expect many such readers, but one feels all the more grateful if one does find them. Mr. Romanes was at home in the whole subject, and with him what I endeavoured to prove by linguistic evidence—namely, that concepts are altogether impossible without names—formed part of the very A B C of his psychological creed. He is indeed almost too sanguine when he says that concerning this truth no difference of opinion is likely to arise. The columns of NATURE and the opinions quoted in my book tell a different tale. But for all that, I am as strongly convinced as he can be that no one who has once understood the true nature of words and concepts can possibly hold a different opinion from that which he holds as well as I.

It seems, therefore, all the more strange to me that Mr. Romanes should have suspected me of holding the opinion that we cannot think without pronouncing or silently rehearsing our thought-words. It is difficult to guard against misapprehensions which one can hardly realize. Without appealing, as he does, to sudden aphasia, how could I hold pronunciation necessary for thought when I am perfectly silent while I am writing and while I am reading? How could I believe in the necessity of a silent rehearsing of words when one such word as "therefore" may imply hundreds of words or pages, the rehearsing of which would require hours and days? Surely, as our memory enables us to see without eyes and to hear without ears, the same persistence of force allows us to speak without uttering words. Only, as we cannot remember or imagine without having first seen or heard something to remember, neither can we inwardly speak without having first named something that we can remember. There is an algebra of language far more wonderful than the algebra of mathematics. Mr. Romanes calls that algebra "ideation," a dangerous word, unless we first define its meaning and lay bare its substance. I call the same process addition and subtraction of half-vanished words, or, to use Hegel's terminology, *aufgehobene Worte;* and I still hold, as I said in my book, that it would be difficult to invent a better expression for thinking than that of the lowest barbarians, "speaking in the stomach." Thinking is nothing but speaking *minus* words. We do not begin with thinking or *ideation*, and then proceed to speaking, but we begin with naming. and then by a constant process of addition and subtraction, of widening and abbreviating, we arrive at what I call thought. Everybody admits that we cannot count—that is to say, add and subtract—unless we have first framed our numerals. Why should people hesitate to admit that we cannot possibly think, unless we have first framed our words? Did the Duke of Argyll mean this when he said that language seemed to him necessary for *the progress of thought*, but not at all for the mere act of thinking? How words are framed, the science of language has taught us; how they are reduced to mere shadows, to signs of signs, apparently to mere nothings, the science of thought will have to explain far more fully than I have been able to do. Mr. Romanes remarks that it is a pity that I should attempt to defend such a position as that chess cannot be played unless the player "deals all the time with thought-words and word-thoughts." I pity myself indeed that my language should be liable to such misapprehension. I thought that to move a "castle" according to the character and the rules originally assigned to it was to deal with a word-thought or thought-word. What is "castle" in chess, if not a word-thought or thought-word? I did not use the verb "to deal" in the sense of pronouncing, or rehearsing, or defining, but of handling or moving according to understood rules. That this dealing might become a mere habit I pointed out myself, and tried to illustrate by the even more wonderful playing of music. But, however automatic and almost unconscious such habits may become, we have only to make a wrong move with the "castle" and at once our antagonist will appeal to the original meaning of that thought-word, and remind as that we can move it in one direction only, but not in another. In the same manner, when Mr. Romanes takes me to task because I said that "no one truly thinks who does not speak, and that no one truly speaks who does not think," he had only to lay the accent on *truly*, and he would have understood what I meant—namely, that in the true sense of these words, as defined by myself, no one thinks who does not directly or indirectly speak, and that no one can be said to speak who does not at the same time think. We cannot be too charitable in the interpretation of language, and I often feel that I must claim that charity more than most writers in English. Still, I am always glad if such opponents as Mr. Romanes or Mr. F. Galton give me an opportunity of explaining more fully what I mean. We shall thus, I believe, arrive at the conviction that men who honestly care for truth, and for the progress of truth, must in the end arrive at the same conclusions, though they may express them each in his own dialect. That is the true meaning of the old dialectic process, to reason out things by words more and more adequate to their purpose. In that sense it is true also that no truth is entirely new, and that all we can aim at in philosophy is to find new and better expressions for old truths. The poet, as Mr. A. Grenfell has pointed out in his letter to NATURE (June 23, p. 173), often perceives and imagines what others have not yet conceived or named. In that sense I gladly call myself the interpreter of Wordsworth's prophecy, that "the word is not the dress of thought, but its very incarnation."

F. MAX MÜLLER.

The Molt, Salcombe, July 4.

ON THE PRESENCE OF BACTERIA IN THE LYMPH, ETC., OF LIVING FISH AND OTHER VERTEBRATES.[1]

I FIRST noticed bacteria in the blood of a roach (*Leuciscus rutilus*). This roach, for some hours before it was removed from the water, had been occasionally swimming on its side at the surface—an indication that it was in an exhausted condition. Immediately after the fish was killed, a drop of blood was taken from the heart by a sterilized pipette (with all the necessary precautions) and examined. The blood was found to contain a considerable number of slender motionless bacilli, measuring from 0·003-0·008 micromillimetres in length. On an average, four bacilli were visible in the field at a time, with Zeiss's F objective and No. 1 eye-piece. The peritoneal fluid which was next examined contained so many bacilli that it was impossible to count them; the bacilli were usually lying amongst large granular lymph-cells, and they were longer and more slender than those in the blood. Similar bacilli were found in the lymphatics, spleen, liver, and kidney, and they were abundant in the muscles in contact with the peritoneum, while very few were found in the muscles under the skin of the trunk, and still fewer in the muscles near the tail. The intestine was crowded with similar bacilli to those found in the body-cavity, and, in addition, there were a number of large and small bacteria and micrococci. Bacilli also were found in the walls of the intestine and in the bile-duct. Believing that there was some relation between the diminished vitality of the above roach and the numerous bacilli in the tissues, I examined a considerable number of healthy roach in the same way, and also other fresh-water fish, *e.g.* trout (*Salmo levenensis*), perch (*Perca fluviatilis*), carp (*Cyprinus auratus*), and eels (*Anguilla vulgaris*). In all the healthy specimens examined, with the exception of the trout, bacilli were found in the

[1] Abstract of Paper by Prof. J. C. Ewart, read before the Edinburgh Royal Society on June 6.

body-cavity. Bacilli were also present in the blood of the carp, and on one occasion four bacilli were detected in a drop of blood from what appeared to be a healthy roach. In some the peritoneal fluid contained numerous bacilli, while in others only a few were visible; generally there was a relation between the number in the body-cavity and the number in the intestine, and they were most abundant in fish which had lived for some time in aquaria without food; but in trout which had been fasting for at least ten days, no bacilli could be observed in the peritoneal fluid. The carp which had bacilli in their blood had been living for some months in a small glass aquarium.

The difference between the roach first examined and those examined subsequently led me to endeavour to ascertain whether a sudden change of temperature would produce any influence in the number and distribution of the bacilli. As I anticipated, a rapid change from a spring to a summer temperature (from 48° to 65° F.) greatly diminished the vitality of all the fish experimented with, except the carp; and, as the fish became more and more exhausted, the bacilli gradually increased. If the temperature was raised from 48° F. to 65° F. in two hours, the bacilli of the peritoneal fluid not only increased in the roach, perch, carp, and eel, but they made their appearance in considerable numbers in the body-cavity of the trout, and on one occasion a number of small bacilli were found in the blood of a trout. Although the carp seemed to enjoy the rise of temperature, they were not exempt from the increase of the bacteria in the blood as well as in the peritoneal fluid. In some specimens of blood as many as eight short slender bacilli were visible in the field of the microscope at one time, and the peritoneal fluid in some instances swarmed with long and short bacilli, some of which were motile.

The above observations were confirmed by cultivations in gelatine agar-agar, and in infusions of fish-muscles. In healthy active specimens of the roach and perch, cultivations were easily obtained of the peritoneal bacilli, and generally also from the muscular fibres lying near the peritoneum, but in no instance did I succeed in obtaining cultivations when the blood, or the muscles from immediately under the skin, were used for infecting the culture-media.

Of the sea fish examined I have found bacilli—sometimes long and slender, sometimes short and thick—in the peritoneal fluid and blood of the whiting (*Gadus merlangus*), haddock (*Gadus æglefinus*), cod (*Gadus morrhua*), herring (*Clupea harengus*); and in the peritoneal fluid only of the flounder (*Platessa flessus*), plaice (*Platessa vulgaris*), and lumpsucker (*Cyclopterus lumpus*). I have not hitherto succeeded in demonstrating the existence of bacteria in either the peritoneal fluid or blood of the skate (*Raia batis*), dogfish (*Acanthias vulgaris*), or fishing frog (*Lophius piscatorius*).

There can be no doubt that the bacteria enter the body-cavity by penetrating the walls of the intestine; neither can there be any doubt that, having once established themselves in the peritoneal fluid, they do their utmost to find their way into the blood and tissues. Notwithstanding the presence of active bacteria in the intestinal canal, and the bile and pancreatic ducts, I have failed to discover either bacilli or micrococci in the body-cavity of either amphibia, reptiles, birds, or mammals, when in a healthy condition. Hence it may be taken for granted that, in the higher vertebrates, under ordinary circumstances, either (1) the walls of the intestine form an effective filter or screen, which prevents the passage of the bacteria into the body-cavity; or (2) that the living cells of the mucous and other layers so act on the bacteria that they are destroyed before they reach the body-cavity; or (3) that the cells of the peritoneal fluid effectively sterilize the bacteria which succeed in entering; or (4) that the bacteria are destroyed as they pass along the lymphatics towards the general circulation. Most fish seem capable of tolerating the presence of one or more kinds of bacteria in the peritoneal fluid, whilst others can even tolerate considerable numbers in their blood. It seems, however, that there is a limit to this toleration; for when the equilibrium is disturbed, when by a change of the surroundings the vitality of the tissues is diminished, the bacteria rapidly increase, and unless the tissues as rapidly recover, the bacteria may directly or indirectly cause death.

From the observations made, it appears that bacteria travel most easily along the lymphatic canals and spaces, the lymph-cells being apparently less able to arrest their progress than the blood-corpuscles.

As to the nature of the bacilli found in fish nothing has hitherto been determined. Olivier and Richet seem to think they are neither specific nor putrefactive. At first I thought they were putrefactive, but not specific. Having made some further experiments, I am now inclined to consider them specific and not putrefactive. It has been asserted by previous writers that bacteria are always present in the living tissues of fish, but this conclusion should be accepted with some reserve. For example, trout, roach, and eels, which were gutted immediately after death, and introduced for a short time into a 5 per cent. solution of phenol, and then transferred into sterilized water, remained unchanged for weeks. When examined, dead bacteria were found on the surface of the skin and in the peritoneal lining of the body-cavity, but no living bacteria could be detected in the muscles, nor did they appear in cultivations into which fragments of muscle had been introduced. As was anticipated, when the fish were placed in ordinary water, putrefaction at once set in. Hence, in the meantime, it may be taken for granted that while bacteria exist in the tissues of some fish even at comparatively low temperatures, they are not always, if ever, present in the tissues of others.

THE PROGRESS OF SCOTCH UNIVERSITIES.

THE following three diagrams are meant to convey an idea of the progress of the Scotch Universities—Edinburgh, Glasgow, Aberdeen, and St. Andrews—in recent

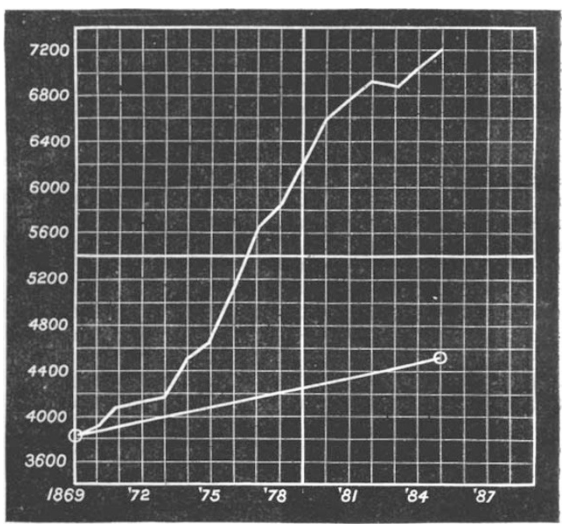

Fig. 1.—Total number of students at the four Scotch Universities (with line of population).

years. The first shows the total number of students each year from 1869 to 1885, and it appears that, with an increase of population of about 18 per cent. in that period, the