This amount of work exceeds the work done by the muscles during a boat-race (as already stated) in the proportion of 20 to 15, or of 4 to 3.

3. There is yet another mode of stating the wonderful energy of the human heart. Let us suppose that the heart expends its entire force in lifting its own weight vertically; then the total height through which it could lift itself in one hour is thus found, by reducing the daily work done in foot-tons (124·208) to the hourly work done in foot-ounces, and dividing the result by the weight of the heart in ounces:—

Height through which the human heart could raise its own weight in one hour $= \frac{124{\cdot}208 \times 2240 \times 16}{24 \times 9{\cdot}39} = 19754$ ft.

An active pedestrian can climb from Zermatt to the top of Mont Rosa, 9,000 feet, in nine hours; or can lift his own body at the rate of 1,000 feet per hour, which is only one-twentieth part of the energy of the heart.

When the railway was constructed from Trieste to Vienna, a prize was offered for the locomotive Alp engine that could lift its own weight through the greatest height in one hour. The prize locomotive was the "Bavaria," which lifted herself through 2,700 feet in one hour; the greatest feat as yet accomplished on steep gradients. This result, remarkable as it is, reaches only one-eighth part of the energy of the human heart.

From whatever mechanical point of view, therefore, we regard the human heart, it is entitled to be considered as the most wonderful mechanism we are acquainted with. Its energy equals one-third of the total daily force of all the muscles of a strong man; it exceeds by one-third the labour of the muscles in a boat-race, estimated by equal weights of muscle; and it is twenty times the force of the muscles used in climbing, and eight times the force of the most powerful engine invented as yet by the art of man.

No reflecting mind can avoid recognising in its perfection, and regarding with reverential awe, the Divine skill that has constructed it.

SAMUEL HAUGHTON

THE SCIENCE OF LANGUAGE

Darwinism tested by the Science of Language. Translated from the German of Professor August Schleicher, by Dr. Alex. V. W. Bikkers. (London: J. C. Hotten, 1869.)

IT is not very creditable to the students of the Science of Language that there should have been among them so much wrangling as to whether that science is to be treated as one of the natural or as one of the historical sciences. They, if any one, ought to have seen that they were playing with language, or rather that language was playing with them, and that unless a proper definition is first given of what is meant by nature and by natural science, the pleading for and against the admission of the science of language to the circle of the natural sciences may be carried on *ad infinitum*. It is, of course, open to anybody so to define the meaning of nature as to exclude human nature, and so to narrow the sphere of the natural sciences as to leave no place for the science of language. It is possible also so to interpret the meaning of growth that it becomes inapplicable alike to the gradual formation of the earth's crust, and to the slow accumulation of the *humus* of language. Let the definitions of these terms be plainly laid down, and the controversy, if it will not cease at once, will at all events become more fruitful. It will then turn on the legitimate definition of such terms as nature and mind, necessity and free-will, and it will have to be determined by philosophers rather than by scholars.

Unless appearances deceive us, it is not the tendency of modern philosophy to isolate human nature and to separate it by impassable barriers from nature at large, but rather to discover the bridges which lead from one bank to the other, and to lay bare the hidden foundations which, deep beneath the surface, connect the two opposite shores. It is, in fact, easy to see that the old mediæval discussions on necessity and free-will are turning up again in our own time, though slightly disguised, in the discussions on the proper place which man holds in the realm of nature; nay, that the same antinomies have been at the root of the controversy from the days when Greek philosophers maintained that language existed either φύσει or θέσει, to our own days, when scholars range themselves in two hostile camps, claiming for the Science of Language a place either among the physical or the historical branches of knowledge.

It is by supplying a new point of view for the consideration of these world-old problems, that Darwin's book "On the Origin of Species" has exercised an influence far beyond the sphere for which it was originally intended. The two technical terms of "Natural Selection" and "Struggle for Life," which are in reality but two aspects of the same process, are the very categories which were wanted to enable us to grasp by one effort of thought the reciprocal action of the one on the many and of the many on the one; the mutual dependence of individuals, species, and genus; or, from another point of view, the inevitable limitation of spontaneous action by the controlling influences of social life. I may be allowed to repeat what I said on a former occasion:—"Who has thought about the changes which are brought about, apparently by the exertions of individuals, but for the accomplishment of which, nevertheless, individual exertions would seem to be totally unavailing, without feeling the want of a word—that is to say, in reality, of an idea—to comprehend the influence of individuals on the world at large, and of the world at large on individuals; an idea that should explain the failure of Huss in reforming the Church, and the success of Luther; the defeat of Pitt in carrying parliamentary reform, and the success of Russell? How are we to express that historical process in which the individual seems to be a free agent, and yet is the slave of the masses whom he wants to influence; in which the masses seem irresistible, and are yet swayed by the pen of an unknown writer? Or, to descend to smaller matters, how does a poet become popular? How does a new style of art or architecture prevail? How, again, does fashion change?—how does what seemed absurd last year become recognised in this, and what is admired in this become ridiculous in the next season? Or take language itself. How is it that a new word, such as 'to shunt,' or a new pronunciation, such as '*gold*' instead of '*goold*,' is sometimes accepted, while at other times the last words newly coined or newly revived by our best writers are completely ignored or fall dead? We want an idea that is to exclude caprice as well as necessity—that

is, to include individual exertion as well as general co-operation—an idea applicable neither to the unconscious building of bees, nor to the conscious architecture of human beings, yet combining within itself both these operations, and raising them to a new and higher conception. You will guess both the idea and the word, if I add that it is likewise to explain the extinction of fossil kingdoms and the origin of new species:—it is the idea of 'Natural Selection' that was wanted, and being wanted it was found, and being found it was named. It is a new category, a new engine of thought; and if naturalists are proud to affix their names to a new species which they discover, Mr. Darwin may be prouder, for his name will remain affixed to a new idea, to a new genus of thought." *

Professor Schleicher, whose recent death has left a gap in the ranks of the students of language which it will be difficult to fill, has written down the impressions which he, as a comparative philologist, received from a perusal of Mr. Darwin's work, in a letter addressed to his distinguished colleague, Professor Haeckel, of Jena. It is but a slight sketch, and it would not be fair if the English public took the measure of Professor Schleicher's powers from the translation of his pamphlet which has just been published by Dr. Bikkers, under the somewhat inappropriate title of "Darwinism tested by the Science of Language." Professor Schleicher could hardly have thought that the truth or falsehood of Mr. Darwin's theories depended on any test that can be applied to them by the Science of Language. But he thinks rightly that the genesis of species, as explained by Mr. Darwin, receives a striking illustration in the genealogical system of languages, and particularly of the Aryan and Semitic languages; and he very properly calls attention to the fact, that as this ramification of human speech took place within what may be called, if not historical, at least post-tertiary times, it may be useful as a kind of confirmation of Mr. Darwin's theory, which postulates a similar process in far more distant periods of the world's history. "We observe," he says, "during historical periods how species and genera of speech disappear, and how others extend themselves at the expense of the dead. I only remind you, by way of illustration, of the spread of the Indo-Germanic family, and the decay of the American languages. In the earlier times, when languages were still spoken by comparatively weak populations, this dying-out of forms of speech was, no doubt, of much more frequent occurrence, and, as the idioms of a higher organisation must have existed for a very long time, it follows that the pre-historic period in the life of speech must have been a much longer one than that which falls within the limits of historical record. . . . . It is very possible that many more species of speech perished during the course of that time than the number of those which have prolonged their existence up to the present day. This explains the possibility of so great an extension as, for instance, that of the Indo-Germanic, the Finnic, the Malay, and South African families, which, over a large territory, branched off into such a multitude of directions. A similar process is assumed by Mr. Darwin with regard to the animal and vegetable creation; that is, what he calls 'the struggle for life.' A multitude of organic forms had to perish in the struggle in order to make room for comparatively few favoured races."

Although this struggle for life among separate languages exhibits some analogy with the struggle for life among the more or less favoured species in the animal and vegetable kingdoms, there is this important difference that the defect and the gradual extinction of languages depend frequently on external causes, *i.e.* not on the weakness of the languages themselves, but on the weakness, physical, moral, or political, of those who speak them. A much more striking analogy, therefore, than the struggle for life among separate languages, is the struggle for life among words and grammatical forms which is constantly going on in each language. Here the better, the shorter, the easier forms are constantly gaining the upper hand, and they really owe their success to their own inherent virtue. Here, if anywhere, we can learn that what is called the process of natural selection, is at the same time, from a higher point of view, a process of rational elimination; for what seems at first sight mere accident in the dropping of old and the rising of new words, can be shown in most cases to be due to intelligible and generally valid reasons. Sometimes these reasons are purely phonetic, and those words and forms are seen to prevail which give the least trouble to the organs of pronunciation. At other times the causes are more remote. We see how certain forms of grammar which require little reflection, acquire for that very reason a decided numerical preponderance; become, in fact, what are called regular forms, while the other forms, generally the more primitive and more legitimate, dwindle away to a small minority, and are treated at last as exceptional and irregular. In the so-called dialectic growth of languages we see the struggle for life in full play, and though we cannot in every instance explain the causes of victory and defeat, we still perceive, as a general rule, that those words and those forms carry the day which for the time being seem best to answer their purpose. Why did the French use *maison*, i.e. mansion, for house? Because *casa* having dwindled down to *chez* was not sufficiently distinct in pronunciation, and because *domus* being frequently used for ecclesiastical buildings, was no longer sufficiently precise in its meaning, if applied to an ordinary house. Why do verbs in *ir*, like *finir*, form the plural *nous finissons*, instead of *nous finons?* Because the example which was set in Latin by the early formation of so-called inchoative verbs, like *durescere*, *florescere*, *implescere*, *gemiscere*, proved attractive, partly on account of its removing any doubts on the exact terminations of a verb, partly because of its giving a fuller body to monosyllabic verbs. Thus *finiscere* was substituted for *finire* in all tenses but the infinitive, the perfect, the future, and the conditional; and while this new species, the so-called second conjugation, was gradually being established, a few scattered remnants only survived of the former race, fossilised, petrified, or, as they are called in grammatical parlance, irregular, such as *nous venons* from *venir*, *nous partons* from *partir*, &c.

There is one point on which Professor Schleicher seems to have misapprehended the meaning of Mr. Darwin. According to him, the different species of the Aryan as well as of the Semitic languages presuppose each a typical language from which they are genealogically

* "Lectures on the Science of Language." Second Series. Second Edition, p. 309.

derived. There was, according to him, an ancient Aryan language, not only perfect and complete in itself, but so constituted that it contained the germs of everything which we find in Sanskrit, Greek, Latin, German, Celtic, and Slavonic. Such a language may no doubt be constructed theoretically, in the same manner as out of French, Italian, Spanish, and Portuguese, some kind of Latin language might be reconstructed. But such Latin would be very different from real Latin. Historically the admission of type-languages is perfectly impossible. No one would think of deriving the ancient Greek dialects from one actually existing common language containing within itself the germs of every dialect. No one could realise a language which should be at the same time both High and Low, and yet neither High nor Low German. What kind of language could the primitive Celtic have been, if it had to combine the peculiarities of the Gadhelic and the Cymric branches? How could a common Italian language have existed, if it had to maintain and to neutralise the distinctive features of Oscan, Latin, or Umbrian speech? What applies to the dialects of each language, applies with the same force to all these languages in common, when considered themselves as dialects of Aryan speech. As we cannot derive the Greek dialects from a presupposed primitive κοινή, we should not attempt to derive the great dialects—viz. Greek, Latin, Celtic, Teutonic, and Slavonic—from a presupposed primitive Palæo-Aryan type of speech. In tracing the origin of species, whether among plants or animals, we do not begin with one perfect type of which all succeeding forms are simply modifications, but we begin with an infinite variety of attempts, out of which by the slow but incessant progress of natural selection, more and more perfect types are gradually elaborated, some of which are still further improved by artificial domestication. It is the same with languages. The natural state of language consists in unlimited dialectic variety, out of which, by incessant weeding, more and more definite forms of languages are selected, till at last by literary cultivation those highly elaborated classical languages are produced which, in spite of their beauty, are nevertheless abnormal and unnatural, and invariably die without leaving any offspring. New languages do not spring from classical parents, but draw their life and vigour from the spoken rustic and vulgar dialects. No reader of Mr. Darwin's books can fail to see that an analogous process pervades the growth of a new species of language, and of new species of animal and vegetable life. But these analogies should not be carried too far. At all events we should never allow ourselves to forget that, if we speak of languages as natural productions, and of the science of language as one of the natural sciences, what we chiefly wish to say is, that languages are not produced by the free-will of individuals, and that if they are works of art, they are works of what may be called a natural or unconscious art—an art in which the individual, though he is the agent, is not a free agent, but checked and governed from the very first breath of speech by the implied co-operation of those to whom his language is addressed, and without whose acceptance language, not being understood, would cease to be language.

There are other spheres of mental activity to which the same remark applies, but to none so much as to language. It might be said, and it has been said by high authorities, that neither in framing his codes of law, nor in settling the rules of morality, nor in believing the truths of religion, is man an entirely free agent, but that the freedom of the individual is necessarily limited by the pressure exercised by all upon all, and by the circumstances and conditions of the age in which we live. It is true, also, that the science of psychology, which forms the basis of juridical, ethical, and religious science, is imperfect unless it has its foundations in physiology. "La tendance de la physiologie moderne," as M. Claude Bernard remarks, "est donc bien caractérisée ; elle veut expliquer les autres phénomènes intellectuels au même titre que tous les autres phénomènes de la vie ; et si elle reconnait avec raison qu'il y a des lacunes plus considérables dans nos connaissances relativement aux mécanismes fonctionnels de l'intelligence, elle n'admet pas pour cela que les mécanismes soient par leur nature ni plus ni moins accessibles à notre investigation que ceux de tous les autres actes vitaux ?"

But in none of these spheres of mental activity is the freedom of the individual so completely absorbed, and all but annihilated, as in the sphere of language. Not only are the first impulses of language purely physical ; not only is the material of language entirely dependent on the physical organs, such as they are ; not only does the activity of the functional nervous centre of speech become quickly habitual, automatic, and almost instinctive, but even in its purely mental aspect, language rests from the very first on an unconscious compromise. Speech in its very nature is mutual : even a mere exclamation is nothing unless it is understood. Even now we do not speak to others as we should speak to ourselves, but speak their language rather than our own. So it was, only in an infinitely higher degree, in the first formation of speech. If we represent the individual speaker by ^{1}, and the unlimited number of his fellow-creatures by x, the conscious freedom of action which can be claimed for any individual speaker may be expressed by $^1/x$, a quantity oscillating between one divided by one, and one divided by infinity. With every generation this x becomes larger and larger, because it includes not only the present, but the more powerful influence of the past, till at last use and habit exercise the power of a tyrant,

"Quem penes arbitrium est et jus et norma loquendi,"

and whose behests we can no more think of disobeying than the laws of nature.

It is but fair to state, in conclusion, that the first suggestion of the necessity of admitting some of the so-called moral sciences to the circle of the natural sciences came, not from the students of psychology and glossology, but from the historian of the inductive sciences, who saw that the old definition of natural science was becoming too narrow, and that with a new definition the circle of physical knowledge had necessarily to be widened. Dr. Whewell wrote in 1845 :—"We have seen that biology leads us to psychology, if we choose to follow the path ; and thus the passage from the material to the immaterial has already unfolded itself at one point ; and we now perceive that there are several large provinces of speculation which concern subjects belonging to man's immaterial nature, and which are governed by the same laws as sciences altogether physical.

It is not our business to dwell on the prospects which our philosophy thus opens to our contemplation; but we may allow ourselves, in this last stage of our pilgrimage among the foundations of the physical sciences, to be cheered and animated by the ray that thus beams upon us, however dimly, from a higher and brighter region."

MAX MULLER

THE UNIVERSE

The Universe; or, the Infinitely Great and the Infinitely Little. By F. A. Pouchet, M.D., &c. Pp. 790, 343 engravings, 4 coloured plates. (London: Blackie and Son.)

"WHAT a charming title!" was the thought which first came to us when we saw the announcement of this splendid book. "What a terrible title!" was the thought which swiftly followed. Is it a message from some modern prophet to a people, who, having eyes, see not, and having ears, hear not; imploring them to take heed to the tale written in every character in all space, and chanted in every note by every atom, so long and so often in vain? Will it tell us of the signs written in lines of light and lines of black, which have been travelling earthward from the outermost space since the oldest time, till now unnoticed and unread? Will it speak of the oozy mother of living things, which lies and creeps and grows over the whole bottom of the ocean's depths, and comes and goes in every little stagnant pool and slimy puddle? Will it teach us of the quivering flight of atoms in every fire that burns on earth, and in the flaming ministers which rush through illimitable space; of the fairy chains which are welded when the chamber window is sculptured with the frost, and which hold in bonds the elements of the salt that is spilt; and of the giant chains which curb the comets and bind the invisible stars to us? Will it make us to know the great pulsations which shake the earth, and the little throbs which stir the tiny cells of every thing which lives and dies?

All notions of this kind were scattered to the winds when the volume came into our hands. The prophets of old were clothed in sackcloth and ashes, and those of to-day go about in black, mourning for the sins of the people; but this work is resplendent in purple and gold—a very Dives among books. And every anticipation of a prophetic wail died away when we found that the author was a Frenchman.

It is just such a work as might be expected from a nimble-witted gyrating Gaul, a sort of *petit maitre* of

NEPTUNE'S CUP (*Raphidophora latera*)

PITCHER PLANT (*Nepenthes distillatoria*, Linn.)