impetus from the work of Johannes Müller. His text-book of physiology was a book which focussed the work of preceding generations for the purpose of pointing out the direction which the work of succeeding generations should take. This, and the subsequent discoveries of Laennec, formed the first scientific basis of medicine. The next step forward was the founding and development of morbid anatomy, going hand in hand with clinical medicine; in fact, any further progress of the latter without the former was impossible. In this respect the Vienna School, as exemplified by the clinician Skoda, working in connection with the pathologist Rokitansky, did giant service. Subsequently the researches of Pasteur, upon fermentation, and the antiseptic work of Lister form striking monuments in the century's progress. The latter was of value, according to the author, in a somewhat unanticipated direction, in that it rendered explorative operations possible, and thus enabled clinicians to observe disease in a stage short of that which it presented at the post-mortem examination. Last, but not least, Prof. Naunyn refers to the rise and the progress made by pharmacology, and points out the brilliant therapeutical results which have issued from pharmacological research.

THE DISTRIBUTION OF VERTEBRATE ANIMALS IN INDIA, CEYLON AND BURMA.[1]

THE completion of the seven volumes containing descriptions of all the vertebrata, in the "Fauna of British India," affords an opportunity of reviewing generally the distribution of terrestrial vertebrate animals throughout the British possessions in India, Ceylon and Burma.

For the study of zoological distribution there are few, if any, regions on the earth's surface that exceed British India and its dependencies in interest. The area is about 1,800,000 square miles, and although the vertebrate fauna is by no means thoroughly explored, it is well known throughout the greater part of the area and fairly known throughout the whole, better, probably, than in any other tropical and sub-tropical tract of approximately equal extent. The variety of climate is remarkable; within the area are included the almost rainless deserts of Sind and the locality on the Khási Hills, distinguished by the heaviest rainfall known, the cold, arid plateau of the Upper Indus drainage, and the damp tropical forests of Malabar and Tenasserim. The country is bounded on the north by the highest mountain range in the world and on the south by an ocean extending to the Antarctic regions. Another element of interest lies in the fact that the peninsula of India is a land of great geological antiquity, there being no evidence that it has ever been submerged, although the greater part of the Himalayas and Burma have at times been beneath the sea.

The plan adopted for the study has been to divide the whole country into nineteen tracts, distinguished by physical characters —such as rainfall, temperature, presence or absence of forests, and prevalence of hilly ground, and to construct tables showing the distribution of each genus of land or fresh-water vertebrate in the tracts. Genera have been selected for consideration because families and sub-families are too few in number and too wide in range, whilst species are too numerous and too unequal in importance. In the demarcation of regions and sub-regions, terrestrial mammalia are regarded as of primary importance.

The tracts are the following:—

A. *Indo-Gangetic Plain.*

1. Punjab, Sind, Baluchistan and Western Rajputana.
2. Gangetic Plain from Delhi to Rajmahal.
3. Bengal from Rajmahal to the Assam Hills.

B. *Indian Peninsula.*

4. Rajputana and Central India as far south as the Nerbudda.
5. Deccan from the Nerbudda to about 16° N. lat. and from the Western Ghats to long. 80° E.
6. Behar, Orissa, &c., from the Gangetic Plain to the Kistna.
7. Carnatic and Madras, south of 5 and 6, and east of the Western Ghats.
8. Malabar Coast, Concan and Western Ghats or Sahyádri range from the Tapti River to Cape Comorin.

C. *Ceylon.*

9. Northern and Eastern Ceylon.
10. Hill Ceylon, the Central, Western and Southern Provinces.

D. *Himalayas.*

11. Western Tibet and the Himalayas above forest.
12. Western Himalayas from Hazára to the western frontier of Nepal.
13. Eastern Himalayas, Nepal, Sikhim, Bhutan, &c.

E. *Assam and Burma.*

14. Assam and the hill ranges to the south with Manipur and Arrakan.
15. Upper Burma, north of about 19° N. lat.
16. Pegu from the Arrakan Yoma to the hill ranges east of the Sittang.
17. Tenasserim as far south as the neighbourhood of Mergui.
18. South Tenasserim, south of about 13° N. lat.
19. Andaman and Nicobar Islands.

A review of the fauna of these tracts leads to the following conclusions:—

(1) The Punjab tract differs greatly in its fauna from the Indian Peninsula and from all countries to the eastward, so greatly that it cannot be regarded as part of the Indo-Malay or Oriental region. Of terrestrial mammals, bats excluded, 30 genera are met with, of which 8 or 26½ per cent. are not Indian, whilst of reptiles (omitting crocodiles and chelonians) 46 genera occur, and of these 20 or 43½ per cent. are unknown further east. Of the corresponding orders of mammalia 46, and of reptiles 80 genera occur in the Peninsula, and 24 or 52 per cent. of the former and 57 or 64 per cent. of the latter are not found in the Punjab tract. All the genera met with in the Punjab tract and wanting further east are either Holarctic forms or peculiar, but with Holarctic affinities.

The Punjab, Sind and Western Rajputana are in fact the eastern extremity of the area known as the Eremian or Tyrrhenian or Mediterranean sub-region, generally regarded as part of the Holarctic region, but by some classed as a region by itself corresponding to the Sonoran in North America.

(2) The Himalayas above the forests and such portions of Tibet as come within Indian political limits (Gilgit, Ladák, Zanskar, &c.) belong to the Tibetan sub-region of the Holarctic region. Of twenty-five mammalian genera hitherto recorded from No. 11 (the Tibetan) tract, 11 or 44 per cent. are not found in the Indo-Malay region. That Tibet forms a distinct mammalian sub-region has already been shown in other papers.

(3) India proper from the base of the Himalayas to Cape Comorin, and from the Arabian Sea and the eastern boundary of the Punjab tract to the Bay of Bengal and the hills forming the eastern limit of the Gangetic alluvium, should, with the addition of the island of Ceylon, be regarded as a single sub-region, and may be conveniently entitled the Cisgangetic sub-region. The forests of the Sahyádri range and of the western, or Concan and Malabar, coast and the hill area of Southern Ceylon have a far richer fauna than the remaining area, but are not sufficiently distinct to require sub-regional separation.

The Cisgangetic sub-region is distinguished from the Transgangetic by the presence amongst mammals of Hyænidæ, Erinaceinæ, Gerbillinæ, of three peculiar genera of antelopes and of some other types; amongst birds by the occurrence of Pterocletes (sand grouse), Phœnicopteri (flamingoes), Otididæ (bustards) and Cursoriinæ; amongst reptiles by the possession of the families Eublepharidæ, Chamæleontidæ and Uropeltidæ, together with many peculiar Geckonidæ, Agamidæ, Lacertidæ and Scincidæ, and amongst batrachians by about one-half of the genera found in each sub-region being absent in the other. The difference between the reptiles and batrachians by itself would justify the classification of the two areas as distinct regions, a view adopted by several writers.

The difference between the Cisgangetic vertebrate fauna and that inhabiting the rest of the Indo-Malay or Oriental region is partly due to the absence in the former of numerous Eastern types, and partly to the presence of two constituents besides the Oriental genera, which, especially in forest, form a majority of the animals present. One of these two constituents consists of mammals, birds and reptiles having a distinct relationship with Ethiopian and Holarctic genera, and with the Pliocene

[1] Abridged from a paper read at the Royal Society, on December 13, 1900, by Dr. W. T. Blanford, F.R.S.

Siwalik fauna. This constituent of the Cisgangetic fauna it is proposed to distinguish by the term Aryan. The other constituent is composed of reptiles and batrachians and may be termed the Dravidian element. The latter is well developed in the south of the Peninsula and especially along the south-west or Malabar coast, and in Ceylon, but it gradually disappears to the northward, its northern limit, so far as is known at present, not extending to the 20th parallel of north latitude. It is probable that this is the oldest part of the Cisgangetic fauna, and it may have inhabited the country since India was connected by land with Madagascar and South Africa, across what is now the Indian Ocean, in Mesozoic and early Cenozoic times. The other two elements, the Indo-Malay or Oriental and the Aryan, are probably later immigrants, and its wider diffusion may indicate that the Indo-Malay element has inhabited the Indian Peninsula longer than the Aryan has. There appears some reason for regarding the Indo-Malay portion of the fauna as dating in India from Miocene times and the Aryan from Pliocene, whilst in the Pleistocene epoch the proportion of Aryan to Indo-Malay types of mammals in India, as shown by the fossil faunas of the Nerbudda and the Karnul caves, was much larger than at the present day.

There are some other peculiarities of the Indian Peninsula fauna to which attention may be called. One of these is the presence of genera and sometimes of species which are found on both sides of the Bay of Bengal, but not in the Himalayas or Northern India. A good example is afforded by the genus *Tragulus*, of which one species inhabits Ceylon and India south of about 22° N. lat., whilst two others are found in Southern Tenasserim and the Malay Peninsula. In Pliocene times the genus inhabited Northern India. Another instance is the lizard *Liolepis guttatus*, found in Burma and Arrakan and also in South Canara on the west coast of India. Examples amongst reptiles are rather numerous. Moreover, whilst there are numerous alliances between the animals of Peninsular India and those of Africa, there are also some curious connections between India and Tropical America, but these are chiefly amongst invertebrates. Some, however, are found in reptiles. It is probable that such Indo-American connections are vestiges of older life than the Indo-African. They are, of course, generally speaking, instances of animal groups once more widely distributed, but now only preserved in a few favourable tropical localities.

(4) The forest area of the Himalayas belongs to the same sub-region as Assam, Burma (except South Tenasserim), Southern China, Tonquin, Siam and Cambodia, and to this sub-region the term Transgangetic may be applied. It is distinguished from the Cisgangetic sub-region by the absence of the animals already specified as characteristic of that area and by the presence of the following, which are wanting in the Indian Peninsula—Mammals: the families Simiidæ, Procyonidæ, Talpidæ and Spalacidæ, and the sub-family Gymnurinæ, besides numerous genera such as *Prionodon*, *Helictis*, *Arctonyx*, *Atherura*, *Nemorhaedus* and *Cemas*. Birds: the families Eurylæmidæ, Indicatoridæ and Heliornithidæ, the sub-family Paradoxornithinæ. Reptiles: Platysternidæ and Anguidæ. Batrachians: Discophidæ, Hylidæ, Pelobatidæ and Salamandridæ.

The relations of the Himalayan fauna to that of Assam and Burma on the one hand, and to that inhabiting the Peninsula of India on the other, may be illustrated by the mammals with bats omitted. Of forty-one genera occurring in the Himalayas, three are not found in the hills south of Assam or in Burma, whilst sixteen are wanting in the Cisgangetic region. It should be remembered that a large number of the genera are widespread forms. As the result is not in agreement with the views of some who have written on the subject, the relations of species have been examined. It results that eighty-one species of mammalia, belonging to the orders Primates, Carnivora, Insectivora, Rodentia and Ungulata, are recorded from the forest regions of the Himalayas. Of these two are doubtful, twenty-two are not known to occur south of the Himalayan range in India or Burma, twenty-one are wide ranging forms and are found in both Burma and the Indian Peninsula, one only (*Hystrix leucura*) is common to the Himalayan forests and the Indian Peninsula, but does not range east of the Bay of Bengal, whilst thirty-five are found in the countries east of the Bay of Bengal but not in the Peninsula south of the Ganges. Of the thirty-five, eight only range as far as the hills south of the Assam Valley, sixteen to Burma proper, and eleven to the Malay Peninsula and Archipelago. Of the twenty-two species not ranging south of the Himalayas a large majority are either Holarctic species or belong to Holarctic genera.

The fauna of the Himalayan forest area is partly Holarctic, partly Indo-Malay. It is remarkably poor, when compared with the Cisgangetic and Burmese faunas, in reptiles and batrachians. It also contains but few peculiar genera of mammals and birds, and almost all the peculiar types that do occur have Holarctic affinities. The Indo-Malay element in the fauna is very richly represented in the Eastern Himalayas, and gradually diminishes to the westward until in Kashmir and farther west it ceases to be the principal constituent. These facts are consistent with the theory that the Indo-Malay constituent of the Himalayan fauna, or the greater portion of it, has migrated into the mountains from the eastward at a comparatively recent period. It is an important fact that this migration appears to have been from Assam and not from the Peninsula of India.

(5) Southern Tenasserim agrees best in its vertebrata with the Malay Peninsula, and should be included in the Malayan sub-region of the Indo-Malay region.

There are several points left which require explanation. There is the much greater richness of the Oriental constituent in the Cisgangetic fauna to the southward in Malabar and Ceylon, although this is far away from the main Oriental area, and the ocurrence also in the southern part of the Peninsula of various mammalian, reptilian and batrachian genera, such as *Loris*, *Tragulus*, *Draco*, *Liolepis* and *Ixulus*, which are represented in Burma and the Malay countries but not in the Himalayas or Northern India. In connection with this the limitation of the Dravidian element to the south of India should also be remembered. Then there is the occurrence of certain Himalayan species on the mountains of Southern India and Burma and even farther south, but not in the intervening area. There is also the predominance of the Western, or what I have proposed to call the Aryan, element in the Pleistocene fauna of the Nerbudda Valley, and of Karnul in the north of the Carnatic tract. Lastly, we have to account for the apparently recent immigration of Oriental types into the Himalayas.

Whilst it is quite possible that other explanations may be found, it is evident that all these peculiarities of the Indian fauna may have been due to the Glacial epoch. The great terminal moraines occurring at about 7000 feet in Sikhim and the occurrence of similar moraines and other indications of ice action at even lower levels in the Western Himalayas clearly show that the temperature of the mountain range must have been much lower than at the present day, when no glacier in Sikhim is known to descend below about 14,000 feet.

During the coldest portion of the Glacial epoch, a large part of the higher mountains must have been covered by snow and ice, and the tropical Indo-Malay fauna which had occupied the range, and which may have resembled that of the Indian Peninsula more than is the case at present, must have been driven to the base of the mountains or exterminated. The Holarctic forms apparently survived in larger numbers. The Assam Valley and the hill ranges to the southward would afford in damp, sheltered, forest-clad valleys and hill slopes a warmer refuge for the Oriental fauna than the open plains of Northern India and the much drier hills of the country south of the Gangetic plain. The Oriental types of the Peninsula generally must have been driven southwards, and some of them, such as *Loris* and *Tragulus*, which must originally have been in touch with their Burmese representatives, have never returned. It was probably during this cold period that the ossiferous Nerbudda beds and the deposits in the Karnul caves were accumulated. The tropical damp-loving Dravidian fauna, if it inhabited Northern India, must have been driven out of the country. Unless the temperature of India and Burma generally underwent a considerable diminution, it is not easy to understand how plants and animals of temperate Himalayan types succeeded in reaching the hills of Southern India and Ceylon, as well as those of Burma and the Malay Peninsula.

When the whole country became warmer again after the cold epoch had passed away, the Transgangetic fauna appears to have poured into the Himalayas from the eastward. At the present day the comparatively narrow Brahmaputra plain in Assam is far more extensively forest-clad, especially to the eastward, than is the much broader Gangetic plain of Northern India, and if, as is probable, the same difference between the two areas existed at the close of the Glacial epoch, it is easy to see how much greater the facilities for the migration of a forest-haunting fauna

must have been across the Brahmaputra Valley than over the great plain of the Ganges. This difference alone would give the Transgangetic fauna of Burma an advantage over the Cisgangetic fauna in a race for the vacant Himalayas, even if the latter had not been driven farther to the southward than the former, as it probably was during the Glacial epoch.

The theory, however, is only put forward as a possible explanation of some remarkable features in the distribution of Indian vertebrates. At the same time it does serve to account for several anomalies of which some solution is necessary. If thus accepted, it will add to the evidence, now considerable, in favour of the Glacial epoch having affected the whole world, and not having been a partial phenomenon induced by special conditions, such as local elevation.

SCIENCE TEACHERS IN CONFERENCE.

FOR the third time the Technical Education Board of the London County Council has arranged and held a conference of teachers of science from all parts of the kingdom. Since their inauguration, these annual meetings have steadily grown in popularity. At the first conference, in 1899, there was an attendance of eighty persons, in 1900 the number had grown to 200, while at the meetings held last week the attendance reached the total of 350. These satisfactory results are largely due to the efforts of Mr. C. A. Buckmaster, of the Board of Education, and Dr. Kimmins, the Inspector to the Technical Education Board, who have steadily worked during the three years in encouraging lecturers, demonstrators and inspectors to meet together for the discussion of methods of teaching different branches of science. The addresses and papers brought before the conference at the South-Western Polytechnic, Chelsea, on January 10 and 11, dealt with subjects of great importance in an interesting and instructive manner; but the discussions were not entirely satisfactory. It is useless to expect teachers to contribute anything valuable to a discussion at a moment's notice. It should be possible at future meetings to obviate in a large measure the desultory speeches on more or less general topics which this year followed the addresses and papers. If half a dozen well-known, practical teachers were given an abstract of the paper before the meeting, they would be able, with a few days' preparation, to place succinctly before the meeting the results of their own practice, and besides putting the discussion on right lines, they would lead other teachers with experience of the matter in hand to help forward a complete presentation of the subject.

One more preliminary remark is necessary. Too much was attempted at separate meetings, at some of which as many as three papers were read and put down to be discussed in two hours. The consequences were unfortunate. To name one instance only: at the third meeting, not only was Prof. Armstrong unable to deliver the whole of the paper he had prepared on the teaching of domestic science, but though the discussion was continued some fifteen minutes after the proper time, he was not called upon to reply to the points raised by different speakers. It is to be hoped that next year fewer subjects will be taken up at each meeting, and more pains taken to secure an ample discussion, rigidly kept to the matter in hand.

INSTRUMENT MAKING.

At the first meeting of the conference, Mr. T. A. Organ, the Chairman of the Technical Education Committee of the London County Council, presided. In his introductory remarks the Chairman insisted on the need there is still for improved science teaching in our schools, and directed attention to a growing danger of doing too much for students. What has been called in America "peptonised" education seems to be on the increase, and is much to be deprecated. Addresses were given on "Instrument-making for schools and technical classes," by Mr. W. Hibbert, of Regent Street Polytechnic; and on the "Co-ordination of workshop and laboratory instruction," by Mr. T. P. Nunn, of William Ellis's School, and Mr. A. G. Hubbard, of Raine's School. During the course of his remarks, Mr. Hibbert described, with the aid of lantern slides, a large number of simple pieces of apparatus for use in the teaching of electricity and magnetism, amongst which his magnetometer, which can be easily converted into an astatic galvanometer, his electroscope, capable of detecting one-tenth the potential difference recognisable by the ordinary forms of instrument, and his standard magnets are particularly worth mention. The remaining addresses described successful attempts to make the work of the manual instruction teacher assist the practical study of physics. In the subsequent discussion, Dr. Gladstone, F.R.S., referred to the efforts he had made on the London School Board in the direction of supplying the teachers of the schools of the Board with simple, inexpensive apparatus which would satisfactorily demonstrate the elementary principles of physics and chemistry.

THE FITTING UP OF LABORATORIES.

Sir W. de W. Abney, K.C.B., F.R.S., took the chair at the second meeting, and lectures were given by Messrs. J. B. Coleman, A. Schwartz and W. W. Pullen, describing the fittings and apparatus of the chemical, physical and mechanical laboratories, of which they respectively have charge at the South-Western Polytechnic. After the addresses, which were profusely illustrated with lantern slides, a discussion was opened by Prof. Armstrong, F.R.S. Referring to the provision which Mr. Coleman has made for the proper writing of notes in the laboratory itself at the time the practical exercise in science is actually performed, Prof. Armstrong urged that one of the most valuable results from intelligent science teaching is the excellent progress the pupil makes in his ability to express himself in a literary manner when called upon to systematically describe the work he has performed. He also urged that it is a great mistake to suppose that palatial establishments, such as those described by the lecturers, are really necessary for teaching science to boys and girls. Pretentious "drawing-room" laboratories are by no means desirable; what is wanted is not so much a laboratory as a workshop, which need be little more than a shed, such as a contractor about to put up a large building erects for the use of his workmen. Students who work in the sumptuously-fitted places now provided are not suitably trained for the work of life; nobody in commercial undertakings gets a place anything like as good as a school laboratory in which to do his professional work. The thing of importance is the spirit with which the work is undertaken, not the number of appliances at the disposal of the teacher and pupil.

In acknowledging a vote of thanks, and at the same time summarising the papers and discussion, Sir W. Abney explained that his experience in connection with the Board of Education at South Kensington has shown him what a great deal can be done with very simple apparatus. He had, he said, again and again met, in different parts of the country, teachers using the simple pieces of physical apparatus they had made in the laboratories of the Royal College of Science during the courses of instruction arranged for them there during the summer vacation. The teacher of science who has learnt how to make and devise these simple pieces of apparatus can, with the aid of his pupils, easily turn out apparatus quite suitable for satisfactorily demonstrating the important laws of chemical and physical science.

DOMESTIC SCIENCE.

The third meeting, over which Mr. Bousfield, Chairman of the Girls' Public Day School, presided, was devoted to a consideration of the science teaching in girls' schools, especially as to what form of instruction in domestic science is desirable. The first paper was read by Miss Aitken, of the North London Collegiate School, who gave it as her opinion that the best practical teaching in science for girls is given in the now well-known schools of science held in connection with the South Kensington branch of the Board of Education. The generality of girls' schools are not, Miss Aitken finds, properly provided with necessary and suitable accommodation for the pupils to themselves make experiments with simple apparatus, the classes in science are too large, and the amount of time placed at the disposal of the science mistress is ludicrously inadequate.

Prof. Armstrong, in a paper on the teaching of domestic science, laid it down that the object of their instruction should be the formation of habits, not the accumulation of knowledge. Elementary work, in what Prof. Armstrong prefers to call *νους* or "knowingness" rather than science, should throughout aim at developing and strengthening a young pupil's mother wit. Anything may be taught and in any way, provided it leads to the cultivation of *νους*. All teaching in domestic science must be guided by considerations of this kind, and the fundamental subjects of a suitable course will be measuring work, which will not be unduly prolonged, but give place at an early stage to continued exercises with the balance; the study of the