in the neighbourhood of Hordle huge masses of fallen cliff alternate with hollow chines. At Barton also the loss is great, averaging over certain periods one yard per annum, and the whole frontage of Christchurch Bay is similarly affected.

The shingle immediately westward of Hurst becomes smaller, as is universally the case with these spits. Hurst Beach in effect, with alternating withdrawals and renewals, due to change of wind, represents by its height and the size of its pebbles the general leeward accumulating drift.

General observation leads to the conclusion that littoral shingle travels mainly along the shore, as in all cases the coarse pebbles are succeeded by fine shingle, and this ultimately, by sand, silt, or clay; but that spits of shingle grow out into deep water, creating a base for themselves the numerous nesses on our coasts amply show; but before arriving on the shore that shingle does travel at very considerable depths is shown by such cases as the above-mentioned submarine shingle bank west of the Needles passage and the "Boulders" off Selsea Bill.

Here the "Park Anchorage" eastward of the Bill is the traditional site of the bishop's see, and hydrograpnic authorities cited in the English Channel Pilot describe the gravel bottom as rough and thinly covering a strong clay. J. R. REDMAN

6, Queen Anne's Gate, Westminster, S.W., May 18

Difficult Cases of Mimicry

IN the very interesting communication by Mr. Wallace, in NATURE, *ante* p. 86, on some difficult cases of mimicry, there is one statement which apparently challenges comment.

Mr. Wallace states that although it has been so suggested, it is highly improbable that young birds have a hereditary instinct enabling them to distinguish uneatable butterflies antecedent to experience. Mr. Wallace has not alluded to the very thorough and careful experiments made by the late Mr. Dougl. A. Spalding on this point. It is unnecessary to refer to the results obtained by Mr. Spalding in proving the inherited acquisition of ideas and experience in young chickens, it will at least suffice to repeat the observations made by him, on the actions of a young turkey which he had adopted—"When chirping within the uncracked shell." Now this young turkey, not only on the tenth day of its life, exhibited the most intense terror at the sound of a hawk's voice which was confined in a cupboard but also proved its *inherited* knowledge of uneatable insects.

"When a week old my turkey came on a bee right in its path—the first, I believe, it had ever seen. It gave the danger chirp, stood for a few seconds with outstretched neck and marked expression of fear, then turned off in another direction. On this hint I made a vast number of experiments with chickens and bees. In the great majority of instances the chickens gave evidence of instinctive fear of these sting-bearing insects, but the results were not uniform, and perhaps the most accurate general statement I can give is, that they were uncertain, shy and suspicious."

If domesticated fowls and turkeys exhibit such inherited "instinct," may we not postulate a much greater excess of the same in purely insectivorons birds in a state of nature. And if this is so, it will be unnecessary to explain away, what appears to be one of the most philosophical considerations in the doctrine of "mimicry." W. L. DISTANT

Deaf-Mutes

J'APPRENDS seulement aujourd'hui par M. Graham Bell que *La Nature* à bien voulu mentionner mes communications à l'Académie des Sciences sur l'accent des sourds muets. Je regrette que les *Comptes Rendus* n'aient pas reproduit mes communications *in extenso* et que M. le Secrétaire perpétuel se soit borné à en faire une analyse incompléte. Je prends donc la liberté de vous adresser ces quelques lignes afin que vos lecteurs sachent au juste la portée de ma communication.

J'ai dit que nous sommes frappés de la ressemblance des visages et quelquefois aussi des mains parce que se sont les seules parties du corps, qui ne soient pas couvertes par les vêtements, mais qu'évidemment la ressemblance s'etend à toutes les parties du corps. J'ajoute même que la ressemblance ne s'arrête pas aux traits extérieurs, on doit la retrouver entre les organes. Pourquoi les organes de la voix feraient-ils seuls exception à la règle générale?

M. le sénateur Robin et M. Milne-Edwards, de l'Institut, à qui on ne saurait refuser la compétence en ces matières, nous disaient qu'il ne comprenaient pas qu'on pût faire des objections sérieuses au fait que j'ai signalé touchant la transmission héréditaire de l'accent; que la voix, avec ses diverses propriétés, hauteur, intensité, timbre, accent, est une manifestation des organes-vocaux au même titre que toutes les manifestations dont notre corps est le siége. Rien ne se produit au dehors qui n'ait sa cause ou son siége au dedans; c'est dans la constitution intime de notre corps qu'il faut chercher la raison de tous les phénomènes externes. Ainsi s'expliquent les transmissions par voie d'hérédité, soit des aptitudes comme celles pour les mathématiques, les arts graphiques, etc.; soit des affections maladives comme la goutte, le cancer, la folie, etc.; soit des monstruosités comme les doigts surnuméraires, le bec-de lièvre, etc. Pourquoi dans les ressemblances, les organes vocaux seraient-ils exceptés?

Il faut chercher la ressemblance dans la cellule; sans doute, il n'est pas facile de la saisir, mais nous n'osons pas dire, que c'est chose impossible. Une longue expérience est nécessaire pour arriver à saiser des nuances imperceptibles au grand nombre. Ne sait-on-pas qu'un berger reconnait et distingue chaque mouton de son troupeau, tandis que pour nous tous les moutons sont les mêmes à fort peu près.

Ne serait-il pas possible, d'ailleurs, qu'il y eut moins de nuances d'accent chez les sourds-muets et les entendants-parlants americains que chez les Français du Nord et du Midi, de l'Est et de l'Ouest. La voix de nos chers Alsaciens est teintée de sons germaniques, tandis que celle de nos Provençaux a acquis une sonorité et un timbre particuliers qui lui viennent sans doute du long séjour des Romains dans le Midi. Peut-être nous est-il plus facile de constater ces nuances dans la voix chez les sourds-muets de notre pays.

Voici un nouveau fait très curieux sur lequel j'appelle votre attention.

Nanterre (Seine) FELIX HEMENT

Caution to Solar Observers

IN the interest of solar observers I send you a caution. A first-class sample of black glass was set with a bit of white paper behind it, and exposed for an instant to the focus of a 7-inch lens. The paper was charred where an eye would be placed. A longer exposure of a few seconds made the glass burst asunder.

J. F. CAMPBELL

Niddry Lodge, Kensington, London, W.

Aurora Borealis

WHAT was, probably, the termination of the aurora seen at Worcester and Dublin on May 14 was observed here, by me, between midnight and 1 a.m. of the morning of the 18th. At that time, and for some time after, I saw along the north-west horizon a strong, green, auroral glow. The evening of the 14th was bitterly cold; the sunset clouds threatened snow, wind, light north-north-east light, cloudy. At dawn, the sky was cloudless and wonderfully clear. The 15th was warm and pleasant.

Glasgow, May 24 S. MAITLAND BAIRD GLENNILL

ON THE MUTUAL RELATIONS OF CARBON AND IRON IN STEEL[1]

IN this paper the author sets himself to prove the following four propositions concerning steel: (1) the carbon of steel is (primarily) in a state of simple absorption in the iron; (2) the hardening of steel is due to a metamorphic change in the condition of the carbon, which then assumes a crystalline form closely analogous to the diameter; (3) the varying temper of steel results from the dissociation of this crystalline carbon, at varying but low temperatures; (4) the real strength of steel does not vary to any material degree with a varying content of carbon—that is, *ceteris paribus*, steel is not increased in tensile strength by an increased percentage of carbon.

With regard to No. 1, the author rejects the idea that carbon in steel can be in chemical combination. The only possible hypothesis would be that it is found as a carbide of iron dissolved in excess of iron; and this no modern author holds. It may be alleged in its support that hydrocarbon gas is evolved on dissolving steel in hydrochloric acid; but the great variation in the results and the fact that more or less carbon is at the same time deposited, forbid us to suppose that we have here a definite chemical decomposition. The Eggerty colour test, again, which was supposed to be founded on the same theory, has been in great measure abandoned on account of its inaccuracy. The

[1] Abstract of paper by Mr. George Woodcock, read before the Iron and Steel Institute.

phenomena of the conversion of iron into steel in the cementation process all point to the conclusion that the carbon is simply absorbed, as the varying rate of impregnation with variations of temperature, the gradual change from the outside to the inside, and the large deposition of free carbon from such steel, if dissolved in hydrochloric acid, or chloride of copper, or cold dilute nitric acid.

As to No. 2, the author adopts the theory of Jullien, that the hardening of steel is due to the crystallisation of the so-called combined carbon (really absorbed) in a form resembling the diamond. He observes that cemented steel only becomes hard when heated and quenched, and that the fracture then shows innumerable small crystals, which, under the microscope, present physical features very much like small diamonds. These crystals do not appear in wrought iron, increase in number as the proportion of carbon increases, and as the hardening increases, and are more numerous at the outside of the piece, where the hardness is also less. They are therefore crystallised carbon, in other words, diamond. Estimations of carbon in the different layers of a piece of hardened steel have always shown that the actual proportions, as formed by combustion, are the same throughout, but that, as examined by the colour test, they increase gradually from the outside to the inside. This shows that some change has taken place in the carbon. The author's theory is that at a red heat the molecules of iron are expanded and partially separated; that in this state the absorbed carbon is partially dissociated from the iron, and upon the steel being suddenly quenched, the carbon is not re-absorbed, but takes up a small amount of hydrogen, and is fixed in the state of diamond. It is known that hydrogen is present in the diamond, and also in steel, and it is submitted that it forms the active agent in reducing the carbon from the amorphous to the crystalline form. On analysing this hardened steel, it is supposed that the crystalline carbon goes off in all cases as gas; so that less "combined carbon will remain to be shown by the colour tests or deposited on solution in hydrochloric acid. It must follow from this view that carbon is the acting hardener of steel, and that the idea of other elements, as phosphorus hardening steel is a delusion. In support of this it is observed that phosphorus does not harden wrought iron and that probably the real effect of phosphorus and silicen is to cause dissociation of carbon, thus producing a larger extent of crystallisation and a harder metal. Thus it is found that the higher the proportion of phosphorus, the greater will be the difference between the carbon, as shown by the colour test, and as fixed by analysis. Again, English Bessemer or Siemens steel will require 20 per cent. less carbon to make it work and harden equally well with best Swedish steel; the explanation being that the phosphorus in the former assists the dissociation and crystallisation. To this effect of phosphorus many of the mysterious failures of steel may probably be traced.

With regard to No. 3, the author regards the variations of tempering as due solely to the completeness, or otherwise, of the decomposition of the crystalline carbon in the hardened steel. He observes that carbon and iron have no action on each other at the heat at which tempering is effected; while, even at such temperatures, the abstraction of hydrogen from carbon, in the presence of iron, cannot be deemed impossible. The tempering of steel by simply quenching it in hot water or oil, may thus be explained; the outer layers may be supposed to be hardened at first in the ordinary way, but then, as the interior heat does not pass away so rapidly, it has time to act on the crystalline carbon, and partly to dissociate it again, thus producing something between hardened and unhardened steel—in other words, tempered steel. The crystallised carbon in the hardened steel is supposed to be diffused in a state of molecular disaggregation, and to be less intimately united with the iron than before hardening.

As to No. 4, the startling statement that the ultimate strength of steel is very little dependent on its amount of carbon, is explained to refer to the strength as calculated upon the fractured area, not the original area. It is, therefore, equivalent to saying that the contraction of the fractured area in iron or steel is proportional to the diameter of ultimate strength. The author finds that this is the case, both in the various published tables of tensile strength of steel, and in his own experiments. Hence he holds that the contraction of area should be taken as the proper measure of ductility (as is usual on the Continent), and not the elongation. He looks upon hard steel as a metal of a certain strength, having diffused through its mass a greater or less number of particles of a very hard and rigid substance. Hence, as ductility means the power of contracting in area, and extending in length by molecular flow, the ductility will be less as flow is more difficult; and flow will be more difficult as there are more of the rigid crystals in the mass. The apparent strength per unit of original area is thus increased; but the strength per unit of fractured area is usually diminished, probably because the hard sharp crystals tend to cut the metal between them, and produce a sort of tearing action. For these reasons the use of ductile and mild steel, in structures of every kind, is much to be preferred to that of a brittle material, though of a higher apparent tenacity.

A CHAPTER IN THE HISTORY OF CONIFERÆ

THE ABIETINEÆ

THE most recent classification of the *Abietineæ*, and the one that will probably be chiefly adhered to, at least in England, is published in the "Genera Plantarum" of Bentham and Hooker, 1880. In it *Pinus*, *Cedrus*, *Picea*, *Tsuga*, *Pseudotsuga*, *Abies*, and *Larix*, are recognised as separate genera. The tribe comprises the cedars, larches, firs, pines, and contains some 150 species, and is almost exclusively confined to northern and north temperate regions. The genera are all cone-bearing, and with few exceptions produce winged samaroid seeds. No definite remains are known of earlier age than Jurassic, but with the Wealden and Cretaceous they become plentiful, and already in the Neocomian and Gault the ancestors of several existing genera were completely differentiated.

Pinus, Linn.—The cones in this genus vary from the size of a walnut to a length of 19 inches, or possibly even more. The scales are woody and persistent, and closed until the seeds are ripened, when they gape widely. The seeds are in pairs under each scale, and, with few exceptions, winged. The leaves are acicular, and in some cases very long, and are sheathed in bundles of two, three, or five. Nearly all classifications are mainly founded on the number of leaves that occur in a fasciculus, but this character is rejected in the "Genera Plantarum" as inconstant. Two natural divisions are, however admitted—*Pinaster* and *Strobus*.

The former and larger division is distinguished by the scales being very closely adpressed before shedding the seeds, and by their quadrate, umbonate, or elongate, conical heads. The *Strobus* section is comparatively small, and has elongated, often pointed cones, with hard and rigid, yet scarcely woody, loosely imbricated scales, thicker centrally than at the margins, and terminating in a minute or obsolete umbo. Cones of *P. strobus* and *P. excelsa*, representing this section, may be picked up in most botanical gardens, while the *Pinaster* section comprises all the pines commonly grown in plantations.

Besides the "Genera Plantarum," many excellent accounts of the tribe have recently been published. Among these are Gordon's "Pinetum" (1880), Veitch's "Manual of the Coniferæ" (1881), Dr. Maxwell Masters' "Coniferæ of Japan" (*Linn. Trans.* 1881), and an exquisitely illustrated essay on the "Coniferous Forests of the Sierra Nevada," in *Scribner's Magazine*, also in 1881.

Of the *Pinaster* division seventy-seven fossil species were enumerated by Schimper; none, however, are definitely assigned to the group from deposits older than the Eocene of Aix, and most are from the upper Miocene, and even later deposits. The oldest forms are from Solenhofen, and the Gault of Hainault is said to contain connecting-links between the two sections.

Of the *Strobus* division twenty species are enumerated, the oldest being from the Komeschichten of Greenland; but there are a number of additional species which cannot well be grouped in either section.

In England no cones are known that can be referred to Pinus, as now restricted, from rocks older than the Purbeck, but their number gradually increases until the close of the Tertiaries.