DR. THOMAS NELSON ANNANDALE'S WORK IN INDIA.

Thomas Nelson Annandale was born in Edinburgh on the 15th of June, 1876 : he was the son of Thomas Annandale, Professor of Clinical Surgery in Edinburgh University, and as he once told me, it was probably in consequence of this and the fact that his father was of such eminence in the Medical Profession that he was able to enlist the services of the very best doctors in the City, that Annandale survived his infancy. He was educated at Rugby, where he rose to be head of the school, and later at Balioll College, Oxford, graduating in 1898. From early life he had a keen desire to travel and while still an undergraduate he paid visits to the Faroe Islands and Iceland. From Oxford he proceeded in 1899 to the Malay Archipelago as a Member of the Skeat Expedition. During this period his chief interest was centred in Anthropology, and with Skeat he tried to contact a small jungle tribe of Pagans but failed to do so, though he was able to photograph their dwelling places and graves. He was, however, also able to make a number of valuable contributions to our Zoological knowledge : in a temple at Ban Nah he noticed that one of the small figures of Buddha that had been deposited there contained a fossil shell, and this clue being carefully followed up led to the discovery of the quarry from which the fossil had been taken. This geological formation proved to be of Cretaceous age and it is noted in the account that " well authenticated finds of fossils in the Malay Peninsula have been of the rarest possible occurrence " He also made a close study of the adaptations to its surroundings of a species of Mantis, *Hymenopus bicornis*, and he took part in dredging in the Inland Sea—a chain of Lakes—partly fresh and partly brackish-water, some 60 miles long and thus commenced his study, in later years one of his most outstanding contributions to our knowledge, of the fauna of the inland lakes of Asia. In 1901 Annandale was appointed to a Research Fellowship in Edinburgh University and he held this appointment till 1904 ; during these three years on more than one occasion he revisited the Malay Peninsula, usually in company with Mr. H. C. Robinson, and his main interest seems still to have been centred on Anthropology ; but his published work in the three volumes of *Fasciculi Malayenses* already showed that great breadth of outlook that later became such a characteristic feature of his Zoological work, for he wrote on pure Ethnography, physical Anthropology, Folk Lore, Religion and Magic. In later years, in spite of the prior claims of Zoology, he continued during his travels in Asia to make observation on Ethnology, while for several years he devoted much of his time on holidays and Sundays, when in Calcutta, to obtaining data for an Anthropological study of the Anglo-Indian population, the results of which were submitted to statistical analysis by Prof. P. C. Mahalonobis, of Calcutta University ; as Annandale pointed out in his Introduction to this series of Reports (published in Vol. XXIII of the *Records of the Indian Museum*, 1922-1940) he admits

to having had doubts as to the value of bodily measurements taken on the living person and, when the opportunity arose, he determined to see whether these doubts were further justified by the investigation of a race known to be of recent origin. Throughout his period of service in India Annandale was very closely associated with the Asiatic Society of Bengal and especially with the Anthropological side of the work of this Society. Almost immediately after his arrival he was appointed Anthropological Secretary to the Society and he continued to hold this appointment, with only an occasional break when he was away on leave or when he was President of the Society, till the time of his death. His first term of office was from 1904 to 1911 and his next from 1915 to 1920. For many years he was a Vice-President of the Society and was elected President in 1923, after which he again became the Anthropological Secretary. The Society showed its appreciation of his work by making him a Fellow of the Society in 1910 and awarding him the Barclay Memorial Medal in 1919.

In 1904 Annandale was appointed to the Staff of the Zoological and Anthropological Section of the Indian Museum under Colonel Alcock, who was the Superintendent, and three years later he succeeded Alcock as Head of the Section. At this time the Section was hopelessly understaffed and Alcock's retirement was very largely due to the fact that he was unable to persuade the Government to increase the number of scientists. Annandale was, however, more fortunate and in 1908 the Staff was increased to four by the appointment of the late Dr. S. W. Kemp, of the Irish Fisheries Department, Dr. F. H. Gravely from Manchester University and Dr. B. L. Chaudhuri : also attached to the Section was the Surgeon-Naturalist to the Marine Survey of India. Annandale was a bachelor and permitted, and indeed encouraged, other scientists and friends to make use of his official quarters in the Museum House as a "Chummery" I was appointed Surgeon-Naturalist in 1910 and first met Annandale in September of that year, when I stayed as his guest in the Museum House for some days before joining the R. I. M. S. "Investigator" in Bombay. Annandale was generous almost to a fault. He used to get seriously perturbed if the credit balance due to him at his bank showed signs of increasing and he would at once cast round to see in what way he could profitably expend his savings, either by undertaking a tour in some distant land or in helping some of his friends. During the 1914-18 war he equipped young Anglo-Indian Officers at his private expense and he used to give a series of short lectures to the troops stationed in Calcutta on some of the Museum Exhibits and at the end entertained his audience to a sumptuous tea.

In 1906 when Annandale became Superintendent of the Indian Museum, touring for the scientific staff had become an obsolete practice, but, although he was the only gazetted officer of the Zoological Section, he persuaded the Trustees to allow him to go on tour, at first surreptitiously and then openly and officially. In the same year he persuaded the Trustees to institute the publication of two Journals, namely the *Records* and *Memoirs of the Indian Museum.* Previous to this the Trustees had published at irregular intervals a series of Monographs, for the most part dealing with the fauna of the deep seas round India

but Annandale realised that a number of shorter papers, published in various Journals and especially in the *Journal and Proceedings of the Asiatic Society of Bengal*, did not receive the attention to which they were entitled from Zoologists in other parts of the world. As a direct result of the institution of these periodicals the Indian Museum was enabled to acquire by exchange the Journals of a large number of Scientific Societies all over the world : in 1920 these numbered 120 and by 1926 the number had increased to 157. As he has himself pointed out, at this time, thanks very largely to the work of Col. Alcock and the R. I. M. S. "Investigator", our knowledge of the fauna of the deep waters of the Bay of Bengal was considerably more advanced than that of the fresh and brackish-waters of the continent itself and he at once set himself to remedy this defect. As a result, in the course of a very few years he had established himself as a recognised expert in several groups of the Animal Kingdom. Most Zoologists are satisfied to be regarded as an expert in a single group. In a country such as India, apart from the study of such "popular" groups as are of interest to the amateur naturalist or the sportsman, such as the Mammals, Birds, Fishes and Butterflies, very little work had been carried out on the fauna ; and anyone who takes up the more obscure groups very quickly realises that most of his time, especially at first, must be devoted to systematic and taxonomic studies, in order to discover what species are present, and only at a later stage is it possible to extend one's researches into Ecology and Geographical Distribution. Annandale commenced his work in India by taking up the study of the fauna of fresh or brackish-water and especially of the Sponges, Polyzoa and *Hydra*, and he very rapidly built up a reputation as an acknowledged expert on these groups, so that by 1909 he had been entrusted with the work of identifying and reporting on collections that had been made by several other Institutions and Expeditions, and he published papers on the Fresh-water Sponges from such widely-separated regions as Japan, New Guinea, the Philippine Islands, Australia, South Africa, North and South America and the Lake of Geneva in Europe.

In 1912 Annandale defined his attitude towards his work as Superintendent of the Zoological and Anthropological Section of the Indian Museum in the following words :—"Since I became Superintendent of the Indian Museum a little more than five years ago it has been my ambition, without neglecting marine work, to do for the study of the fresh-water fauna of India what my predecessor, Col. Alcock, did for the abyssal fauna": so, in addition to his work on the fresh-water Sponges and Polyzoa, he took up the study of the Barnacles, and especially of the stalked Barnacles ; and here again in a few years he had established himself as an expert on this group and his published work includes not only a number of papers on the Indian species but also Reports on Barnacles from the Malaysia, New Zealand, the Gulf of Siam and the Irish Seas.

In 1916 Annandale persuaded the Government of India to promote the Zoological and Anthropological Section of the Indian Museum to the status of the Zoological Survey of India and the Department was thus placed on an equal footing with the Geological and Botanical Surveys. As the late Dr. S. W. Kemp wrote in his Obituary Notice of

Annandale in 1924, " To many the change must have seemed purposeless, for it brought no improvement in the conditions of service of the Staff and no increase in their numbers ; and it was absurd to suppose that any comprehensive survey of the fauna of so vast a territory as the Indian Empire could be effected by a department with only four scientific officers. But Annandale showed himself far-sighted in this, as in many less important administrative matters. He saw the advantages that would ensue if Zoology were given equal recognition with her sister sciences, Geology and Botany: above all, that the change would sweep aside all possibility of restricting the activities of the department (at one time a very real danger) and would establish it firmly as an institution with research as its main object and the entire Empire as its field of work "

In the same year Annandale put forward a scheme for the appointment of Research Assistants to the Zoological Survey and on receiving the sanction of the Government for these appointments he selected Mr. Sunder Lal Hora, now the Director of the Survey, and Mr. Gautam Sondhi, both of whom were M.Sc. graduates of the Punjab University and pupils of Lt. Col. J. Stephenson, who was Professor of Zoology in Government College, Lahore and who had built up a flourishing school of research. Mr. Sondhi only held the appointment for a few months and then had to give up in consequence of ill health and was succeeded by Mr. Amin-ud-Din, also from Government College, Lahore, and an M.Sc. graduate of the Punjab University.

From the inception of their appointment, Annandale intended that these Research Assistants should not function merely as glorified Laboratory Attendants and he encouraged them to undertake independent research: he collaborated with them in working out collections and in writing reports on those groups to which their attention had been assigned, and he was meticulously careful to give full credit for all the work done by these young colleagues. It would be hard to find a better training for Zoological Survey work than participation in one or more tours that were undertaken by Annandale. He was very scornful of those Zoologists who deliberately confined their interests and studies to Taxonomy alone. Adopting a term coined by the American Philosopher, Oliver Wendell Holmes, he remarked in his Presidential Address to the Asiatic Society of Bengal in 1923, " Almost all of us ' learned men ', as we are called, must admit ourselves to be ' Scarabees ', each in his own narrow sphere. But I cannot admit that this is an ideal state of mind, though it be rife in all branches of learning " He took a very wide view of the necessity for including in studies of the fauna of any area, not only the animals themselves but also their ecology and relationships to other animals and plants in the environment, as is clearly indicated in his studies, for example, of the fauna of Barkuda Island in the Chilka Lake, for which he enlisted the help of Officers of the Botanical and Geological Surveys in elucidating the Physiography and Vegetation of the island and of myself in studying the Salinity and Temperature of the surrounding water of the Lake. Annandale's outlook is summed up in his own words, " that Taxonomy is an equal partner with morphology, bionomics and embryology in elucidating the problems of life,

laying a firm path for their progress and consisting not only of the examination of specimens in the laboratory and of reading what has been written but also of the consideration of organisms in relation to other organisms, to evolution, environment and geographical range" This view, he tells us, "has come to me by inheritance as the successor of a long line of broad-minded taxonomists in the Asiatic Society of Bengal and the Indian Museum.. In Calcutta we have always maintained that a taxonomist should be a Zoologist before he is a specialist" and he goes on to point out that " in the Indian Museum with our much smaller staff (than in most other museums) we have the great advantage that when one of us undertakes an important investigation the others know almost as much about it by the time it is finished as the worker himself"

He always insisted on the great importance of field-work and in his Triennial Report for 1917-1920 he writes, " It is impossible to separate Field-work from the more detailed taxonomic work in the Laboratory.. Observations made in the field are as much research as those made in the Laboratory"' He aimed at allowing each officer in the Survey to spend about half the year collecting and observing in the field and the other half in the Laboratories of the Indian Museum. It was also part of his policy that areas that had already been surveyed should subsequently be visited again from time to time in order to check the conclusions that had been arrived at and to carry on investigations on particular points, the importance of which only became evident as the material, which had been collected, is worked out. In 1918 in his Report on the Molluscs of the Inlé Lake (*Rec. Ind. Mus*, XIV) he remarks, " It seems very doubtful whether the peculiar modifications of the shell observed in so many of the aquatic molluscs of the Inlé Lake can have any bearing on the more highly specialised modern theories of evolution, which, even if sound in certain instances, are perhaps of less general application than their rival exponents are willing to admit. None of these theories have been put forward with the same wealth of natural illustration that Darwin gathered together in his *Origin of Species* and it is just as important that observations should be continued in the field on as large a scale as possible and without reference to any one preconceived theory, as that experiments should be conducted in the laboratory or garden-plot with a theory to support"

During his service in India he travelled very widely, visiting different parts of the Indian Empire, and during his periods of leave he extended his travels to far distant lands. In 1912 and again in 1921 he visited Palestine ; in 1916 he toured from the Malay States to China and Japan and in 1921 he visited Morocco. Between 1913 and 1920 he put into effect a wide scheme for the study of the macroscopic fauna of the lakes of Asia. These studies extended from Lake Biwa in Japan, through the Tai Hu in China, the Talé Sap in Siam, the Inlé Lake in Burma, the Chilka Lake in India, and the Hamun-i-Helmand in Persia, to the Lake of Tiberias in Palestine : he divided these lakes into four main types :—

(*a*) Maritime Lakes (Chilka Lake, Talé Sap and Tai Hu)
(*b*) Inland River Basins (Hamun-i-Helmand)
(*c*) Normal Inland Lakes (Lake Biwa and the Lake of Tiberias)
(*d*) Specialised Lakes (The Inlé Lake)

and in each of these Lakes he made a detailed study of the molluscs. Although he had published a few short papers on mollusca in previous years, Annandale's study of this group really began towards the closing period of the 1st World War. Several years earlier, in 1912, he had in a lecture to the Asiatic Society of Bengal put forward the view that " some day the Government of India may be forced to realise that the real problems which a civilised government must tackle are not political problems but sanitary ones. .Some day perhaps the medical profession will also realise, as some of its members already do, that sanitary problems are fundamentally biological and chemical, not medical at all " It was not until the concluding stages of the war that Annandale's suggestion was translated into actual fact. At this time Indian troops who had been serving overseas in Egypt and Mesopotamia were being invalided back suffering from the disease Schistosomiasis, and the Government of India and the Medical Department were seriously perturbed at the possibility of this disease being introduced into India, where it had previously been unknown. The parasite that causes the disease passes a stage of its life history in certain fresh-water mollusca, and it was therefore of the greatest importance to know whether any possible mollusc host existed in this country. They therefore requested Annandale to put his department at their service, and this he did with alacrity and his usual energy. The problem was tackled from several angles ; Annandale himself and Baini Prashad took up the study of the mollusca, in order to discover whether any possible host-species existed in India ; Kemp and Gravely attempted to infect the more common molluscs with the early stages of the parasite, obtained from infected individuals ; and on my return from active service at the beginning of 1919 I was transferred temporarily to the Zoological Survey and carried out investigations into the ' cercaria ' stage of the parasite's development, that lives in the snails, in order to discover what species of allied Trematodes were already present. It was during this period that Annandale investigated the Hamun-i-Helmand in Persia. These investigations enabled Annandale to inform the Government that the results obtained were entirely negative ; there was no known host of this parasite in India, no other mollusc seemed to be capable of harbouring the parasite and, although allied species of Schistosomes were present and infected goats and cattle, the human-infecting species was absent.

A survey of this nature necessarily entailed a close study of the taxonomy and systematics of the Mollusca and so Annandale added this group to the number of those of which he was already an acknowledged expert.

From his faunistic studies Annandale was enabled to put forward evidence that clearly indicated that in any given area the fauna may be the result of changes that have taken place in the geology of the region in times past. In his summary of the origin of the fauna of the Lake of Tiberias he points out that the conspicuous African element consists of Vertebrates, rather than Invertebrates, and, moreover, of Vertebrates that are known to be abnormal in their capacity to resist unfavourable conditions. The origin of the Ethiopian element he attributed to the existence in Pleistocene times of a river flowing southward from the Jordan Valley through the Red Sea and discharging into the Indian

Ocean. The Palaearctic element, he suggests, is of relatively recen origin and most of the species came in either from the east or west ; and he calls attention to the fact that the Nile, while serving as a high-way for certain Ethiopian species, has actually acted as a barrier and has separated some forms living to the west of the delta from those found on the east side. In Seistan, he points out, the majority of the fish can only have reached this region from the watershed of the Hindu Kush, while a minority seem to have come in from the lower areas of Baluchistan : but as regards the aquatic molluscs and the Oligochaetes the origin is more varied and includes a more distinct Indian element. His work on the fresh-water sponges of the Malabar zone showed that the majority of the forms found in this area are either African or else are closely related to African forms ; he further indicated that a relationship, though less definite, exists between the Malabar fauna and that of countries to the east of India, namely Sumatra, the Philippine Islands and even China, and he emphasises that this distribution cannot be attributed to either wind or marine currents and demands a true geographical and geological explanation ; he remarks, " No more satisfactory explanation has as yet been put forward than that of a former land connection between Africa and the Malaysia through Malabar at a period (probably late Cretaceous) when the Western Ghats were much higher than they now are " That even a change in the humidity of the atmosphere may be a more important factor in the distribution of reptiles and insects than actual temperature is suggested by him as an explanation of the presence of a lizard, *Lygosoma sikkimense*, in the eastern Himalayas and on Paresnath Hill : the geological history of this region suggests that this lizard " once lived on the plains as well as, or instead of, in the hills but that a fall in the atmospheric humidity of the former, perhaps due in part to movements of glaciers in the Himalayas, drove it up into the Eastern Himalayas on the one hand and the summit of Paresnath on the other or confined it to comparatively high altitudes " (Annandale : The fauna of Paresnath Hill, *Rec. Ind. Mus.* VI, 1912).

At the time of his death in 1924 Annandale was still occupied with the study of the mollusca, but he had practically concluded his systematic and taxonomic work and had just commenced to write up a summary of his work, in which he proposed to incorporate the whole of his investigations and experience gained during his many tours not only in India but throughout the whole breadth of the Asiatic continent. His method of work was most unusual : he had little or no interest in ordinary social intercourse and when he had finished his day's work in the laboratory he used after dinner in the evening to ascend to the roof of the museum and there walk up and down, thinking over the various problems in which he was interested. Late at night he came down and went to his room, and then sat down and put on paper the results of his contemplations. At times it seemed as though he forgot that he had already done so and when he woke the following morning he would get up and again write them down. After his death the writing table in his room was piled with a series of these rough notes, some of them almost word for word identical. Most unfortunately Annandale's handwriting was at the best of times extremely difficult to decipher and even

those who were best acquainted with it found that it was impossible to make head or tail of a great deal of this material. Both Kemp and I attempted the task but had to abandon it in despair. The loss of these notes is of a magnitude that it is impossible to estimate.

From a study of Annandale's published work and especially from his later papers we are able to see the direction in which his thoughts were shaping. The trend of his work had led him to a consideration of the effect that climate, environment and geographical distribution have had on the evolution of the species. As he himself remarks (Museums and Taxonomy, *The Museum's Journal* Vol. XXI, 1922), " Every new piece of faunistic work I undertake I am more impressed with the need for regarding the taxonomy of the groups I describe, not as a thing apart, but in correlation with the climate, the geographical position and geological formation, the vegetation and the composition of the water of each district surveyed " From his earlier studies of the Fresh-water Porifera and Polyzoa he had showed that the effect of environment might be quite different even in related species of the same genus : he gave evidence to show that in Europe species that occur both in that country and in India have developed different reactions to the climatic conditions. In Europe these animals produce statoblasts, gemmules or resting buds in Autumn, which lie dormant during the winter and develop in the following spring ; but in India in the Bengal area they produce these asexual resting buds at the approach of the hot weather and flourish during the cooler winter season, while others reach their maximum development during the rainy period in July-September and die down during the winter months.

He had a firm belief in the effect of environment on the species through a modification of the germ-plasma : from his studies of the adaptations to local conditions that are present among the fishes and tadpoles of hill streams he concluded, " we have thus evidence that these particular structures (*i.e.* adhesive discs) have come into existence, not through mutation and not by any Mendelian segregation of characters, but through a gradual accumulation of small changes. The close correlation, especially in *Garra*, between these change and differences in the flow of water in which species and even individuals live is at any rate suggestive. Whether we are witnessing the survival of the fittest in the Darwinian sense or must accept a frankly Lamarchian explanation only experiment can prove " (Annandale and Hora : Parallel Evolution in the Fish and Tadpoles of Mountain Torrents, *Rec. Ind. Mus.* XXIV, 1922). Among the Mollusca, Annandale concluded that plasticity is a more common phenomenon than individual variability and that the two are not necessarily connected, but that both are specific characters and may be acquired or be lost in the course of evolution and that the moulding forces or the causes of plasticity of greatest influence are not the same in all species and apparently slight differences in environment are sometimes of greater practical moment than changes which seem to be much greater (Annandale : Aquatic Molluscs of the Inlé Lake and connected waters, *Rec. Ind. Mus.* XIV, 1918). In connection with his studies of the species and varieties of the genera of the Family Viviparidae he remarks, "in certain regions of the earth's surface there is or has been

some influence at work which has produced a similar collective peculiarity in the shells of the Viviparidae on diverse occasions and in different parts of the world. What the influence is or was we do not know. I would hazard the suggestion that it had something to do with a peculiar chemical stimulus in the water which exerted its influence for long periods and from generation to generation, ultimately affecting the germ-plasm as well as the soma of the molluscs " Since the future sculpture of the shell can also be seen in embryonic shells he concludes that, " this would seem to prove at any rate that the sculpture cannot be due merely to the direct effect of the environment on the individual. Once the tendency has been implanted in the race, however, it can have full play only in favourable environment. Details must have been different in the various forms but the conditions in which these forms lived or live would seem to have been more or less parallel ", and he remarks, " My explanation of the phenomena discussed in this paper implies an acceptance of the doctrine of the survival of the fittest and at the same time a firm belief in the inheritance of one kind of acquired character. Mendelism is true in some cases ; some species produce mutations, but gradual changes also take place under the influence of environment and are perpetuated. In some circumstances these changes are utilised and become more strongly developed, in some they produce harmless by-products ; in others the result is harmful and the race perishes. No one formula can express, much less explain, evolution " (Annandale : The Evolution of the Shell-Sculpture in Freshwater Snails of the Family Viviparidae, *Proc. Roy. Soc.*, B, Vol. 96, 1924).

In 1923 the Government of India showed their appreciation of the splendid work that Annandale had been doing during his twenty years of service by conferring on him the honour of C. I. E., and in 1924 his name was on the list of those scientists who had been selected for the honour of being awarded the Fellowship of the Royal Society of London. Unfortunately he did not live to receive this recognition of his work, for he died during the short interval that has to elapse between the selection of the Candidates by the Council of the Society and the actual award of the honour by the Fellows at their subsequent meeting.

Annandale firmly believed that Indians were capable of carrying out Zoological research of the highest standard, if they were given a full and thorough training in the subject, and it is worth noting that after the selection of the two British scientists, Kemp and Gravely, in 1906, all subsequent appointments to the Survey were filled by Indians, for my appointment by the Government to succeed him as Director, in 1925, was not a new appointment to the Survey, since the Surgeon-Naturalist to the Marine Survey of India had been incorporated in the Zoological Survey as an Hon. Assistant Superintendent in 1906 and I had been connected with the Survey since 1910, first as Hon. Assistant Superintendent and later as Officiating Superintendent. That this belief and trust was fully justified has been amply confirmed in the past and I cannot do better in closing this summary of his work than by quoting the words of Dr. S. W. Kemp in his Obituary Notice in 1925, " His name will endure as an inspiration to his successors who will feel

that the memorial he would most have desired is the steady progress of the Institution, which he served with such devotion ".

The Zoological Laboratory,
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