the proper motions of about 12,000 stars. These have been obtained by comparison of the Greenwich positions with those given in the catalogues of the Astronomische Gesellschaft and the earlier catalogues of Bessel and Lalande. For the latter catalogues systematic corrections were determined for each separate night's observations.

A determination of the mean parallax of stars of different magnitudes has been made from these proper motions and published in the Monthly Notices of the Royal Astronomical Society. The results confirm very closely the formula given by Kapteyn. It is hoped to communicate to the society a short discussion of the proper motions with reference to star streaming. The publication of these summaries of results by the Royal Astronomical Society is specially valuable because of the delay in the printing and publication of the catalogue itself.

During the year 222 photographs were taken with the Cookson floating zenith-telescope, 216 for latitude groups and six for scale determination. The measurement of the photographs to the end of 1916 is completed, and the results for the variation of latitude for 1916 were communicated to the Royal Astronomical Society, and published in the Monthly Notices for March, 1917.

Throughout the year the 28-in. refractor was at the disposition of M. Jonckheere. Fifty-nine new close double stars were detected, making 259 since October, 1914. Up to November 22, 1916, the observations mainly consisted of the measurement and verification of stars discovered to be double since 1905, the date to which Mr. Burnham's catalogue extends. Since November 22 the programme of work has comprised (1) the measurement of stars from Burnham's General Catalogue which had been previously observed at the Lille Observatory, and (2) the re-measurement of double stars in vol. lxi. of the Royal Astronomical Society's Memoirs. Altogether 604 double stars have been measured during the year. Of these stars—

213	have a separation	under 2″.
156	„ „	between 2″ and 3″.
132	„ „	„ 3″ „ 4″.
62	„ „	„ 4″ „ 5″.
41	„ „	greater than 5″.

The catalogue of double stars discovered since 1905 has been published by the Royal Astronomical Society in vol. lxi. of the Memoirs.

With the Thompson equatorial, in accordance with the programme of previous years for the determination of stellar parallax, a first exposure has been made on eighty-six plates, and a second one on 154 plates. At the request of Dr. de Sitter the series of photographs commenced at the Cape Observatory for the determination of the constants of the four Galilean satellites of Jupiter has been continued at Greenwich.

With the astrographic equatorial during the year 109 plates have been taken on thirty-five nights for the determination of proper motion by comparison with earlier plates. Of these nine have been rejected; eighty-five plates, of which fifty-two have two fields on them, have two short exposures, usually of 4m. and 2m.; fourteen have a single exposure of 12m.; one is for focus of the instrument.

The plates with short exposures are being compared in the duplex micrometer, but only for the stars contained in the *Bonn Durchmusterung*. The plates with longer exposures are being compared with earlier plates—usually chart plates—by Mr. Innes at Johannesburg, using a blink microscope. With the duplex micrometer 177 pairs of plates have been measured during the year. From the results obtained all proper motions greater than 10″ a century and many smaller ones are being determined. Simultaneously the proper motions of the brighter stars are being determined by comparison with earlier meridian observations.

In the year ended May 10, 1917, photographs of the sun were obtained on 208 days. Photographs have been received from the Royal Observatory, Cape of Good Hope, and supplementary photographs have been received through the Solar Physics Committee, from Dehra Dûn, India, in both cases to the close of the year 1916. Two days in 1916 still remain unrepresented, viz. June 19 and September 29. From 1910 to 1916 inclusive there are only two other days unrepresented in the combined series of photographs for measurement, one in 1911 and one in 1912.

The mean daily spotted area of the sun continued to increase during the past twelve months, and there is no indication as yet that the maximum has been reached.

The mean values of the magnetic elements for 1916 and five previous years are as follows:—

Year	Declination W.	Horizontal force (C.G.S.)	Dip
	° ′		° ′ ″
1911	15 33·0	0·18549	66 52 6 (3-in. needles)
1912	24·3	0·18548	51 46 „ „
1913	15·2	0·18534	50 27 „ „
1914	15 6·3	0·18518	49 27 „ „
			51 13 (inductor)
1915	14 56·5	0·18508	51 50 „
1916	46·9	0·18494	52 45 „

It will be noticed that the annual diminution of declination increased considerably about 1910, its average value from 1900 to 1910 being 4·9′. The horizontal force, which had been increasing since measurements at Greenwich were begun in 1846, reached a maximum about 1910, and is now diminishing. The dip, which has been diminishing since measurements were begun in 1843, appears also to have recently reached a turning point. There were no days of great magnetic disturbance in 1916, but three were classified as of lesser disturbance.

The principal features of interest in the meteorological conditions at Greenwich during the year ended April 30, 1917, are:—(i) The continued cold weather from December to April—the latter month had a mean temperature 1° lower than any other April since 1841; and (ii) the general deficiency of sunshine.

The scientific work of the observatory has necessarily been somewhat curtailed, but it has been found possible to keep up all observations of the sun, moon, and planets; sun-spots; latitude; magnetic and meteorological registers—observations which would otherwise have been permanently lost.

One special piece of work to which a good deal of attention was devoted this year was the preparation of magnetic charts. In 1912 it was arranged that the compilation of the Admiralty charts of magnetic variation, hitherto undertaken by the Compass Department, should be transferred to the Royal Observatory. A card catalogue of magnetic declination data from all parts of the world was formed. From this and published data of various surveys the charts for 1917 have been prepared during the past year. They are now in course of publication by the Hydrographic Office.

RESEARCHES ON KALA-AZAR.[1]

I HAVE chosen the subject of twenty years' research on kala-azar for the main portion of my address to-night, both because of the great importance of this disease in a large area of India, and also of the ignorance of the general public regarding it. Most people have fairly definite ideas about malaria and

1 From the presidential address delivered to the Asiatic Society of Bengal on February 8 by Sir Leonard Rogers, F.R.S.

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cholera, but few have any regarding the far more deadly and insidious kala-azar, which, on account of its extremely high mortality and the painfully lingering nature of the disease, is without doubt the most terrible scourge occurring in India. It is now more than twenty years since I was fortunate enough, when with less than three years' service, to be selected to carry out the second investigation of the Assam epidemic of kala-azar, and it has never ceased from that time to occupy my thoughts, although my opportunities for continuing my researches on it have sometimes been more limited than I should have liked. Fortunately, I have been able to discover how to prevent the spread of the disease, and also independently to find a cure for it. The time, therefore, seems to be ripe for giving a brief popular summary of the progress which has been made in our knowledge of kala-azar through the researches of the last twenty years, which has resulted in a very great degree of success as regards both the prevention and the cure of the disease, although some links in the chain of infection still remain to be forged.

In the first place, I wish to remove a misconception which I find is commonly prevalent among the public, namely, that kala-azar and black-water fever are the same disease, or at least intimately related. It is true that some years ago a high medical authority did make such a suggestion on theoretical grounds, but I do not think any medical man now holds that view. As a matter of fact, it would be difficult to imagine two more widely different conditions than the lingering kala-azar and the short, sharp, black-water fever complication of malaria, which ends in death or recovery within a very few days. That black-water fever is but a complication of malaria is a view with which I am in agreement. But the differentiation of kala-azar from chronic malaria was not possible before the discovery of a distinct parasite in the former in 1903, and up to quite recently it remained very difficult on purely clinical grounds in many cases. It is, therefore, not surprising that the two were for long confused even by research workers, including myself in my report of 1897 on the Assam epidemic, and a little later by such a great authority on malaria as Sir Ronald Ross, who proved malaria to be mosquito-borne.

It is generally known that kala-azar spread through Assam for a number of years, causing a great mortality; but it is difficult to convey to those who have not seen its effects anything like an adequate idea of the terrible nature of the affliction. At the time of my investigation in 1896–97 the disease was at its height in the Nowgong district, the population of which in the decade 1891–1901 actually showed a decrease of 31·5 per cent., against an increase of 9 to 16 per cent. in the more easterly unaffected districts. Large areas of land fell out of cultivation, and even at the headquarters town of Nowgong land absolutely lost its value, being quite unsaleable. When the tea-gardens became infected in this district, and accurate figures were available, it was found that the mortality in several hundred carefully treated cases varied from 90 to 96 per cent.

But I must pass on to show you some photographs of cases taken during my investigation. The first group was taken in the Nowgong dispensary, and the second in that at Mangaldai. Both show the great emaciation contrasting with the tumid abdomens due to great enlargement of the spleen, and often also of the liver, while the skin becomes darker and more muddy, which, according to some, gave rise to the term kala-azar or black fever. Now it will no doubt occur to many of you that you have seen precisely similar cases in malarious areas round Calcutta, and you will ask, How do you differentiate between kala-azar and chronic malaria? That, indeed, was the problem which confronted me in Assam, with the added difficulty that the disease was spreading and causing an awful mortality such as malaria was not known to do in Lower Bengal, and that the people themselves had no doubt that the disease was an infectious one, though malaria was not believed to be so at the time of my investigation, which, of course, was several years before the mosquito-borne theory of malaria was established. In fact, there were at that time two rival theories regarding kala-azar: one that the disease was malarial, and therefore could not be infectious; and the other that it was infectious, and therefore could not be malarial, so must be some undescribed disease. I early set to work to find out if kala-azar was infectious. I found that the disease always began in a village through an infected person coming to reside there, the next to be attacked being those living in the same house as the infected visitor. This naturally led me to suspect that the disease was not malarial, yet I frequently found malarial parasites in the blood (it was not then known that in malarious parts many apparently healthy persons harboured malarial organisms in their blood), and, search as I would, I could find no differentiating point from malaria. I therefore visited Sylhet, to the south of the Khasia Hills, where kala-azar was then unknown, and there found cases of malarial cachexia which in every respect, including investigations of the blood changes, resembled kala-azar of the Brahmaputra Valley, except that they were much more chronic and sometimes lasted as many years as epidemic kala-azar did months. With the boldness of comparative youth I therefore declared the spreading kala-azar of Assam to be an epidemic infectious form of malaria, corresponding in some respects with the well-known Mauritius malarial epidemic of 1877. We shall see presently that I was partly wrong and partly right in coming to this conclusion.

However, I was not content with merely theoretical considerations, but strove for practical results from my inquiries. I therefore sought for more accurate data on the tea-gardens, which had become badly infected in the Nowgong district, and on which I investigated many cases with the help of my friend, Dr. Dodds Price, who has a unique experience of kala-azar and has rendered me the greatest possible assistance throughout a number of years. I ascertained that on one of his gardens so many deaths had occurred from kala-azar that two hundred new coolies had to be imported at one time. He had already independently recognised the infectiousness of the disease before I went to Assam, and had arranged for separate coolie lines to be built to prevent as many as possible of the new coolies going into the infected houses of the old lines. Only one hundred and fifty could be accommodated in the new lines, so fifty had to go into the old ones. On learning this, I at once set to work to ascertain the results of this important measure, and we found that in the course of two years no single case of kala-azar had occurred in the new lines (and the same was true eighteen years later), while no fewer than 16 per cent. of the new coolies living in the old infected lines were already dead of the disease, although the two sites were only about two hundred yards apart. This experience led me to urge moving out all the healthy people from the infected lines into new ones, taking none from infected houses, segregating the remaining infected families, and destroying the old houses. The results were so successful that the plan was repeated by Dr. Price on other gardens, and in 1913, during a visit to Assam in the Puja vacation, we worked out the results of eighteen years' experience. This may briefly be summarised by saying that the dread disease had been

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completely stamped out of ten coolies' lines, in one of which three-fifths of the whole population had the disease in their households, while the new lines had afterwards remained free from the disease in every case, namely, from twelve to eighteen years in five of them, and for shorter periods in the others, no recurrence having ever taken place where Dr. Price had been able to get his orders carried out by the garden managers to prevent any infected person being allowed to live in the new lines. That this success was not due to the decline of the disease in the Nowgong district was clear from the fact that on two gardens where he could not get the managers to adopt my measures the disease was still present at the time of my 1913 visit, having persisted on them for twenty years. When it is stated that the population of the new kala-azar-free lines in 1913 amounted to 6727 souls, and that the deaths from kala-azar alone in the old lines before removal had amounted to 1393, or no fewer than 207 per mille, more than one-fifth; that the loss would have continued indefinitely, as shown by the fact that the disease remained present for twenty years on two gardens where the plans were not adopted; and that coolies cost about Rs.200 a head to recruit by the time they reached Assam, the saving to the tea industry in this one district alone must have amounted to lakhs of rupees. I am glad to be able to say that the industry has shown its gratitude in a very practical way by promising Rs.20,000 a year for five years for investigations in connection with the School of Tropical Medicine

The more difficult question remained as to whether anything could be done to check the spread of the disease up the Brahmaputra Valley. On turning once more to the map, you will see that the only traffic eastward is along the narrow strip between the hills and the Brahmaputra River, which also has comparatively few inhabitants. I found it to be free from kala-azar in 1897, so recommended that steps should be taken to stop infected people from passing up into the Golaghat subdivision of the Sibsagar district, and that if any villages became infected in Golaghat the segregation measures should at once be carried out and the healthy people moved to a new site. This was actually done later with success, and as the epidemic has abated in Nowgong, although sporadic cases remain, there is good reason to hope that the main danger has been averted and the eastern part of the valley saved from devastation little, if at all, less disastrous than the war itself. A recent investigation by Major McCombie Young, Sanitary Commissioner, Assam, has shown that the disease remains in a sporadic form in just those parts of Assam which I found to be infected with the epidemic twenty years ago—an important point I shall return to presently. Before leaving this part of the subject let me emphasise the fact that all the above practically important prophylactic measures were worked out as a result of my epidemiological studies before we had any accurate knowledge of the true nature and causation of the disease, so that, however wrong my theories proved to be, I have the satisfaction of knowing that my earliest important investigation in India led to much saving of life and suffering, which has always been a greater satisfaction to me even than the making of purely scientific discoveries without much practical value.

In the meanwhile, my theory that kala-azar was an epidemic malaria, although supported by the high authority of Sir Ronald Ross, was criticised by others, and Dr. Bentley, on the strength of what ultimately proved to be erroneous blood tests made at Kasauli, declared the disease to be an epidemic of Malta fever, but at the same time brought forward some strong arguments against the disease being malarial. While opinions were thus divided in India, researches on two other continents led to a solution of the difficult problem—so closely is scientific thought all over the world united by medical literature at the present day. In Africa the late Dr. Dutton, the most brilliant worker yet produced by the Liverpool School of Tropical Medicine, discovered a trypanosome in the blood of a patient suffering from a fever, which was later proved by Sir David Bruce to be the early stage of the deadly sleeping sickness. Sir William Leishman then recorded having found some minute bodies in the spleen of a soldier who died in England of a fever contracted in Dum Dum, and suggested that they were degenerate trypanosomes. Lt.-Col. C. Donovan, of the Madras Medical College, immediately announced that he had independently found the same bodies some months before, and added the important fact that they could be obtained by spleen puncture during life, thus disproving Leishman's theory that they were degenerate trypanosomes. Donovan also suggested that the so-called malarial cachexia and kala-azar might also be due to this parasite. Leishman and Donovan were therefore the joint discoverers of the parasite of kala-azar which is called after them, and I am glad to say that the Asiatic Society has been the first to recognise the importance of Donovan's work by electing him to our fellowship last year, although it is but a small recognition for such an important discovery. The way was now cleared for more rapid advance, and Dr. Bentley and myself independently found the same parasite in epidemic kala-azar in Assam, and I also found it in cases in the north-west of the Dinajpur district, where the disease had been known as kala-dukh. Thanks to the kindness of the physicians of the Medical College Hospital in 1904-5, and especially to Surgeon-General Harris, I was able to investigate scores of cases of what had hitherto been always regarded as malarial cachexia, with the result of showing that a large proportion of them were kala-azar.

These observations established the important fact that a sporadic form of kala-azar is widely prevalent in Lower Bengal, and I found it to be exactly similar to the cases I had formerly studied in Sylhet. The mystery of the nature of kala-azar was thus cleared up, the destructive Brahmaputra Valley wave having been an epidemic form of the disease which is epidemic in Lower Bengal and Sylhet; so that, although I was wrong in regarding it as malarial, I was correct in saying it was an epidemic variety of the disease I had found in Sylhet, which had always been regarded as malarial cachexia, but which we now know to be sporadic kala-azar. As special skill and laboratory facilities are required for demonstrating the parasite of kala-azar, while the treatment of kala-azar is different from that of chronic malaria, it still remained a matter of great practical importance to solve the century-old problem of finding a simple clinical differentiation between kala-azar and malarial cachexia. Only in January I recorded the results of three years' investigation of this problem in the Medical College Hospital, thanks to facilities kindly afforded me by my medical colleagues, which has, I believe, resulted in a simple and practical solution of this difficulty, and will enable the curative treatment I shall come to presently being successfully used by the general practitioner, even in places remote from laboratories.

The discovery of the parasite of kala-azar in 1903 placed me in a position to study it with the view of ascertaining its life-history, and so to obtain a clue to the mode of infection. In the following year I was

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fortunate enough to succeed in cultivating this protozoal parasite in test-tubes under certain conditions and in watching the minute spleen form develop into a long flagellate organism resembling one of the stages of a trypanosome, but which further study showed to belong to the closely allied herpetomonas. This discovery gave the required clue to the nature and probable life-history of the parasite, as similar organisms are found naturally in the digestive canals of certain flies, indicating that the infection is probably insect-borne. I spent the next year in studying the conditions favourable to the growth of the parasite in cultures, and for reasons into which I have not time to go I came to the conclusion that the homely bed-bug is the carrier of the disease. The fact which had by this time been established by Dr. Dodds Price, that two to four hundred yards is a sufficient distance to remove healthy lines from infected ones, is sufficient to exclude a flying insect such as a mosquito. At this time Major Patton, of the Bacteriological Department, was placed on special duty to work at the subject in Madras. After some two years' work he obtained a development of the parasite up to the flagellate stage in the digestive canal of bed-bugs fed on kala-azar patients with the parasites in their blood. Lt.-Col. Cornwall has recently confirmed these experiments, and although the final proof of communicating the disease by means of infected bed-bugs has not yet been furnished (experiments on human beings, such as were carried out in the case of malaria, not being justifiable in the deadly kala-azar), still the evidence incriminating these insects is sufficiently weighty to make it desirable to wage war upon them wherever the disease is present. Coco-nut oil applied to the runs of the bugs on walls, and to the buttons of mattresses, etc., where they often hide, is a useful measure for this purpose. As these insects can live for months without food, the way in which the infection clings to houses is well explained on my theory that they are the carriers of the disease.

Lastly, I come to the most important discovery regarding kala-azar, namely, that of a trustworthy cure of this formerly very deadly disease. Antimony preparations have proved to be of value in trypanosomiasis, and nearly two and a half years ago I decided to try intravenous injections of tartar emetic in kala-azar. Unfortunately, just at that moment I had no clinical facilities for testing my idea, and for six months I carried about sterile capsules of tartar emetic without being able to use them, a disability which will end when the Carmichael Hospital for tropical diseases is opened. Eventually I obtained the facilities I required, and soon saw reason to believe that the drug was proving effective. Imagine my disappointment when I read that two Italian doctors had recorded successes in the treatment of the African form of kala-azar with the very drug I was using in Calcutta, although the fact that I had independently discovered the treatment will save some of the credit for the Indian Medical Service. At any rate, I am now in the happy position of being able to say that, thanks to the kind help of Capt. H. N. Hume and Lt.-Col. O'Kinealy, no fewer than twenty-five consecutive cases of kala-azar, including three children, have been successfully treated in the European General Hospital by this method, and the most deadly disease of India, if not of the world, has now been largely conquered, as regards both prevention and cure, perhaps more completely than any other highly lethal disease known, as a direct result of the researches of the last twenty years.

In conclusion I cannot resist this opportunity of pointing the moral, namely, that no greater benefit can arise than from successful medical research, and that no better use can be made of wealth than in endowing such research for the benefit of the present and all future generations. Bengal, and I would add Bihar, have already nobly responded to my appeal for endowments for the Calcutta School of Tropical Medicine, and when the terrible war is over we hope to have at least nine research workers in the new laboratories, instead of one poor man with routine professorial duties devoting such time as he can snatch to medical research.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. A. E. Shipley, F.R.S., master of Christ's College, has been elected Vice-Chancellor for the next academical year.

OXFORD.—A decree passed by Convocation on June 5 provides for the suspension of the Romanes lectureship until October 9, 1917, the moneys consequently undisposed of to be transferred to the Emergency Relief Fund of the University.

On the same day statutes passed Congregation empowering the board of the faculty of medicine to recognise certain examinations in natural science, and providing for the further promotion of higher studies in the University, with special reference to the proposed new degree of Doctor of Philosophy. The statutes respecting boards of electors to professorships were amended in some particulars.

Mr. T. R. Glover, fellow of St. John's College, Cambridge, has been appointed Wilde lecturer in natural and comparative religion for three years from October 10, 1917.

Prof. Emile Boutroux, Membre de l'Institut de France et de l'Académie Francaise, has been appointed Herbert Spencer lecturer for 1917.

Two courses of free public lectures have just been commenced at the School of Oriental Studies, London Institution, Finsbury Circus, E.C.2. One course, on "Religion in India and China," is being delivered by Dr. T. W. Rhys Davids, and the remaining lectures will be given on Tuesdays, June 12, 19, and 26; the other course, on "The Way to Buddhahood," by Prof. de la Vallée Poussin, is being delivered on Thursdays, June 7, 14, 21, and 28. The lectures begin at 5.30 in each case.

THE President of the Board of Education has appointed a Departmental Committee to inquire into the principles which should determine the construction of scales of salary for teachers in elementary schools, due regard being had to locality, duties, qualifications, sex, and other considerations consistent with the organisation of the teaching service throughout the country, on a system conducive to the efficiency of national education. The committee will be at liberty to illustrate any system of scales which it recommends by such specific sums of money as it thinks fit; but it is not asked to consider the question of the amounts by which existing scales of salary should be improved in particular areas, or the sources from which the amounts required for that purpose should be provided. The members of the committee are:—Sir H. L. Stephen (chairman), Miss M. M. Allan, Mr. J. W. Alsop, Dr. H. B. Brackenbury, Miss I. Cleghorn, Mr. C. W. Crook, Mr. W. R. Davies, C.B., Miss I. A. Dickson, H.M.I., Mr. A. J. Flavell, Mr. H. Mellish, Mr. H. Pearson, Mr. A. R. Pickles,

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