in which this sense appears to be present. It is popularly believed to occur in members of at least two orders of Insects, viz. white ants and bees, but I am not aware that any authentic cases have been recorded. Horses and cats seem to possess it in a high degree, and sheep must either have wonderful memories, or owe their return, in numerous cases, to the faculty in question. Still more wonderful, if we deny them this faculty, must be the memory of migratory birds, some of which return, after months of absence and over thousands of miles, to the same nests in successive seasons. If we allow them this faculty it is not, from analogy, improbable that migratory mammals and even fishes are likewise endowed with it. The most conspicuous example, however, is perhaps that afforded by carrier pigeons. To take one case: two or three years ago some of these birds were flown from the Crystal Palace to Brussels, and it stands, if I remember correctly, upon the authority of Mr. Tegetmeier, that they arrived within a few minutes of a telegram despatched from the Palace at the moment they were liberated. Now, in this case, even the extravagant supposition sometimes made that carrier pigeons are guided by the sight of their destination is excluded, for, as these birds are not high-flyers, the curvature of the earth between London and Brussels would prevent them from seeing the latter. And, even if we imagine that these particular pigeons occasionally towered to obviate this difficulty, yet the curvature of the intervening clouds would have imposed another quite as effectual.

There is still one important point which has not been noticed during the discussion of this subject. We possess indications that this sense of direction, like other mental capacities, admits of cultivation by exercise, and, indeed, that it may remain altogether latent and useless until thus developed. If these indications represent generalities we have at once an adequate explanation of the apparently capricious manner in which this faculty occurs.* As this communication is already too long, I shall here be brief.

It is, I believe, a recognised doctrine among fanciers that carrier pigeons, however purely bred, must be educated by flying short distances before they can be depended upon for long ones. I remember having myself lost a valuable bird by flying him, for the first time, at a distance of 500 yards from his nest. Although in full view of it he became utterly confused, taking long flights in various directions, and ultimately went straight out to sea.

Here is an analogous case in a mammal:—I kept a terrier, of highly intelligent parentage, enclosed in a yard with high walls from the time of its birth until it was eighteen months old, and then took it out for the first time, along the sea-shore. The experiment elicited several facts of psychological interest, and one of them has bearing upon the present subject. Part of the coast over which we went and returned was rough with large shingle, and the terrier's locomotive power being very limited, it was unable, on the homeward journey, to keep up with my pace. Desiring to see what it would do if left alone, I continued for half a mile, and waited to see it come up. As it did not do so, I returned, and found that the animal had actually reversed its direction and gone fully a quarter of a mile from the place where I had left it. After having been taken out short distances seven or eight times, it was inadvertently lost in a neighbouring wood. Now, it had only been in the wood once before, yet its appreciation of direction had made so great an advance that it returned an hour afterwards. As this terrier never evinced any disposition to track footsteps, I do not think its return was due to scent. Anyhow, in a few weeks it became an inveterate wanderer, roaming over the country far and wide.

GEORGE J. ROMANES

Dunskaith, Ross-shire, July 7

* In connection with these points compare the suggestive remarks of Mr. Darwin, contained in the two concluding paragraphs of his article on Instinct (NATURE, vol. vii. p. 418).

Comte on the Survival of the Fittest

MR. JEVONS called attention some time ago to the desirability of preparing a list of past thinkers and writers who have held, in strength or weakness, the doctrines of Darwin and Spencer. Mr. Darwin has himself named a few of those authors, and Prof. Haeckel has extended the number. Recent communications in NATURE show that the list is as yet incomplete. In reading Comte's "Cours de Philosophie Positive" a few years ago, I was impressed with the general similarity of certain doctrines therein stated with some of Darwin's theories. Referring recently to the 42nd lesson of that course (t. iii.)—"Considerations générales sur la philosophie biotaxique," I find that Comte, in reviewing the Lamarck-Cuvier controversy, says:—

"Toute la célèbre argumentation de Lamarck reposait finalement sur la combinaison générale de ces deux principes incontestable, mais jusqu'ici trop mal circonscrits: 1°, l'aptitude essentielle d'un organisme quelconque, et surtout d'un organisme animal, à se modifier conformément aux circonstances extérieures où il est placé, et qui sollicitent l'exercise predominant de tel organe spécial, correspondant à telle faculte devenue plus nécessaire; 2°, la tendance, non moins certaine, á fixer dans les races, par la seule transmission héréditaire, les modifications d'abord directes et individuelles, de manière à les augmenter graduellement á chaque génération nouvelle, si l'action du milieu ambiant persévère identiquement. On conçoit sans peine, en effet, que, si cette double propriété pouvait être admise d'une manière rigoureusement indéfinie, tous les organismes pourraient être envisagés comme ayant être, à la longue, successivement produits les uns par les autres, du moins en disposant de la nature, de l'intensité, et de la durée des influences extérieures avec cette prodigalite illimitée qui en coûtant aucun effort à la naïve imagination de Lamarck." (1st ed. "Cours de Philosophie Positive," t. iii. pp. 560 and 561.)

Modification and heredity are here strongly asserted, and the conditions of unlimited transformation as strongly sketched. In continuance of the same argument, Comte, on p. 563, objects to Lamarck's hypothesis, of which he thought very highly as a logical effort:—

"Qu'il repose, ce me semble, sur une notion profondément erronée de la nature générale de l'organisme vivant. Sans doute, chaque organisme determiné est en relation nécessaire avec une système egalement déterminé de circonstances extérieures, comme je l'ai établi dans la quarantième leçon. Mais il n'en résulte nullement que la première de ces deux forces co-relatives ait dû être produite par la seconde, pas plus qu'elle n'a pu la produire: il s'agit seulement d'un équilibre mutuel entre deux puissances hétérogènes et indépendantes. Si l'on concoit que tous les organismes possibles soient successivement places, pendant un temps convenable, dans tous les milieux imaginables, la plupart de ces organismes finiront, de toute nécessite, par disparaître, pour ne laisser subsister, que ceux qui pouvaient satisfaire aux lois générales de cet équilibre fondemental; *c'est probablement d'après une suite d'éliminations analogues que l'harmonie biologique a dû s'établir peu à peu sur notre planète, où nous la voyons encore, en effet, se modifier sans cesse d'une manière semblable.* Or, la notion d'un tel équilibre général deviendrait inintelligible et même contradictoire, si l'organisme était supposé modifiable a l'infini sous l'influence suprême du milieu ambiant, sans avoir aucune impulsion propre et indestructible."

The struggle for existence and the survival of the fittest or natural selection are here acknowledged. What is more, the fact that the eliminations due to unfitness for the environment or medium have produced and is producing biological harmony, is pointed out. I have not met with any passages outside of the writings of the new school, which are more explicit than these, though it must not be understood that their author was a transformationist. The preface to the volume in which this occurs is dated "Paris, le 24 Février, 1838." In his general table appended to the sixth volume of his work, Comte says that the Leçon from which these extracts are taken was written between the 9th and 15th of August, 1836.

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New York

The Glacial Period

CAN you inform me if anyone has suggested the following explanation of the existence of the glacial period? And is the explanation I am about to offer a possible one? I put the question in all diffidence, for I have not carefully studied the theory of heat: you must therefore regard any utterance of mine on the subject as merely "a random arrow from the brain." Well, then, it seems to me that the quantity of heat given out in a unit of time from a unit of surface of an intensely heated globe, such as the sun, does not follow the law of radiation of bodies moderately heated. What I mean is this:—It is quite possible that at a time when the sun's mean temperature was higher than it is now, his rate of radiation might have been less; the quantity of heat emitted by him in a unit of time less than it is now. For since his chromosphere must have been thicker, and his solid or fluid nucleus somewhat less in diameter, I suppose that the radiation of the nucleus must have been more retarded by the