

27,000 under vines, and 21,000 hectares under sugar-canes. In 1889 the area under wheat cultivation was further increased, 1,035,000 hectares being under this crop. Thirteen years ago, in 1875, it was estimated by the Inspector of Agriculture that the area under wheat did not amount to more than 100,000 hectares. As regards the live stock, the first attempt made to improve the breed of sheep was in 1826, when a hundred Spanish sheep were imported, and in 1830 a flock of English southdowns. In 1875, the number of horses, according to the official statistical returns, was 3,969,000, of oxen 13,493,000, and of sheep 27,546,000, and these numbers had risen respectively, in 1888, to 4,398,000, 22,860,000, and 70,453,000. The value of wool exported from the Argentine Republic in 1889 amounted to £11,200,000.

### Obituary.

**JAMES SHIRLEY HIBBERD.**—Mr. Shirley Hibberd, the well-known horticulturist, died suddenly at his residence at Kew, on Sunday morning, 16th inst. He began life as a bookbinder, but soon abandoned that calling and applied himself to journalism. He was editor of the *Gardeners Magazine* for many years, and published several works of value on horticulture. At the recent fruit show at the Guildhall Mr. Hibberd was one of the judges, and in recognition of his services on that occasion he was offered by the Fruiters' Company the honorary freedom and livery of the guild, but he declined the honour on account of the pressure of his literary engagements. Mr. Hibberd was one of the founders of the several potato exhibitions that were some few years since commenced at the Crystal Palace, and only a few weeks ago he was called on by the Government to give them the benefit of his advice with reference to the potato disease in Ireland. He also took an active part in the recent discussion on the possibilities of fruit culture in England. Mr. Hibberd, who was in his sixty-sixth year, had been a member of the Society of Arts since 1876.

### General Notes.

**YORUBA TIMBER.**—The Colonial authorities of Lagos are anxious to develop a trade in Yoruba timber. With this object, a circular has been issued in the colony, stating that the Government will readily receive specimen logs of native trees, and will send them to England to be reported on and valued by experts. It appears that throughout the colony there exist a large number and variety of timber trees, and that that part of West Africa (in

common with the Gambia and the Gold Coast) is rich in cabinet woods of good quality and appearance. The co-operation of all who are interested in the matter is invited. Communications on the subject should be addressed to the Colonial Secretary, Lagos.

### MEETINGS FOR THE ENSUING WEEK.

**MONDAY, Nov. 24** SOCIETY OF ARTS, John-street Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. Vivian B. Lewes, "Gaseous Illuminants." (Lecture I.)

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. T. A. Dickson, "The Labour Question as regards Agriculture."

Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. A. Maund "Matabele and Mashona Lands."

Actuaries, Staple Inn Hall, Holborn, 7 p.m.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m.

Mr. W. Pater, "Prosper Mérimée."

**TUESDAY, Nov. 25** Society of Architects, St. James's-hall, Piccadilly, W., 7½ p.m.

Sanitary Institute, 14 A, Margaret-street, W., 8 p.m.

Mr. A. Wynter Blyth, "Sanitary Laws and Regulations Governing the Metropolis."

Medical and Chirurgical, 20, Hanover square, W., 8½ p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m.

Professor John Milne and Mr. John McDonald, "The Vibratory Movements of Locomotives."

Anthropological, 3, Hanover-square, W., 8½ p.m.

Mr. J. Theodore Bent, "The Yourouks of Asia Minor." 2. Mr. A. L. Lewis, "Stone Circles in Wiltshire."

**WEDNESDAY, Nov. 26** SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Francis Galton, F.R.S., "Physical Tests in Competitive Examinations."

Geological, Burlington-house, 8 p.m.

Royal Society of Literature, 20, Hanover-square, W., 8 p.m.

Patent Agents, 10, Southampton-buildings, W.C., 7½ p.m.

1. Mr. G. G. M. Hardingham, "Working German Patents" 2. W. Lloyd Wise, President, "Specifications with especial reference to a recent judgment."

**THURSDAY, Nov. 27** Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 6 p.m.

Mr. H. Blackburn, "Pictures of the Year."

Electrical Engineers, 25, Great George-street, S.W., 8 p.m.

Adjourned Discussion on papers by Prof. W. E. Ayton and Mr. E. W. Smith, "The Efficiency of Secondary Cells," and "The Chemistry of Secondary Cells."

**FRIDAY, Nov. 28** Clinical, 20, Hanover-square, W., 8½ p.m.

Physical, Science Schools, South Kensington, S.W., 5 p.m.

1. Dr. Gladstone and Mr. W. Hibbert, "Notes on Secondary Batteries." 2. Prof. S. P. Thompson, "An Illustration of Prof. Ewing's Theory of Induced Magnetism."

**CORRECTION.**—In the announcement of Professor Vivian Lewes's Cantor lectures on "Gaseous Illuminants," in the last number of the *Journal*, the date of the first lecture was printed, by mistake, as November 25 instead of November 24.

## Journal of the Society of Arts.

No. 1,984. VOL. XXXIX.

FRIDAY, NOVEMBER 28, 1890.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

### NOTICES.

#### CANTOR LECTURES.

Professor VIVIAN B. LEWES delivered the first lecture of his course on "Gaseous Illuminants," on Monday evening, 24th inst.

The lectures will be printed in the *Journal* during the Christmas recess.

#### UNION OF INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Central Young Men's Christian Association, Exeter-hall, Strand, W.C.

### Proceedings of the Society.

#### SECOND ORDINARY MEETING.

Wednesday, November 26, 1890; SIR WILLIAM S. SAVORY, Bart., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Birkbeck, Henry, 34, Southampton-buildings, Chancery-lane, W.C.

Bostock, George Henry, Hatfield, Yorkshire.

Doubleday, William Bennett, 123, Tulse-hill, S.W.

Ebb-Smith, Joseph, Worcester-house, Walbrook, E.C.

Few, William Resbury, Oaklands, Southfields, Wandsworth, S.W.

Levey, George Collins, C.M.G., National Liberal Club, S.W.

Lucas, Charles Phipps, The E'ms, Mottingham, Eltham, Kent.

Pope, Henry R., 34, New Bridge-street, E.C.

Roberts-Austen, Prof. William Chandler, C.B., F.R.S., Royal Mint, E.

Ruffer, Marc Armand, M.A., M.D., B.Sc., 27, Torrington-square, W.C.

Woolcombe, Robert Lloyd, LL.D., 14, Waterloo-road, Dublin.

The paper read was—

### PHYSICAL TESTS IN COMPETITIVE EXAMINATIONS.

BY FRANCIS GALTON, F.R.S.

In the autumn of last year, I brought the subject of the present paper before the Anthropological Section of the British Association. My views and proposals were favourably received, and, in the end, the Council of the Association were instructed to consider them at leisure, and if approved, to submit them to the authorities of the Army, the Navy, and the Indian Civil Service, and to the Civil Service Commissioners. This was done, and the replies were communicated by the Council to the Association at their recent meeting at Leeds.

It appears, from these replies, that the Civil Service Commissioners, moved thereto by the India-office, are now engaged in considering the practicability of the proposals. In the meantime the public are imperfectly informed of a matter that ought to interest many homes, whence candidates will shortly proceed to compete for Government appointments; while a few notes of alarm have been sounded by prominent newspapers, chiefly, as it seems to me, through misconception. I am glad, therefore, of the opportunity of making a fresh statement, with the emendations that have occurred to me, or have been suggested to others. I hope it may disarm some objectors, and more especially that it may encourage constructive criticism, which would be timely and, I presume, not unacceptable to the authorities, whose decision is still in the balance.

*General Statement.*—I will begin with a platitude that is also a truism, namely, that in selecting candidates to fill posts for which physical efficiency is desirable, it is proper that physical qualifications should be taken into account, supposing always that the existing system of study is not affected by doing so. High physical powers are advantageous in certain active professions, or at least in some

of their branches, and it is for these only that their recognition as subjects of examination is proposed. It is intended to be supplementary to the existing system and not to displace any portion of it. I neither praise nor dispraise that system, but leave it alone, including the medical pass examination, just as it is now, or as it may hereafter be modified; I am only concerned with faculties that are untouched by the present literary examinations, and which admit of being tested, as I shall show, without requiring special preparation on the part of the candidate that might distract his attention from his books or exhaust his energy and brain power.

Subject to these important reservations it is a mere truism to say that physical efficiency ought to be taken into account in selecting men to fill the particular posts above alluded to. My object to-night is to show that feasible and trustworthy tests exist, and to explain that if they be applied tentatively and on a small scale, with the avowed intention of reconsidering the whole matter after a few years' experience, very considerable improvements of method are likely to follow.

*Athletic Competition.*—It will prevent one large class of objections from obtaining and distracting the attention if I first disclaim all intention of proposing athletic competition. A scheme in which that was proposed was brought forward in a report presented to the House of Lords on June 28, 1878, by a joint committee of the War-office and of the Civil Service Commissioners. It was discussed three times in the House, and objections were raised against it. It was said that the cost of preparation to the candidates would be considerable, and that the strain of athletic training would be more than the health of the already fully worked students could safely bear. So the recommendation of the committee was not adopted. The objections to athletic competitions appear to me both reasonable and forcible, and I have neither the wish nor the intention to advocate them. What is proposed is to test, not the most that a candidate could do after a severe course of training, but his natural capabilities.

*Inspection.*—The distinction I wish to draw is familiarly illustrated in the two methods of valuing horses. The athletic competition is that of the racecourse. The horses are trained for a long time at great cost till they reach the utmost efficiency that their natures permit, and then they are run against one another. The other method is in much more common

use, as in buying horses at marts. The animals are looked over in their stalls, they are led out into the yard and put through their paces, and they are shrewdly valued after brief inspection. If the horse is young or out of sorts allowance is, of course, made for these temporary drawbacks to efficiency. The scheme of examination that I propose is of this latter kind, supplemented by simple physical tests, which serve as a backbone to the otherwise unchecked judgment of the examiner.

One of the proposals is, that the medical man who conducts the pass examination should in addition to his present duties, assign marks to each candidate according to his opinion of the physical efficiency of the candidate, after examining him. The practice is common of inspecting the candidates for adventurous services before making a final selection. It is certainly sometimes, and I believe always followed, in picking out the best men for such special work as arctic and other exploration. Indeed, it would be preposterous to neglect so obvious a precaution against gross mistakes.

I have often heard, or read, though I cannot now give good references, that when the practice of selling or buying slaves was practised by men of our race, with few qualms of conscience, the slaves were priced after a minute inspection. An experience of my own, of some forty-five years ago, while travelling in the Soudan, is to the point. An Egyptian, who possessed little besides a sword, had attached himself to the caravan with which I was travelling. He was on his way to join a slave-raiding expedition on the borders of Abyssinia, and he had, I found out, considerable experience in slave markets. I asked him many questions, from time to time, about the valuing of slaves, and, at last, begged him, as a favour, to price myself, just as if I was a light-coloured African; for I was curious to know my worth as an animal. He took evident pains, and I think was fairly honest, though with a bias towards flattery. Having regard to the then high state of the market, he estimated my worth on the spot, at a number of piastres that was about equal to £20.

I had the opportunity, a few months since, of seeing a collection of private memoranda that had been made by a gentleman who had occasion, from time to time, to select candidates for an important service. For reasons which I can appreciate, he begged me to give no clue whatever either to himself,

to the nature of the service, not even as to nationality. I was amazed at the variety of his epithets (I will not say in what language), and at his skilful delineations of the characters of the candidates by a sentence or two, not drawn in coarse blacks and whites, but with delicate and humorous shade. I begged and prayed, in vain, to be allowed to take away with me a few anonymous extracts, and to publish them. If this could have been done, they might have given considerable impetus to the progress of the rare art of skilfully drawing characters. Here, then, I found a case in which selection was largely determined by inspection, not of physical qualities only, but of demeanour as well. Character, as a whole, does not concern us now, but a manly bearing and an air of general intelligence may do so to a certain degree, and these might well be taken into some account, as they are not touched by the literary examination.

*Physical Tests.*—I will next speak of the physical tests that are at present available, and afterwards of the way in which a system of marks may be founded upon them. So far as these particular tests are concerned, no latitude is left for uncertainty of judgment. They are definite measures made with standard instruments. The uncertainty is confined to the value of the deductions to be drawn from them. They are as follow:—

1. Stature.
2. A few other linear measures, sufficient to show whether the principal dimensions of the body are or are not well proportioned. These include the span of the arms, the height above the seat of the chair when sitting, and the length of neck.
3. Weight.
4. Strength of grasp.
5. Breathing capacity.
6. Quickness of response to a signal by sound.
7. Quickness of muscular action.
8. Simple tests of vision.
9. Ditto of hearing.

The length of time requisite to make a set of these measures is less than a quarter of an hour. I have caused many thousand sets to be taken that were more extensive than these, and which severally occupied little more than that time. Some were carried on at an anthropometric laboratory that I set up in the International Health Exhibition in 1884, and the rest at another that has been for two years in operation in the western galleries of the science collections at South Kensington. The work-

ing of the process is therefore thoroughly understood. So is its total cost, which including superintendence, registration, and bookwork, need not, under judicious management, exceed 6d. per head.

*Instruments.*—I exhibit a few of the instruments I am now using. They are mostly well known, but that for the measuring the quickness of response has been got into its present very convenient shape only about a year since,\* and that for quickness of muscular action has been contrived still more lately.† It is almost needless to say that both of these qualities can be measured by more than one elaborate and troublesome method. For instance, by electrical action on a very light style, that lightly scratches the smoked surface of a revolving cylinder, whose rate of movement is recorded by another style attached to the end of a stiff spring, and which is maintained in vibration by an electrical impulse at the end of each excursion. This instrument is familiar to physiological students, and is most exact in its records; but it is far too troublesome for the purposes which we are now concerned. Hipp's chronograph is less troublesome, but it, too, is tedious. Something much readier to use and simpler to read off, is necessary if many persons are to be tested in rapid succession. The two instruments that I exhibit fulfil these requirements, and are at the same time more exact than is really needed.

The most difficult of the measures is that of the keenness of hearing. It is impossible, under the conditions of an examination, to obtain standard sounds, because the loudness of any note or noise is largely affected by the arrangements of the room in which the instrument may be set. The test to be employed, must, I fear, be of a very ordinary kind, and of the same general character as the greatest distance at which a particular watch can be heard to tick, or a small electric bell to tingle.

I will not occupy time by explaining the process of performing the physical tests. They have been often described, and can be seen in operation at my laboratory by any one who chooses to go there, for it has hitherto been and still is freely open to the public. It is entered from the new Imperial Institute road, near to its end in Queen's Gate.

*Marks.*—The question is, what to do with

\* For first account see "Journ. Anthropol. Inst.," xix. 1, p. 28; for a second account, "Report Brit. Assoc. for 1889," p. 781.

† "Journ. Anthropol. Inst.," xx. 2, p. 200.

measures after we have got them? How are they to be utilised as a basis for assigning a just allotment of marks? The real difficulty lies in these details, and not in accepting the general principle of the proposed examination. Later on I shall describe the safest guidance for drawing up a scheme of marks, but it is hardly available now. It would be attained after trying that tentative and provisional system which is asked for. There are three groups of faculties that must be dealt with differently.

*First Group.*—The more highly a man is gifted with the five following faculties, the better it would be for him in such posts as we are considering:—Absolute strength, quickness of response, swiftness of muscular action, keenness of vision, keenness of hearing. These faculties are also fairly independent of one another. It follows that we might with propriety mark the candidates according to their measured achievement. Again, it is a rough-and-ready practice to arbitrarily fix two limits in each case. Those who fall beneath the lowest limit are to obtain no marks at all. Those who exceed the highest are to obtain a certain maximum of them; for simplicity of illustration let us say ten. Then an achievement halfway between the limits counts as five, and others proportionately. This is by no means an ideally exact way, but it is good enough for our present purpose. In arbitrarily fixing the limits, we must be guided by some reasonable idea, and the one I should suggest is to take, either exactly or approximately, the lines that respectively cut off the lowest 5 per cent. and the highest 5 per cent. of men of the same age and social status as the candidates. I possess plenty of such statistical measures as these, which are very nearly, if not exactly, applicable to the candidates in view. It will be sufficient to give, merely as an example, a few figures from a table of values that I compiled from the measures taken at the International Health Exhibition of youths between the ages of 23 and 26. The upper and lower limits for strength of grasp are here 56 and 96 lbs. Five per cent. of the whole number stood below the first limit, and 5 per cent. above the second; but, according to the principal laid down, we arbitrarily refuse either to give negative marks for the very weak, or more than a certain maximum of marks to any man, however strong.

To reduce all this to as simple form as possible, let us suppose a maximum of ten

marks; then we might change the limits a little, for the sake of obtaining round numbers, and allot ten marks for a strength under 55 lbs., and one mark for each additional 5 lbs. above that limit, up to 105 lbs., as a maximum. If the maximum marks were to be other than ten, the rule would be modified accordingly, but the general principle would be the same. There is no difficulty of importance in this method of devising a system of marks. Neither would there be any difficulty in its practical application. The marks might be engraved on the scales of the various instruments, together with the correction to be applied for age in the case of absolute strength and of swiftness.

The maximum number to be allotted to each of the five faculties\* I have mentioned would have to be arbitrarily determined, according to some common sense view of the whole case.

*Second Group.*—A second class of qualities has to be estimated relatively to one of the others, not independently or separately, like those just discussed. At least three faculties fall within this group, namely, strength and swiftness, considered from a fresh point of view, and breathing capacity. Here the examiner would probably work with printed tables, in each of which the measures of one faculty would be arranged along the top at the heads of successive columns, and those of the related faculty down the side at the beginnings of successive lines. The marks and the age correction would be read off in the square where the appropriate column and line crossed each other.

In the sense in which strength is now to be considered, a racer is stronger than a cart-horse. Though he cannot perform the same amount of work measured in foot-pounds, he is able to transport himself, and move his limbs the more easily of the two. His strength, relatively to his weight, is greater than that of the cart-horse. It is easy to express the value of this fraction. Strength is supposed always to be measured in the same units: say, in the number of pounds weight that the grasp can resist. Weight is also supposed to be always measured in the same units: say, in pounds

\* I may here mention that the literature connected with "Reaction Time" is voluminous. It has been much experimented on, because it affords a powerful aid to psychological research. A remarkably clear and able compendium of what has been achieved by its measurement has just been published in a little book by Professor Jastrow, called "Time Relations of Mental Phenomena." (Hodges: New York, 1890.) A very useful bibliography of works of reference is contained in it.

also. Then the fraction we want has the units of strength for the numerator, and units of weight for the denominator, which is easily turned into an ordinary decimal. Then, just as in the first method, we find two limits of value. Those whose record falls beneath the lower limit receive no marks at all; those who rise above the upper, receive the maximum.

Swiftness should also be treated relatively to weight, though not as a fraction but as a product. The units of swiftness have to be multiplied into the units of strength, to measure the momentum of a blow or of a rush.

Lung capacity has to be treated on parallel lines to strength. The human body is a locomotive worked by a chemical engine. It is stoked with food, and pumps in air to burn waste products; then it pumps out the air after it has been vitiated by the burnt products, doing this in alternate rhythm. A respiratory apparatus, that is amply large enough for a small human body, may be altogether inadequate for a larger one. Therefore it is the lung capacity relatively to the size of the body that concerns us, and not the lung capacity in an absolute sense. We have to regard the fraction in which the numerator is the number, say, of cubic inches of lung capacity, and the denominator is the number, say, of pounds in the weight, or else some function of the number of inches in the stature. The marks can then be assigned as before.

*Third Group.*—As regards symmetry, I have little of my own to say that is worth saying. The normal proportions of the body are pretty well known in the different races, and it is presumable that a wide departure from them in any direction is prejudicial. We have here an instance of a third class of qualities, where the broad belt of average values would receive full marks, and deviations outside of it on either hand, would receive fewer, until at the limits roughly determined as before on the 5 per cent. principle, they became *nil*. There is at least one simple method of rapidly finding out the marks to be assigned in the cases that fall within this group, but I will not stop to describe it, as I cannot do so very briefly.

Stature is another instance of the same sort. It is largely dependent on race, but in each race there is a normal value. Moderate departures from the normal are not important, but wide ones are, whether in excess or deficiency. Some information about this is to be found in Gould's "Statistics of the American

War," published by the Medical Department of the United States.

It will now, I hope, be understood that there is no important difficulty of principle in assigning fair marks to the results of physical tests, and that if the principle is agreed upon in the sense just explained, its practical application is simple.

These physical tests would afford guidance to the examiner in assigning the marks he has to give according to the result of his inspection. If his judgment appears to be contradicted by the tests, he would reconsider it; if corroborated by them, he would feel the more assurance in his view. The tests would afford a valuable safeguard to the correctness of the final opinion of the examiner.

All that have thus far been proposed could be carried into effect at once. I shall afterwards discuss the directions in which the experience of a few years might be expected to suggest improvements. In the meantime it will be well to answer objections that have been brought against the proposal generally.

*First Objection.*—The two objections that have been most frequently urged are merely blows in the air, struck wide of the scheme, as it will be easy to show. The first is that certain great commanders and strategists had a poor physique, and would have been excluded by the proposed tests from the profession in which they afterwards distinguished themselves; that Nelson, for example, would have been excluded. The reply is that the proposed plan does not peremptorily exclude anybody on the ground of poor physique. There exists already a very salutary medical pass examination that excludes youths who appear to be distinctly unfitted for active service; but the new and additional proposal merely asks that a candidate who is below par in bodily powers should be above par in mental powers as a counterpoise. There is a rather broad belt of barely distinguishable degrees of mediocrity of mind, through or near to which the line runs that divides success from failure in the ordinary competitive examinations. But among the candidates who fall within this belt we may expect to find just as great a variety of bodily powers as among any other group of candidates. It is upon these only that the proposal to give moderate marks for physical efficiency would have any effect of importance. It would raise some men of mediocre intellect, but of powerful frames, into the pleasant table-land of success, and it would

depress an equal number of men of almost equal mediocrity of intellect but with puny bodies as well, into the gulf of failure. The State would gain by the exchange. As for the candidates who had a fair place in the literary class list, the total want of extra marks for bodily efficiency would be insufficient to exclude them. It would only make them lose a few places.

The discovery of Dr. Venn\* is most important to us here. He found that the three classes of high honour men, poll men, and of those who were intermediate between the two, have on the whole almost exactly the same average physical faculties, and that the degree of individual variation amongst them is the same in both classes. He discussed with thoroughness and ingenuity two considerable batches of measurements that were made at Cambridge with some instruments I had set up there, both of which told the same tale independently. That men who are mediocre in intellect are not also mediocre in physique, but are just as variable as any others, has therefore been shown to be a trustworthy fact, and the absurdity of taking no account of their variability becomes conspicuous.

*Second Objection.*—The second objection is that these tests take no account at all of the important quality of energy, which includes pluck, strong will, and endurance. I fully grant it, but half a loaf is better than no bread. The proposed tests tell us something useful that was disregarded before. They do not profess to cover all the *lacune* left by a literary examination. There remain an abundance of important points of character, moral and other, that are wholly undealt with. We must be content with what we can get. It is not impossible that practicable tests of energy in some of its forms may yet be discovered. It must be associated with physiological signs that we have not yet had the wit to discover. The power of enduring fatigue evades measurement, owing to its being largely affected by practice and athletic training; and there occurs, as yet, no way of estimating these disturbing causes. Put one of two similar youths into high training, and he will climb mountains, run races, and so forth, without any disturbance to his health, which the other could not attempt without serious risk. It is greatly to be regretted that we can devise no test for natural energy. It is a characteristic of great men to have an

\* See *Nature*, 1888-90.

unusually large share of it. Sometimes it shows itself in mental work, sometimes in bodily work; often in both combined. The work got through by great commanders, without injuring their health, is enormous. Brief hours of sleep, harrassing anxieties, multifarious objects of attention, climatic changes, are borne for months. Now and then occur the arduous preparations for a great battle, the fighting it, and afterwards a minute and lucid despatch has been written, perhaps in the late evening of the same day.

*Third Objection.*—Another objection concerns the untrustworthiness of the results of examination. There is no reason to suppose that physical tests would be more untrustworthy than literary ones; indeed, such experiments as have been made point the other way. I do not champion the system of examination, but as we have it, and as no one can devise a better way of selecting candidates, we ought to increase its value by making it less one-sided. Those who desire to have a definite notion of the variability of judgment in literary matters among examiners, should study the careful and ingenious memoir by Prof. F. Y. Edgeworth in the current number of the *Statistical Journal*.

*Need of further data.*—Before it is possible to devise as good a system of physical tests as we may reasonably hope at some time to obtain, we require observations in sufficient number and in a sufficiently exact form.

*Worth of Physical Tests.*—We have, for example, to compare the rank in physical efficiency that is assigned to youths by tests and inspection with the rank that they hold according to the consensus of their fellows and competitors in athletic sports. We should thereby ascertain more exactly than we can do now the relative importance that ought to be assigned to the various tests.

*Promise in Youth.*—Again, we have to compare the physique and promises of youth with their achievements in after-life. Now, we obviously cannot examine into this relation unless records are preserved and are easily accessible of the physical powers of youths. We require statistical data on a large scale before it is possible to deduce trustworthy conclusions; and it seems impossible to establish the needed system of records, except under the stimulus of such examinations as I have in view. If the present conditions continue unchanged, inquiries into the important question I have

indicated will linger on indefinitely. It will remain in the hands of a few amateurs, whose energies are largely absorbed by the almost hopeless task of searching for materials. Apply the stimulus of examination, and not only will the required data begin to accumulate, but many intelligent schoolmasters and others will feel it a matter of business to discuss them. There ought to be no difficulty in finding out the physical antecedents of every man when he was a youth. It is easily to be done in respect to his class place in literary examinations, and the value of these in forecasting his future can be discussed; but there are absolutely no records worthy of trust, on a sufficient scale, in respect to his physical powers.

*Vigour of Eminent Anglo-Indians.*—I may here mention an observation that impressed me a good deal at the time. On the eve of the departure of the late Sir Bartle Frere on a high political mission to Africa, his numerous friends entertained him at a farewell banquet. I was present, and seized the opportunity of estimating, as dispassionately and as carefully as I could, the average physical appearance of the eminent Anglo-Indians, who were the preponderating element in the party. I was the more moved to do so because the first feeling was one of surprise at the difference between what they were and what I had expected. I was prepared to see a collection of bilious and worn-out men. Not a bit of it; they were remarkably hale and vigorous. They were above the average stature and breadth—there was an air of force and power about them. They were as fine a collection of human animals as I have ever seen. I am sure that such examiners as those I have in view, would have given high marks to most of them for physical efficiency.

*Tolerance of Tropical Climates.*—Our ignorance is crass in respect of not a few elementary questions of national importance, which cannot be answered until the habit of preserving physical records of youths shall have become more common than it is. One of these regards the indications that a youth will or will not be able to keep his health in a hot and feverish climate. No inquiry has ever been made into these with the thoroughness and precision that the question obviously deserves. There is great variability among men and animals of the same race in their power of enduring malaria and changes of climate. It has happened that I have been more than a

third of a century closely associated with the doings of the Royal Geographical Society, and during that time I have often had occasion to remark the ease with which the constitutions of successful explorers have thrown off the effects of fever. They may have been attacked frequently and severely but the malady rarely takes so strong a hold, as to leave them permanent invalids. Still less does it kill them, as it speedily kills many others who were, to all appearances, equally vigorous and energetic. A careful investigation of numerous cases would probably show that physiological signs might be discerned during youth, either of a natural immunity from malarious fever, or of a disposition towards it. It is cruel and costly to tempt youths to the tropics who are less constitutionally capable than others of thriving there. If we could distinguish those who are fittest for life in hot countries, we should select them even though in other respects they may be somewhat wanting. The tropical possessions of England are become so large that it is a matter of national importance to investigate this question thoroughly. It may yet be possible to find varieties of our race who are capable of permanently establishing their families in those climates.

It would be easy to enlarge on the topic of our astounding and contented ignorance of very elementary questions in respect to the choice of the men who are most likely to succeed in special services, but enough has been said to show the need of stimulating a demand for the collection of trustworthy records. No stimulus would approach in efficiency to that of establishing physical tests in connection with certain of the competitive examinations. If this were done provisionally, as proposed, and on a small scale, many persons who are connected with education, or with the public services, would interest themselves warmly in the subject. It would become a matter of present importance to themselves, and what is now only an academic question would be raised to the rank of a practical one.

I trust now that the two points have been established that it has been the object of these remarks to prove. First, that it is possible at once to devise a system of physical tests and inspection that shall be of real utility. Secondly, that in addition to its present value it would afford a necessary first step towards a more satisfactory scheme.

## DISCUSSION.

The CHAIRMAN said that this paper would afford ample scope for discussion, as the subject was one on which wide difference of opinion might exist, not, indeed, on the principle itself, which was now conceded, for in many examinations physical tests were to a certain extent already used. The more difficult question to answer was the relative value to be attached to these tests, not only in comparison with literary work, but the relative value of the different tests themselves. To express it broadly, some might attach more importance to tests for mere strength, and some to those for physical health. He noticed that the author did not give so much prominence to personal and family history as some might be disposed to do. He took it Mr. Galton's motto would be *mens sana in corpore sano*, but there was a very broad and deep distinction between health and strength.

Admiral COLOMB said the subject of physical tests in competitive examinations was familiar now to every one in the army and navy, because it had been so much talked about, but until to-night he had only heard of it in connection with athletic competitions, which Mr. Galton proposed to discard altogether. So far as he understood the proposal, it would bring forward some useful men whose mental capacity was possibly a little below par, but who made up for the deficiency by their physical qualifications. Whether the Government would ever tentatively adopt such a system was a question, but one point struck him which might have some weight. In the old days a large number of officers were entered for both the army and the navy, and were then left to sink or swim as they could, and there was a sort of natural selection out of an immense body, the best men being retained for the services, and the others disappearing. That system had been abandoned, and by means of artificial tests the field from which officers were drawn was very much reduced. It therefore seemed desirable to make the examinations as complete as the knowledge of the time allowed, and he certainly thought that the tests described would help in selecting the best men and rejecting the worst. He should have thought a test of energy and possible capacity might be obtained from the pulse, the rapidity of the breathing and the effect of starts, and especially from the condition of the digestion. It was an old saying that a man "had no stomach for a fight," and he thought there was more in that than a mere trope. A man's want of courage might come from not having a good digestion. In the excessive fear experienced in dreams, the sensation felt on waking was always about the diaphragm, and when startled by a sudden apparition he had felt the same sensation himself in that part; so that probably digestion had a good deal to do with what was called courage and energy. One physical test not referred to was the cause of

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considerable experience in examining recruits, both officers and privates, and he thoroughly appreciated the great and growing importance of this subject. The acquisition of this knowledge would eventually be of great service to the public, and would enable parents and tutors to judge of the character of the candidates they produced either for the public or private service. Mr. Galton disclaimed any kind of athletic exercises in examination, and reduced his observations to the powers of the candidates—mental, muscular, and nervous. Observations as to some physical features, stature, &c., had been made for years and years, and there were piles of books at the Admiralty and War-office containing the records of centuries; but new branches of inquiry were now opened up which were still capable of much greater development. The power of will, for instance, could be exemplified by the stroke or blow of the fist, if the instrument were properly adjusted. Another point was the power of the voice, which was of great importance both to the private seaman as well as the officer. The captain or the colonel had to make his voice heard on parade, and the boatswain also had often to produce his voice in the most decisive and peremptory manner. Mr. Galton had an instrument for testing the strength of the arm, but it was equally important to test the strength of the leg. Nothing could be of greater importance to a commanding officer than to know the power of his regiment to march; but that had not hitherto been at all investigated by any instrumental method; it was judged of simply by the eye and other means; but it could scarcely be judged of by the appearance of the men. It was well known that the British private was not good at marching, though he might have a good physical appearance and be a good boxer; the Frenchman would beat him in marching, and the reason of that should be ascertained, for it had not yet been investigated by physical observation. Again, the power of balancing was a good test of the perfection of the whole system. Recruits were tested by standing on one leg; that power of balancing showed the perfection of the nervous system, both in the spinal cord and in the brain. It was also important to ascertain whether a man were left-handed or not; both feet and both hands should be of equal power, and both legs also. In fact the suggestions which might be made were almost innumerable, and he only threw these out as perhaps worth consideration.

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The vote of thanks was carried unanimously, and the proceedings terminated.

## Miscellaneous.

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There are three kinds of silkworms in the district of Ningpo—the common, the horned, and the striped—all living on mulberry leaves. Consul Fowler states that there is also a worm which lives exclusively on the leaves of the oak. This comes from New Chwang. This worm is much larger and apparently harder to rear than the ordinary one. It is quite green in colour. The moth of this worm is of a deep yellow, and measures four inches across when the wings are spread out. On each wing are two or three transparent spots called eyes. The natural life of an ordinary silkworm, that is to say, from the time it is hatched to the death of the moth, is said to be from forty-five to fifty days, about five of which

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