertia of the wheel-work.

This inertia represents what is called self-induction, and the result of it is what has been called the "extra current at make," or, more satisfactorily, the opposing E.M.F. of electro-magnetic inertia or self-induction.

So long as the rack moves steadily forward, the wheel-work has no further effect upon it; but directly it tries to stop, it finds itself unable to stop dead without great violence: its motion is prolonged for a short time by the inertia of the wheel-work, and we have what is known as the "extra current at break."

If the rack is for a moment taken to represent the advancing electricity in a copper wire, then the diagram may be regarded as a section of the complete field: the complete field being obtained from it by rotating it round the axis of the wire. Imagining this done, we see that the axis of each wheel becomes prolonged into a circular core, and each wheel into a circular vortex ring surrounding the rack and rolling down it as it moves forward, as when a stick is pushed through a tight-fitting umbrella-ring held stationary (see Fig. 30 B).

As one goes further and further from the rack the lengths of the vortex cores increase, but there is only a given amount of rotation to be shared among more and more stuff, hence it is not difficult to imagine the rate of spin diminishing as the distance increases, so that at a reasonable distance from the conductor the medium is scarcely disturbed.

To perceive how much rotation of the medium is associated with a given circuit, one must consider the shape of its contour—the position of the return current. Take first a long narrow loop and send a current up one side and down the other. The rotations belonging to each are superposed, and though they agree in direction for the space inclosed by the loop, they oppose each other outside, and so there is barely any disturbance of the medium outside such a looped conductor; very little dielectric is disturbed at all, and accordingly the inertia or self-induction is very small.

If the loop opens out so as to inclose an area, as the centrifugal force of the wheels will tend to make it do,

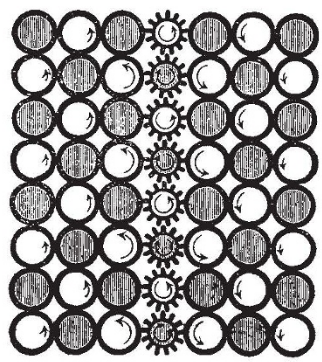

FIG. 40.—Diagram of a direct and return current close together, showing distribution of rotation and of slip in the thickness of the conductor, and in the dielectric between. The dielectric outside is very little disturbed.

then there is a greater amount of rotation, a greater moment of momentum inside it, and accordingly its self-induction is increased. The axis of every wheel is, however, continuous, and must return outside the loop: so the outside region is somewhat affected by rotation, but of a kind opposite to that inside.

Figs. 38 and 41 show the state of things for a closed circuit conveying a current. The free space in Fig. 38 represents a perfect conductor, or perfect breach of connection. Along one side of this space positive electricity is seen streaming in the direction of the arrows, and it may be streaming on the other side also, but nothing happens in its interior—which is therefore not represented.

The corresponding portion in Fig. 41 is intended for an ordinary conductor, full of wheels capable of slip. And slip in this case is a continuous necessity, for the rotation on either side of the conductor is in opposite directions, so the atoms of the conductor have to accommodate themselves as best they can to the conditions; some of them rotating one way, some the other, and some along a certain neutral line of the conductor being stationary. If a conductor is straight and infinitely long, the neutral line of no rotation is in the middle. If it be a loop, the neutral line is nearer the outside than the inside, because the rotation of the medium inside is the strongest. If the loop be shut up to nothing, the neutral line is its outer boundary or nearly so (Fig. 40). If, again, the circuit is wound round and round a ring, as string might be lapped upon a common curtain-ring to cover it, then the axes of whirl are wholly inclosed by the wire, and there is no rotation outside at all.

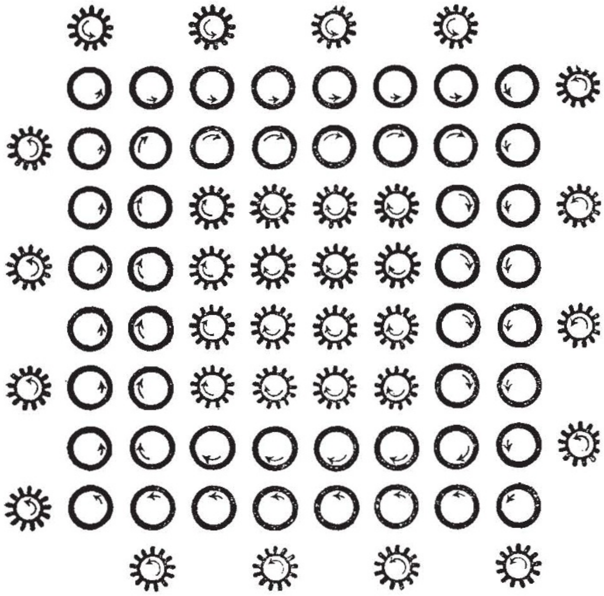

FIG. 41.—Diagram of simple conducting circuit like a galvanometer ring, with the alternate connecting-wheels omitted. The same number of dielectric wheels are drawn outside as inside, to indicate the fact that the total spin is equal inside and out, though the outside is so spread out as to be much less intense.

Fig. 42 shows a section of this last-mentioned condition, and here the wheels of the dielectric outside are not rotating at all. The inside is revolving, it may be furiously, and so between the inner and outer layers of the conductor we have a great amount of slip and dissipation of energy.

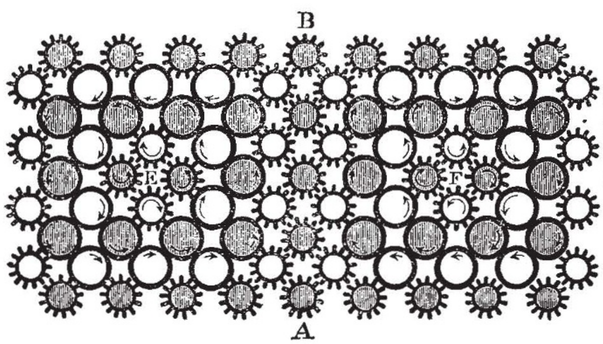

FIG. 42.—Section of a closed magnetic circuit, or electric vortex-ring, or hollow bent solenoid like Fig. 29, inclosing an anchor-ring air space; the axis of the ring being A B, the sections of the core being E and F. The arrows indicate the intensity of the spin, *i.e.* of the magnetic field, which is a maximum at the middle of each section and nothing at all outside. If the core contains iron instead of air, its wheels have to be from 100 to 300 times as massive: slipping wheels if solid iron, cogged wheels if a bundle of fine varnished iron wires.

The process of slip which we have depicted goes on in all conductors conveying a current, whether steady or variable, and in fact *is* the current. The slip is necessarily accompanied by dissipation of energy and production of heat: only in a perfect conductor can it occur without friction. In a steady current the slip is uniformly distributed throughout the section of the conductor; in the variable stages it is unequally distributed, being then more concentrated near the periphery of the wire.

When a current is started in a wire, the outer layers start first, and it gradually though very quickly penetrates to the axis. Hence the lag or self-induction of a wire upon itself is greater as the wire is thicker, and also as it is made of better conducting substance. If it is of iron, the mass or number of the wheels is so great that the lag is much increased, and the spin of its outer layers is great enough to produce the experimental effects discovered by Prof. Hughes.

One must never confuse the slip with the spin. Slip is current, spin is magnetism. There is no spin at the axis of a straight infinite wire conveying a current, and it increases in opposite directions as you recede from the axis either way; arranging itself in circular vortex cores round the axis. But the slip is uniformly distributed all through the wire as soon as the current has reached the steady state. The slip is wholly in the direction of the wire. The axes of spin are all at right angles to that direction.

Rise of Induced Current in a Secondary Circuit.

To study the way in which a magnetic field excited in any manner spreads itself into and through a conducting medium, look at Fig. 43, and suppose the region inside the contour A B C D to be an ordinary conducting region—that is, full of wheels imperfectly geared together, and capable of slip.

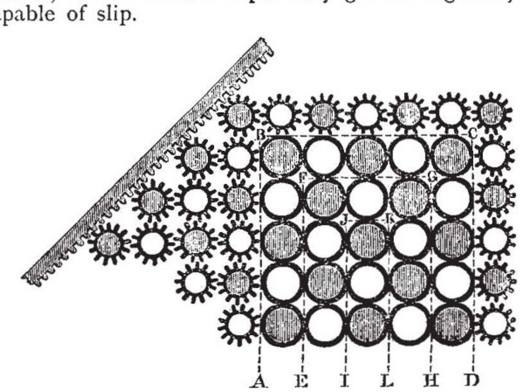

FIG. 43.—Diagram illustrating the way in which an induced current arise in a mass of metal immersed in an increasing magnetic field; also how it decays. The dotted lines A B C D, E F G H, I J K L, are successive lines of slip.

Directly the rack begins to move, all the wheels outside A B C D begin to rotate, and quickly get up full speed. The outer layer of wheels inside the contour likewise begins to rotate, but not at once; there is a slight delay in getting them into full motion. For the next inner layer the delay is rather greater, and so on. But ultimately the motion penetrates everywhere equally, and everything is in a steady state.

But while the process of starting the wheels was going on, a slip took place round the contour A B C D, and round every concentric contour inside it; the periphery of the positive wheels moving in a direction opposite to that of the wheel in contact with the rack, and so suggesting the opposite induced current excited at "make" in the substance of a conductor near a growing current, or generally in an increasing magnetic field.

The penetration of the motion deeper and deeper, and the gradual dying away of all slip, illustrate also the mode in which this induced current arises and gradually dies away, becoming *nil* as soon as the magnetic field (*i.e.* the rotation) has penetrated to the interior of all conductors and become permanently established there as elsewhere.

Suppose the motion of the rack now stopped: all the cogged wheels stop too, though it may be with a jerk and some violence and oscillation due to their momentum; but those inside the contour A B C D will continue moving for a little longer. The outside layer of this region will slip in such direction as to illustrate the direct induced current at "break," and will begin to stop first; the slip and the stop gradually penetrating inwards, just as happened during the inverse process, until all trace of rotation ceases. This inverse slipping process is the direct induced current at "break."

Through a perfect conductor the disturbance could never pass, for the slip of the dielectric wheels on its outer skin would be perfect, and would never penetrate any deeper. A superficial current lasting for ever, or rather as long as the magnetic field (the rotation of the dielectric wheels) lasts, is all that would be excited, and it would be a perfect magnetic screen to any dielectric beyond and inclosed by it. OLIVER J. LODGE.

(*To be continued.*)

THE BIRDS'-NEST OR ELEPHANT ISLANDS OF THE MERGUI ARCHIPELAGO.

OF the geological structure of this group of islands lying off the coast of British Burmah not much is yet known. Our readers will probably be interested in the following account of a visit to one portion of the archipelago, furnished by Commander Carpenter, R.N., to the Hydrographer of the Admiralty, to whose kindness we are indebted for permission to publish it.

The remarkable group of islands called by the Burmans Ye-ei-gnet-thaik (*lit.* sea-birds' nests) is located on the south-east side of Domel Island, one of the largest of the Mergui Archipelago. It is composed of six marble rocks, the highest and largest of which, 1000 feet in altitude, and about one mile in length, is oval-shaped, and rises very abruptly out of a depth of only 5 fathoms. The islands present a very striking appearance, particularly if the weather is hazy, when they are not seen until within five or six miles, for then they gradually loom out through the mist like some huge misshapen monsters that have strayed away from civilization. Their sides are partly clothed with vegetation wherever a break in the limestone has left a cleft in which moisture and dust can lodge. Conspicuous because of its leaning attitudes is a species of tree-fern which grows at any angle, but only above a height of 200 feet from the water. The face of the rocks is reddish, partly from weathering and partly from soil, and where cliffs exist the most beautiful though uncouth stalactites have been formed, showing grotesque and snake-like patterns varying in hue and shape till one feels as if in some enchanted land. But the great feature of the group is the birds'-nest caverns, which as a rule open into the sea, the entrance being below high-water mark; fortunately I visited them at spring tides, and had plenty of leisure to examine each cavern at low water during two days.

At the south end of the largest island stands a "nine-pin" of gray marble 370 feet high, almost separated from the rest. It is hollow, like a huge extinguisher, and the polished light-blue and yellow sides of the interior seem to point to its having been hollowed by the swell of the sea, which on entering the cave would probably expend its force vertically, the mouth of the cave being open to the direction of the strongest seas. This sea-stack forms the western point of a nearly circular cove, 360 yards in diameter, which runs back into the island, and the sides of the cove rise steeply though not perpendicularly from it. At the head of the cove is a perpendicular wall of rock over which can just be seen the 1000-foot summit in the distance.

At half-tide a tunnel, passable for a canoe, opens under the wall of rock at the head of the cove, but a ship's gig can only enter within an hour of low-water spring tides. This tunnel has a roof covered with large stalactitic knobs except at its narrowest part, where it is apparently scoured smooth by the action of the tidal rush. It is about 250 feet long, and 4 feet deep at low water (the rise and fall of the tide being 16 feet), and is covered with dripping marine life, corallines, small corals, Comatulæ, sponges, and sea-horses. Passing through this submarine passage one emerges into another circular crater-shaped basin with perpendicular sides. This basin is only open to the sky; caves here and there enter it, some of which may perhaps lead by long tunnels to other basins. Water was running freely into it from the foot of the cliffs in several places as the tide fell, showing that water spaces existed, and strange gurgling sounds as of air taking the place of water could be heard now and again. There were hardly any signs of the place being frequented by man except here and there the worn ropes of birds'-nest climbers. It was either not the season for the swallows, or they had deserted the islands, for none were seen. A little reddish guano was noticed in some of the caves. There can be but little traffic through the tunnel by which we entered, for the delicate growth on its sides was hardly injured.

On the west side of the northern large island a lofty cavern is connected at half-tide with another nearly circular basin of about the same size as that we have just described, but in this case the basin also opens into the sea on the east side of the island. After contemplating the cliffs that surround these basins, the general circular contour of the ridges of the islands, the undermining action of the sea at the water-line, which causes in some places an overhang of 20 to 25 feet, and the softening of the marble surface of the cavern roofs by moisture, the conviction gradually forces itself on the mind that these circular basins were themselves at one time the floors of huge caverns; that in days gone by the islands rose far higher, with cavern piled on cavern, and that the work of disintegration by solution and wave-action is slowly going on, pulling down these marble monuments of a giant age. Indeed, here and there a fall of blocks has occurred lately, and, as there is no shoal off the base of the slip, the destructive action is probably rapid.

A small oyster covers the rocks at the water-line. A handsome kingfisher was secured and sent to the British Museum. A few doves and an eagle or two were the only other birds seen, besides a small bat in the caves. By the position of the nest-seekers' ropes, the swallows appear to build only on the roofs of the caves. The islands appeared to be entirely composed of a blue-tinted marble. A vessel could lie alongside them and lower the cut blocks straight into her hold, but it is probably of too poor a quality to be worth shipment.

ALFRED CARPENTER.

PRIZE FOR RESEARCHES IN NATURAL HISTORY.

IN accordance with the intentions of the founder, the Committee of Schnyder of Wartensee's Foundation, Zürich, have decided to offer for the year 1890 a prize for the following researches in natural history:—

"New investigations are desired regarding the relation which the formation of the bones bears to the statics and mechanics of the vertebrate skeleton. The results of the investigations as a whole are to be demonstrated in detail by way of example on the skeleton of a definite species."

The conditions are as follow:—

Art. 1. Competitors for the prize must send in their work in German, French, or English, by September 30, 1890, at the latest, to the address given below in Art. 6.

Art. 2. The award will be made by a Committee consisting of the following gentlemen:—Prof. Hermann von