around that sun (Aldebaran) in exactly the same way as round our own. We also get some of the iron lines, the lines of sodium, and the lines of hydrogen, calcium, and a few other elements—nine in all. At the base of the diagram you see indications of the elements, with the bright lines of which Mr. Huggins has compared the black lines which you see in the spectrum of these heavenly bodies. By means of the star spectroscope and of the induction coil, Mr. Huggins tested these lines, as Kirchhoff did in the case of the sun, by actually getting the vapour of magnesium visible at the same time in the spectroscope: and thus you see in a moment that there is no difficulty at all in determining their coincidence, you have the two things brought so closely side by side. If I had time I might remark on the presence of some elements here and the absence of others; but there is one remarkable fact about this lower star (*a* Orionis) which I must mention. As far as its spectrum goes, it appears that the gas hydrogen, which is a very important element in our sun's atmosphere, as we gather from the great distinctness of the hydrogen lines in the solar spectrum—and not only in our sun, but in a great many others—is absolutely absent, whilst magnesium, sodium, calcium, &c., are present.

So far, then, you see that this little prism has enabled us to read a great many secrets of the sun and of the more distant stars; and we must acknowledge that Stokes' and Kirchhoff's hypothesis is a very magnificent one, and we can but wish that there were more men like them, who, undismayed by the failure of those who, for nearly a century before their time, had been endeavouring to unravel these secrets, were still prepared to go on, and endeavour to find them out by means of a prism and a simple sodium flame.

Now, astronomers—who, as I told you, from the time of Wilson had imagined that the sunspots were cavities—very soon began to quarrel with this hypothesis of Kirchhoff's, who said that the sunspots, instead of being cavities, were really clouds floating in the atmosphere. They remarked, and I think with truth, that to make such an assertion was altogether opposed to the evidence of the telescope. And I think I may say that the astronomers have now carried the day, for another line of independent research altogether—I mean the researches into the constitution of the sun by means of the spectroscope—has come to the aid of the astronomers, and it looks very much as if we must still hold to the opinion that Wilson in his observations, now more than a century old, was perfectly right, and that Kirchhoff's analysis, as far as it deals with the sun-spots, is susceptible of improvement. In the remarks I made in my former lecture on radiation in connection with the red prominences visible during eclipses, I drew your attention particularly to the hydrogen lines, and told you that the red flames are, for the most part, composed of hydrogen. There the prism comes to our aid in a very remarkable way indeed. It is clear to you, I think, after what I have said about absorption, that the darkening of the sun's surface, which we call a spot, is really a thing about which the prism can tell us a great deal. For instance, take a sun-spot, in which the usual brilliancy of the sun in the other parts of its disc is altogether wanting. There is not only great darkness here and there, but wonderful turnings and twistings and bendings of this solar envelope, which I have already told you Kirchhoff asserts to be a liquid one, but which I think a little consideration of Fig. 50 will show you is more probably gaseous, or cloudy, than liquid. It is obvious, I say, in this case that there was a great probability of the spectroscope being able to tell us something about this absence of light, for an absence of light means one of two things; it means either that there was a defect in radiation, or that there was some excess of absorption, and I may say that this difference—which I hope you now all thoroughly understand—really formed the battle-ground between the English and French astronomers until a few years ago. Long after Kirchhoff's experiment, M. Faye, a distinguished member of the Institute of France, went all over the work again, and declared that the sun-spot was dark, because we there got the light, not from the brightly shining envelope, but from some feebly radiating gas inside the sun; that the sun was a gigantic bubble, the bubble being nothing else than the photosphere—the liquid sphere of Kirchhoff—the interior being composed of gas, glowing at such an enormous temperature that the light we got from it was extremely feeble. You will see in a moment that, if the sun-spot were really due to the radiation from gas, we should get from that sun-spot a selective spectrum, that is to say, a spectrum with bright lines. The English astronomers said: "No; a sun-spot is not due to defective radiation at all; there is something over the bright portion of the sun which eats away the light:" whether the light was eaten away generally—whether, in fact, we had an instance of general or selective absorption—was not stated, but what they did distinctly state was, that the sun-spot was simply an indication of absorption. So that, you see, here was a thing which a spectroscope might settle almost at once, provided always that a good sunspot could be obtained for the experiment. This was done in 1866. Fig. 51 gives an idea of what is seen when we observe a small sunspot, and it is one which is full of meaning. Here is a very clear image of the solar spectrum near the double line D, and also the double D itself. If it were possible to have given you the whole of the sun's spectrum on the same scale as this, it would require an engraving yards in length, but it would be almost impossible to make my meaning clearer than I hope I can do by this small portion; and I must therefore ask you to take for granted that the dark line which you see running along this yellow portion of the spectrum would really run along the whole length of the spectrum, from the extreme red to the extreme violet. This, then, you see in a moment, was an indication of general absorption; that is to say, in the way in which the light is affected by its passage through the prism, we have the problem settled in an instant, that a sunspot is due to general absorption at all events. Further, in observing the spectra of different sunspots, it was found that the spectrum of the middle of the sunspot is much darker than the outside. So that you see this simple experiment tells us not only that the sunspot is due to general absorption, but that there is more general absorption in the middle of the spot than at its edge. This is the way in which this little prism is able to deal with these great problems.

J. NORMAN LOCKYER

(*To be continued.*)

MIND IN THE LOWER ANIMALS

I RECENTLY received a letter from Mons. J. C. Houzeau, the author of the "Études sur les Facultés Mentales des Animaux comparées a celles de l'Homme," published at Mons, Belgium, in 1872, and reviewed by Mr. Wallace in NATURE of October 10, 1872. The latter eminent writer asserts that M. Houzeau's work "contains a mass of curious facts, acute observations, and sound reasoning, which fully entitle its author to take high rank among philosophical naturalists" (p. 471). I quite agree with him in his estimate of M. Houzeau's labours, being disposed to place his two volumes of "Études" on a par with the works of Mr. Darwin; and with another work, which, while little, if at all, known in this country, deserves, nevertheless, the highest consideration at the hands of all interested in comparative psychology—the "Traité de la Folie des Animaux de ses Rapports avec celle de l'Homme," by Dr. Pierquin, published in Paris (in 2 vols.), so long ago as 1839.

I need not say that any suggestions coming from an observer of such experience as M. Houzeau deserve the attention of the now many earnest students of the subject of "Mind in the Lower Animals;" and I therefore make no apology for bringing under the notice of your readers certain remarks contained in the letter aforesaid.

In the first place, M. Houzeau begs to direct attention to "the high importance of sparing—at least for observation—what remains of anthropoid animals in Asia and Africa. It is my deep regret that there are none in the country where I live" (Jamaica); "and that I am thereby deprived of an opportunity to study them. They should be tamed, domesticated, and studied in their own climate—at home. The gorilla, for instance, should be perpetuated in Guinea in domesticity. As I stated in my book, it does not appear impossible that apes might learn to talk. Should the attempt succeed even partially, what would not be the bearing and importance of it physiologically and historically? Could not some means of study be devised in the English colonies? To save the Anthropoids from destruction, and to promote the study of their mental capacity, is worthy surely of the earnest exertions of naturalists."

I quite concur with him as to the desirability of educating by domestication—so far as possible, and studying the results of such education in the anthropoid apes, and indeed the whole group of the Quadrumana. We know what has been the result in the dog of centuries of association with, and training by, man; though even in that familiar animal we do not yet know the extent of his capabilities, because training in certain directions has scarcely been attempted. Man has, for his own ends, directed special attention and effort to the development, in the dog, of his power of scent, swiftness, vision, courage, watchfulness, and other qualities that render him useful in the chase, as a watch-animal, as a companion, and so forth. But no similar persistent efforts have been made to cultivate, for instance, his moral sense—to produce an animal good in a moral point of view—honest, affectionate, benevolent, conscientious, in the highest degree. And yet that it is quite as possible to produce or educe moral greatness or goodness as physical swiftness or muscular strength, I am firmly persuaded. Notwithstanding all that has been said of the superior intelligence of the dog, horse, elephant, ant, and bee, I believe that were as much care bestowed on the training of the moral qualities of many monkeys or apes as is given to the instruction of the pointer or setter, the homing pigeon, piping bullfinch, or talking parrot, or to the training of the race-horse, results of a startling kind would be attained, or would be shown to be attainable. There are certain respects in which apes and monkeys approach more closely to man than do the dog or the other animals just mentioned: they possess potentialities or capabilities of which some of the almost marvellous stories told us by reputable traveller-naturalists give us but a glimpse.

I cannot, however, discuss that or other subjects in comparative psychology here, hoping, as I do, to have fuller and more fitting opportunity in a forthcoming volume of the "International Scientific Series" of Messrs. H. S. King and Co.

M. Houzeau expresses surprise that, at the present day, the belief should be almost universal that, while all races and conditions of man have souls, the best of other animals have none. This is obviously a matter of pure speculation, which I must not now discuss. But I may direct the attention of your readers to a curious book published in Aberdeen in 1824, by Peter Buchan, entitled, "Scriptural and Philosophical Arguments or Cogent Proofs from Reason and Revelation that Brutes have Souls, and that their Souls are Immortal." The work in question is, however, now so rare, that it may be difficult to obtain even a perusal of it. The reader of German literature may also refer to a book on the same subject by Schmarda, to which my attention was called some time ago by the late Professor Day, of St. Andrews.

M. Houzeau animadverts on the anomaly that the persons, from whom we should expect the most valuable evidence regarding the mental acquirements or capacities of the lower animals—those who are habitually and intimately associated with them—drovers and drivers, horsemen and huntsmen, shepherds and sportsmen, jockeys and grooms, butchers, and even veterinarians, are those, on the contrary, in whom we too frequently meet with the strangest ignorance or prejudice. They would seem to be, as a rule, incapable of honestly observing and of making logical inferences from facts observed; instead of using their own eyes and reason, they permit themselves to be blinded and befooled by obsolete tradition or fable.

Notwithstanding the perfectly overwhelming bulk and variety of the literature of comparative psychology—or at least of the data on which it may be founded, there are many points in the mental history of the lower animals that require and admit of elucidation by *observation and experiment*. If any person of ordinary intelligence—either abroad or at home—feels inclined to plead, as an excuse from contributing to the progress of comparative psychology, the want of proper opportunity, I would commend to his consideration the example of M. Houzeau as a noble one of the successful "pursuit of knowledge under difficulties." He modestly describes himself as a traveller-naturalist: and in the letter above referred to thus refers to the circumstances under which he collected the materials for the two bulky volumes of *Études*, that constitute one of the most important contributions yet made to the science of comparative psychology. "It was rather occasionally that my attention was called to the subject of the 'Mental faculties of animals,' having been almost exclusively engaged, previous to my sojourn in America, in astronomical and geographical pursuits. Still the subject was pressed upon me when, in the wildernesses of Texas and Northern Mexico, I had to live in the open air, in the constant company of domestic animals and in close proximity to wild ones; far away," as he says, "from the European field of labour and even from intellectual resources," in a foreign wild land, without the means of literary or scientific reference. Under circumstances, in a word, most unfavourable to such a publication, he has nevertheless produced a work that would do honour to any of our own *savans*, with all the appliances of our large cities, large societies, and large libraries at their command.

W. LAUDER LINDSAY

NOTES

FREE admission to the lectures and courses of practical instruction in Chemistry, Physics, Mechanics, and Biology at South Kensington will be granted to a limited number of Teachers and Students of Science Classes under the Science and Art Department, who intend to become Science Teachers. The selected candidates will also receive a travelling allowance, and a maintenance allowance of 1*l.* 1*s.* per week, while required to be present in London. The course in Chemistry will commence in October, and end in the following June. The course in Biology will commence in October and close in February or March. The course in Physics will commence about February and close in June. The course in Mechanics will probably commence about February and close in June. Students are required to attend from 9 or 10 A.M. to 4 or 5 P.M. daily, in addition to the time required in the evening for writing up their notes, &c. Candidates for these Studentships must send in their applications on Science Form No. 400, copies of which may be obtained on application to the Secretary of the Science and Art Department. For the courses in Biology and in Mechanics some power of drawing is essential, and no candidate will be admitted who cannot show that he has acquired sufficient power.