The physical examination and development of public school boys, based upon records of over 40,000 observations : a paper read before the Associaton on April 4th, 1899 / by Cecil Hawkins.

Medical Officers of Schools Association.

THE PHYSICAL EXAMINATION AND DEVELOPMENT OF PUBLIC SCHOOL BOYS.

BASED UPON RECORDS OF OVER 40,000 OBSERVATIONS.

A PAPER READ BEFORE THE ASSOCIATION

On April 4th, 1899.

BY

CECIL HAWKINS, M.A.,

HAILEYBURY COLLEGE.

London:

J. & A. CHURCHILL, 7, GREAT MARLBOROUGH STREET.

1900.

MEDICAL OFFICERS

OF

SCHOOLS ASSOCIATION

Founded 1884.

Presidents.

1884.

Surgeon-Major **EVATT**, A.M.S., M.D.

1885.

THOMAS FULLER, M.D., M.R.C.S.

1886-9.

Sir **WILLIAM SAVORY**, Bart., F.R.C.S.

1890.

JAMES ANDREW, M.D., F.R.C.P.

1891-4.

WILLIAM HOWSHIP DICKINSON, M.D., F.R.C.P.

1895-7.

EUSTACE SMITH, M.D., F.R.C.P.

1898-9.

HOWARD MARSH, F.R.C.S.

Honorary Members.

ALLBUTT, T. CLIFFORD, F.R.S., LL.D., M.A., M.D., F.R.C.P., Regius Professor of Physic University of Cambridge.

BELL, The Rev. G. C., M.A., Head Master, Marlborough College.

LYTTELTON, The Rev. the Hon. Canon, M.A., The Master, Haileybury College.

SANDERSON, J. BURDON, F.R.S., D.C.L., D.Sc., LL.D., M.D., F.R.C.P., Regius Professor of Physic University of Oxford.

TEALE, PRIDGIN, M.A., M.B., F.R.C.S., Member General Medical Council, and Consulting Surgeon Leeds General Infirmary.

WARRE, The Rev. E., D.D., Head Master, Eton College.

The Right Rev. Lord Bishop of Calcutta (The Rev. J. E. C. WELLDON, D.D.), late Head Master, Harrow School.

WOOD, The Rev. JOSEPH, D.D., Head Master, Harrow School.

COUNCIL, 1899—1900.

The President.

MARSH, HOWARD, F.R.C.S., Consulting Surgeon Hospital for Sick Children, Great Ormond Street.

The Past Presidents.

Vice-Presidents.

CLARKE, Lt.-Colonel, R.A.M.C., M.D., M.R.C.S., Medical Officer Royal Military College, Sandhurst.

FARQUHARSON, ROBERT, M.P., LL.D., M.D., late Medical Officer Rugby School.

HAIG-BROWN, C. W., M.D., M.R.C.S., Medical Officer Charterhouse, Godalming.

MURPHY, SHIRLEY, M.R.C.S., L.S.A., Medical Officer of Health for the County of London.

THURSFIELD, T. W., M.D., F.R.C.P., Medical Officer Leamington College.

Honorary Secretaries.

ALDERSMITH, H., M.B., F.R.C.S., Medical Officer Christ's Hospital, London.

SHELLY, CHARLES E., M.A., M.D., M.R.C.P., Consulting Medical Officer Haileybury College.

Honorary Treasurer.

ABERCROMBIE, JOHN, M.D., F.R.C.P., Consulting Physician Foundling Hospital, London.

ARMSTRONG, H. GEORGE, M.R.C.S., L.S.A., Medical Officer Wellington College.

GRIPPER, WALTER, M.A., M.B., M.R.C.S., Medical Officer Female Orphan Asylum, Beddington.

IEVERS, EYRE, B.A., M.D., M.Ch., Medical Officer Tonbridge School.

MURRAY, H. MONTAGUE, M.D., F.R.C.P., Consulting Physician Foundling Hospital, London.

BINDLOSS, ARTHUR H., B.A., M.B., B.C., Medical Officer Harrow School.

INGLE, ARNOLD C., B.A., M.D., B.C., Medical Officer The Leys School, Cambridge.

PARKES, LOUIS C., M.D., M.R.C.S., Medical Officer of Health, Chelsea.*

REID, T. WHITEHEAD, M.D., M.R.C.S., Medical Officer King's Schools, Canterbury.

FREEMAN, WILLIAM T., L.R.C.P., F.R.C.S., Medical Officer Bradfield College.

HAWKEN, LOCKWOOD, M.R.C.S., L.S.A., Medical Officer St. John's College, Hurstpierpoint.

NORRIS, EDWARD STACY, M.A., M.B., M.R.C.S., Member of the Eton College Medical Board.

SAVORY, HORACE, M.A., M.B., M.R.C.S., late Medical Officer Haileybury College.

* Auditor.

THE PHYSICAL EXAMINATION AND DEVELOPMENT OF PUBLIC SCHOOL BOYS.

THE chief objects of general interest to be gained by systematic observation of growing boys are :—

(1) Advancement of our knowledge as to the general rate of growth of the human frame.

(2) Advancement of our knowledge as to the growth which may reasonably be expected of any individual at any stage of his development.

(3) Advancement of our knowledge as to the effect which systematic physical exercises produce upon the development of the frame.

I believe that the present state of our knowledge upon each of these points is far less extensive and accurate than is generally supposed, and that there is too much disposition to accept the variations of certain averages as fixing the correct rate of growth of the healthy boy, and to assume that any marked departure from this rate of growth is an unhealthy sign. This tendency is accompanied by too strong a belief that the healthy condition of the individual under observation can be correctly gauged by the exactness of his conformity to certain rules of proportion or symmetry, which have been based upon averages.

Such a method of diagnosis does not, in my opinion, sufficiently take into account what the natural scheme, so to speak, of the individual's growth may be, for there is no doubt that it is natural to a considerable proportion of the human race to differ in a marked degree from the general average as regards their proportionate structure,

and that such variation is a part of the general scheme of their growth, and is to be regarded as the normal condition of their development. We have only to look around us to see that there are fully as many different types of human beings as there are of horses or sheep. Now, nobody would dream of saying that the weight of a racehorse in training was so much below the average of horses of the same height, that there was grave reason to be apprehensive of some constitutional defect. No one would expect to find the same rate of growth in a Scotch black-faced lamb as in one of the Down sheep bred by special selection to secure early maturity. Yet we are constantly told that a healthy child at such and such an age should grow so many inches a year. We constantly hear that X. is so many pounds lighter than he ought to be, or that Y.'s chest is so many inches less than it should be for a boy of his height, and so on. I believe that the problem of a boy's growth is far too complex to be solved in so rough and ready a manner. I believe that the general scheme of his growth *must* be taken into account for purposes of diagnosis, and I am sure that, in order to ascertain what this scheme may be, an accurate and continuous record of his growth should be available.

It may appear that I have rather overstrained my argument in taking the analogy of different types of horses and sheep, and that I have neglected the fact that averages are given for various different classes of the population, which may be supposed to correspond roughly to the different types of the lower animals; but it must not be forgotten that our boys are not bred purely from one class, like our pure bred sheep or horses; that the classes into which human beings are divided are few in number and very arbitrary; that there is no such sharp line of demarcation between them as there is, for instance, between a black-faced sheep and a Cheviot; and that the characteristic growth of an individual may be, and often is, strongly influenced by the presence in his system of hereditary tendencies quite foreign to the class in which he is arbitrarily placed. It should be one of the functions

of his physical record to make clear, for each individual, what his characteristic scheme of growth may be, in order that any irregularity of development due to external or removable causes may be discovered. This discovery is the fourth of the chief objects to be obtained by systematic observations, and, from our point of view, the most important; for if we are to secure the best possible development of the boys entrusted to our care, we should surely take steps to discover, by careful observation, whether their development is proceeding satisfactorily in all cases, or whether individual boys do not require supplementary care of one sort or another: it may be in the matter of food, or clothing, or exercise, or it may be simply in advice as to their general habits.

To make a physical record of value, then, it must be accurate and continuous, and no boy should be allowed to escape. It is obvious, too, that this record must be studied by somebody more skilled to read the signs which it contains, than the ordinary gymnastic sergeant to whom the duty, as a rule, is delegated. It must be studied by those who are primarily responsible for the due development of the boy's frame, and who are capable of discovering the causes of any physical deterioration and applying the correct remedy. It must, therefore, if possible, be in the hands of the medical officer of each boy's school, and prepared by him, or, at all events, under his guidance and supervision.

Now, granted that the boy is to be measured, we are next confronted by the important question—How shall we measure the boy? The first step, of course, is to observe the actual measurements of various details of the boy's dimensions; but I propose to show that the word *measure* must be used in a far wider sense than this, if much good is to be extracted from our observations. To deal with these details first, the Americans, who attach great importance to this subject, think it desirable to record observations on 24 details at least: how many of these are necessary is a matter to be settled by experts; but, if the keeping of regular and continuous records is to become a general practice at schools, I am

quite certain that only a few of the most important details should be insisted upon. In England it is usual, where any observations are taken at all, to record observations on 5 details only, in addition to the boy's age. In the present paper I shall deal with the three most important of these, viz., Height, Weight, and Chest-girth.

Suppose, then, that we have obtained a series of measurements of the various details of our boy's dimensions, we still have to make up our minds how we are to form an estimate of the boy as a whole.

Now our boy must be measured, as all physical quantities are measured, by comparison with a standard quantity of the same kind. How is such a standard to be fixed? The standard usually accepted as necessary and sufficient is the average boy, and it appears to be generally assumed that this average boy is a known absolute unit, fixed by Nature, whose rate of growth, and proportionate structure, ought to be followed within narrow limits by any individual examined. But the standard units in general use are, almost without exception, not fixed by Nature in the last instance, but by authority; *e.g.*, the French standard unit of length, which professes to be one ten-millionth part of the length of a quadrant of the earth's meridian, is in reality fixed by the length of a certain bar of metal, which when first constructed was supposed to be that length. This is fixed by authority to be the standard unit, and is an arbitrary and not an absolute unit. So it is with the average boy; he is an arbitrary and not an absolute unit, fixed by the dictum of the last observer, who has worked out the averages of a sufficient number of boys, and regulated by the conditions under which the observations were obtained from which that unit was evolved.

Thus in Fig. 1 the lowest curve gives the growth in height of the average boy of the general population from the age of 10 to 20, as fixed by the Anthropometric Committee of the British Association, and published in the 1883 report; the highest curve gives the growth of the average boy of the professional classes, as fixed by the same authority; the dotted line ..... gives the growth

of the average boy as fixed by Mr. Roberts from observations of public school boys and military cadets. This boy starts as one of the general population, and finishes up amongst the professional classes. The dotted line —·—·—

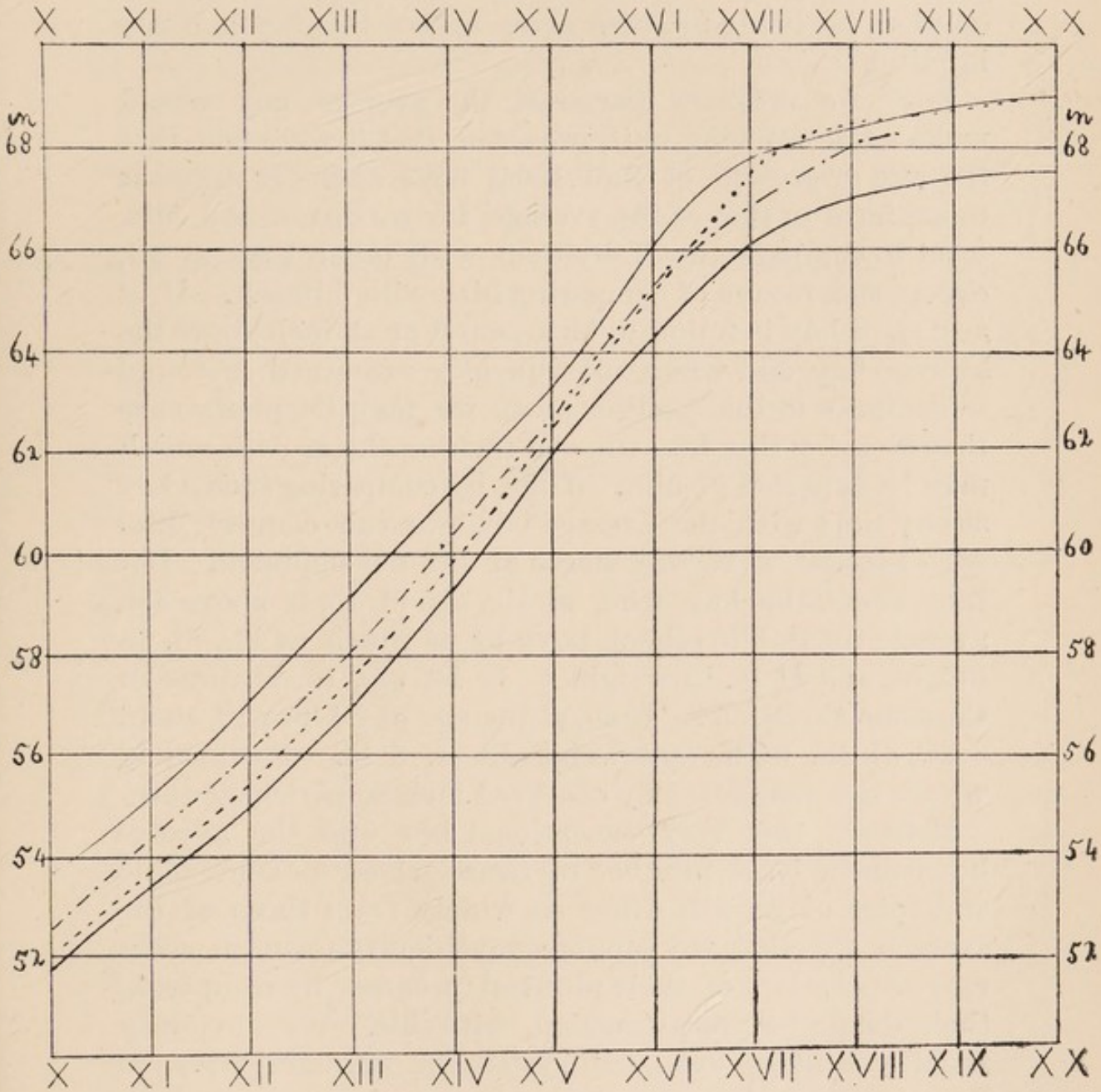

FIG. 1.

is my own mean boy. Now all these curves have approximately the same form, and give practically the same *rate of growth* for the average boy at any selected age; but they are arbitrary and not absolute standards. The difference between the highest and lowest amounts to

more than 2 inches in places, and any argument based upon the absolute difference between the observed average of a class of boys, and the average which they ought to possess according to the particular standard which happens to be quoted in the nearest text-book, must, in my opinion, be liable to grave error unless this fact is borne in mind.

Still, for ordinary purposes, the average boy would make a fair working unit, provided that it were true that the rate of growth of individual boys ought in all cases to conform to that of the average, for we do not, as a rule, want to compare the individual with other boys at all, except as a means of comparing him with himself. If at any age a boy is found to be a pound or an inch above the average boy, and when subsequently examined is found to continue in that position, then we may be pretty sure that he is holding his own, and making the growth which may be expected of him. Thus, by comparing such a boy at any time with the average boy, we can compare him with himself at various stages of his development. But how about the boy who, at the age of 13, is above the average for public school boys by as much as $11\frac{1}{2}$ in. in height, and 41 lb. in weight? Is he too, to continue in the same variation? If so, at the age of 20 he will stand 6 ft. $8\frac{1}{2}$ in. high, and weigh 13 st. 8 lb. Fortunately we are not compelled by observed facts to anticipate this.

Between this very exceptional boy and the average boy come a large number of cases, whose measurements and rates of growth differ so widely from those of the average boy that we cannot conveniently form an accurate conception of their physical progress by comparing their details of measurement with his. We obviously require a more extended system of standard boys, so that we may be able to compare every case which comes under our observation with a standard or standards differing but little from the boy observed.

Such a system of standard boys is practically given to us in the system of percentile grades, explained by Mr. Francis Galton in his charming book "Natural Inheritance." As many people are unfamiliar with this method

of approaching the subject, I had perhaps better explain briefly how the percentile grades are arrived at. The first thing to be done is to form a series of curves of distribution of which the central curve in Fig. 2 is an example. This curve was formed to represent graphically the

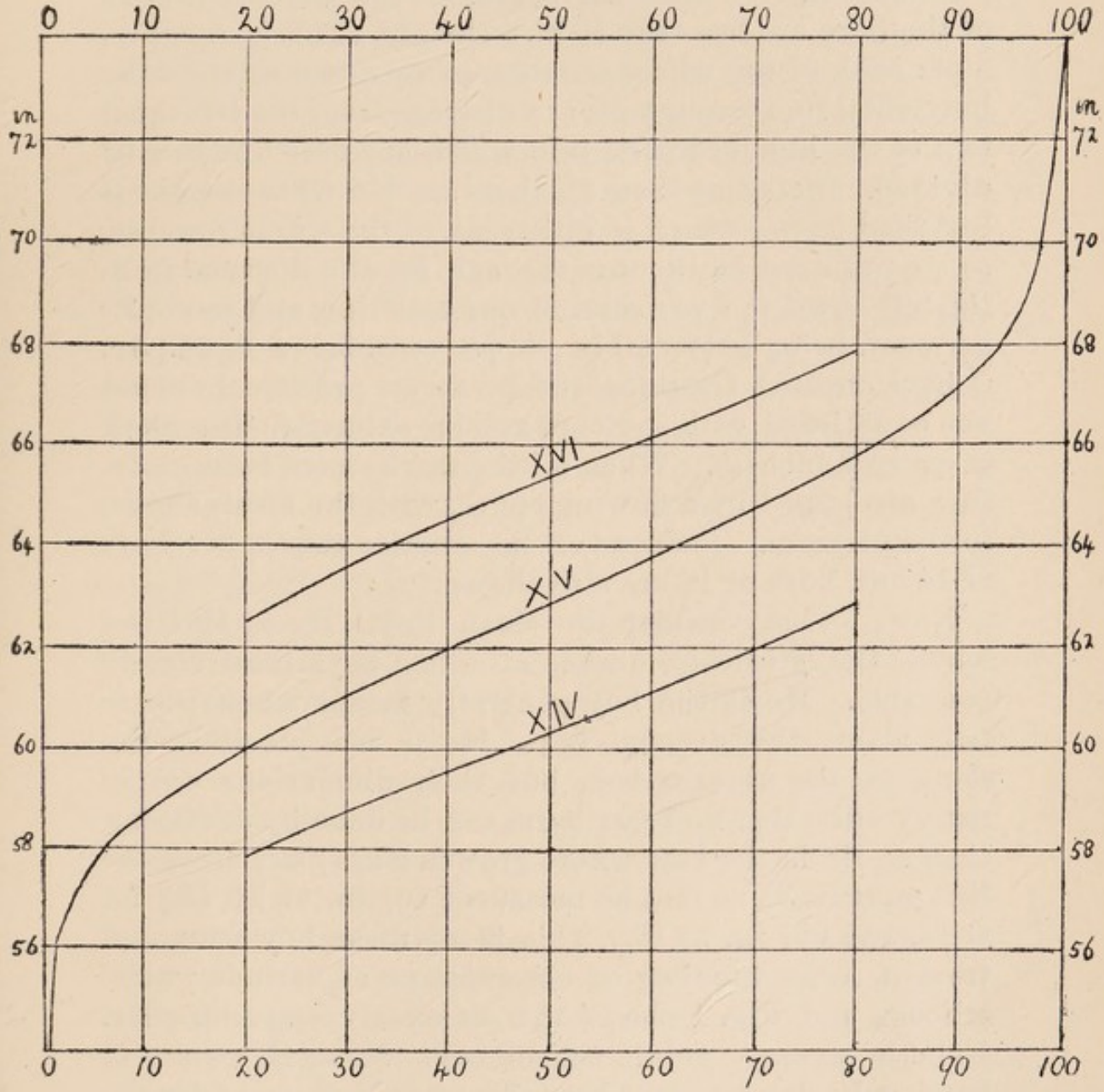

FIG. 2.

manner in which the observed heights of 1,689 school boys of the age of 15, collected from various schools, were distributed. As a matter of fact I took in all boys whose ages did not differ from 15 by more than one month, and I may state, once for all, that that is the general system upon

which I have worked throughout. On the base line in the figure the numbers 10, 20 . . . refer to the number of boys per cent. who are below the height which is found upon the vertical scale opposite to the points where the vertical lines through the numbers 10, 20 . . . cross our curve of distribution. To draw the curve, we first observe that 29 of the boys are less than 56 in. in height. This is, roughly, 2 per cent. of the whole number, so we make a dot on the horizontal line through 56, at a distance from the left equal to 2 of the hundred parts into which our base line can be divided. Including these 29, there are 116 whose height is less than 58 in., which is 7 per cent. of the whole number, so we put a dot on the line through 58, at a distance from the left equal to 7 per cent. of our base line, and so on, 20 per cent. being below 60 in., 40 per cent. below 62 in., &c. (I have omitted fractions, and in actual practice I should not be satisfied with so rough an approximation as a mark at every 2 inches). When all the marks have been made, they are joined by a flowing curve, with the result shown in the diagram. Portions of the similar curves for boys of 14 and boys of 16 are also shown.

Now, let us consider the Mean Boy. He is the boy whom the greatest number of other boys most closely resemble. He is the boy generally meant when people talk about the average boy. He is not precisely the same as the average boy, but their dimensions are so nearly alike that no great harm can be done by confusing them. He is the boy whose growth takes place along the line marked 50, so that he measures $60\frac{1}{4}$ in. at 14, $62\frac{3}{4}$ in. at 15, and $65\frac{1}{4}$ in. at 16. This is my mean boy computed from a large number of observations at various public schools, and Fig. 1 shows that he closely resembles Mr. Roberts' average public school boy. Now, if we are to have only one standard boy, this mean boy must be the right one to take, since a larger number of boys can be readily compared with him than with any single boy whose growth takes place along one of the other vertical lines in our diagram ; but in all other respects any boy whose growth takes place along one of the vertical lines is equally suitable as a standard, since he always keeps

precisely the same relative position amongst his fellows at every age.

Thus the boy whose height at every age throughout his growth is indicated by the point at which the line marked 80 cuts the corresponding curve of distribution, will always have 19 per cent. of the boys of the same age taller than himself and 79 per cent. of them shorter, so that it appears reasonable to take the rate of growth of such a boy as a standard to fix what may reasonably be expected from a boy who coincides with him at any given age. Thus if we measure a boy of 14 and find that his height is $62\frac{4}{5}$ in., we should see on reference to our diagram, that this is the point where the 14 curve cuts the vertical line through 80, and consequently his percentile grade is said to be 80. At 15, if he is to keep his position amongst his fellows, his height should be $65\frac{4}{5}$ in. If he only measures 64 in. at 15 he has sunk to grade 63, and now coincides with the standard boy of grade 63, as may be seen from the diagram. In this paragraph, and in all that follow, the word "boy" must be taken to mean "public school boy."

In actual practice, however, when a large number of boys are to be dealt with, whose details of measurement have been observed at various odd months, this process is most laborious. I tried it for a time, but the labour of fixing each boy's approximate position on a chart was too great, and I had to give the system up, and adopt a modification of it. I came to the conclusion that I must have tables, and I set to work to construct tables from my curves. I found that tables of 100 grades would be too bulky, and that I must reduce the number if possible. This was found to be not only possible, but desirable, for the very important reason that the classification into 100 grades was too sensitive, the difference between the consecutive grades being frequently so small as to be less than the necessary limit of error of observation, which caused the results obtained to be confusing. I consequently, after some thought, adopted the number 20 as giving results fairly commensurate with the probable error of observation. I classified my observations so as to be able to place

every boy in one of 20 grades, so selected that each grade ought to be equally probable, and I numbered these grades from the top downwards. This classification has been found to be very convenient in practice, and to yield results which can be readily understood. In order to ensure that each grade shall be equally probable the limits are so fixed from the curves of distribution that the lowest 5 per cent. at each age are in grade 20, the next 5 per cent. in grade 19, and so on. The curves of distribution employed had been constructed for each half-year of age, and in my first tables I fixed the grades for the intermediate months by interpolation. I have since found out a better way of doing this, which I will explain presently, and I have constructed, for the purposes of this paper, a new set of tables for classification by height, by weight, and by chest-girth, calculated from a large number of observations, recorded at several different schools.

As regards my own power of forming a conception of the position among his fellows held by any boy, of the progress which he is making physically, and of the relation which his development in weight, height, and chest-girth bear to one another, I can only say that the increase of ease in grasping the situation in all its bearings afforded me by the adoption of this system of classification, is quite immeasurable. I take a sheet of observations, which seems a bewildering mass of figures, from which only the closest study can evolve any meaning. I take my tables and some red ink, and in a very few minutes I enter above each observation the number of the corresponding grade. The effect is similar to that produced by supplying the key to a letter written in cipher.

Before constructing my tables I seriously considered whether it would not be better to leave the age out of consideration altogether, and form my tables so as to show the distribution of weight and chest-girth for boys of the same height. I thought at the time, and I believe the idea is a common one, that the relation of weight to height is the true test of a boy's healthy development. I constructed a certain number of curves of distribution upon this principle ; but in order to test the question whether

age might be safely left out of consideration, I arranged all the boys whose age exceeded the age at which the height under observation was the mean, in one group, and

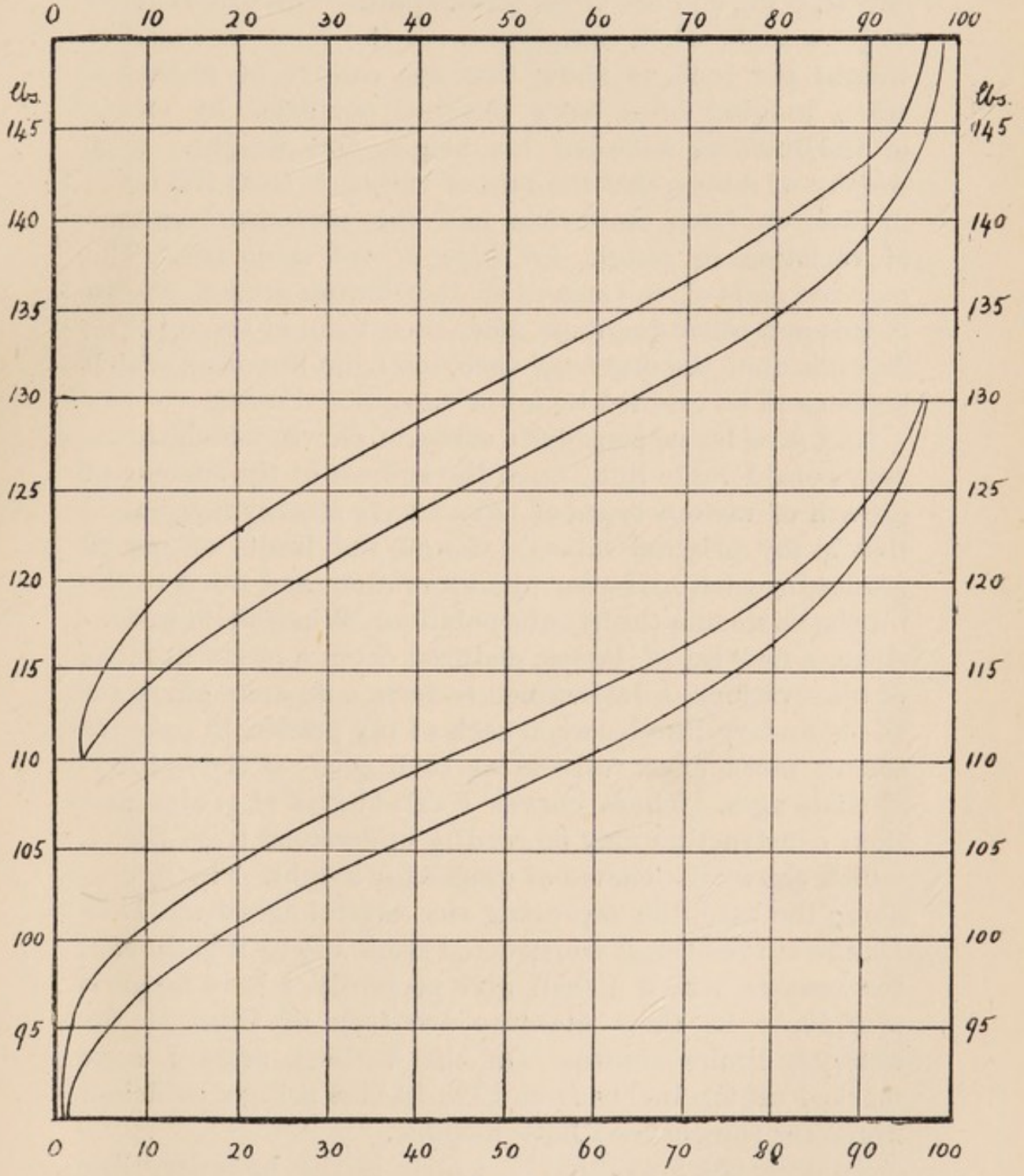

FIG. 3.

all the rest in another. The result is shown in Fig. 3, in which the lower curve of each pair is constructed from the younger boys, and the upper from the older boys.

The lower pair are constructed from boys of 5 ft. 3 in., and their distance apart indicates a mean difference of about 3½ lbs. The upper pair are constructed from boys of 5 ft. 6 in., and are about 5 lbs. apart. This difference is large enough, when compared with the mean increase of weight per inch, to show that age cannot be neglected when judging of a boy's physical condition by means of the relation between his height and weight. It is worthy of notice, that the rate of variation from the mean in these curves is more than half the corresponding rate of variation in weight for boys of the same age. The extreme ends of the curves of distribution are not shown in this and other diagrams, since their form at these points depends upon the degree of variation from the mean which happens to be reached by a few exceptional cases.

And now let us consider a series of curves which throw very considerable light upon the subject of the scheme of growth of various types of boy. I have already mentioned that in my original tables I found the limits of my 20 grades for each half-year by observation, and filled in the intermediate months by interpolation. When about to construct a new set of tables, deduced from a larger number of observations, I determined to form a separate curve for the boundary line between each of my grades, in order to secure more exact values for each grade at these intermediate ages. These curves I call curves of grades, and their construction may be readily understood from Fig. 4, which shows the curves of grades for height. The figures along the base line represent the several ages from 11 to 18, the curves being constructed from 10½ to 18½, though, for reasons which I shall give presently, I have no great confidence in their absolute accuracy of form at the extreme limits shown. On the vertical scale I have marked off the inches from 49 to 73, this being a sufficient range for the curves I have to show.

To draw the lowest curve, which is the boundary line between grades 20 and 19, I mark off on the vertical line through each age the corresponding height for the lower limit of grade 19, taken from my calculated curves of distribution. I then join the points so obtained by a

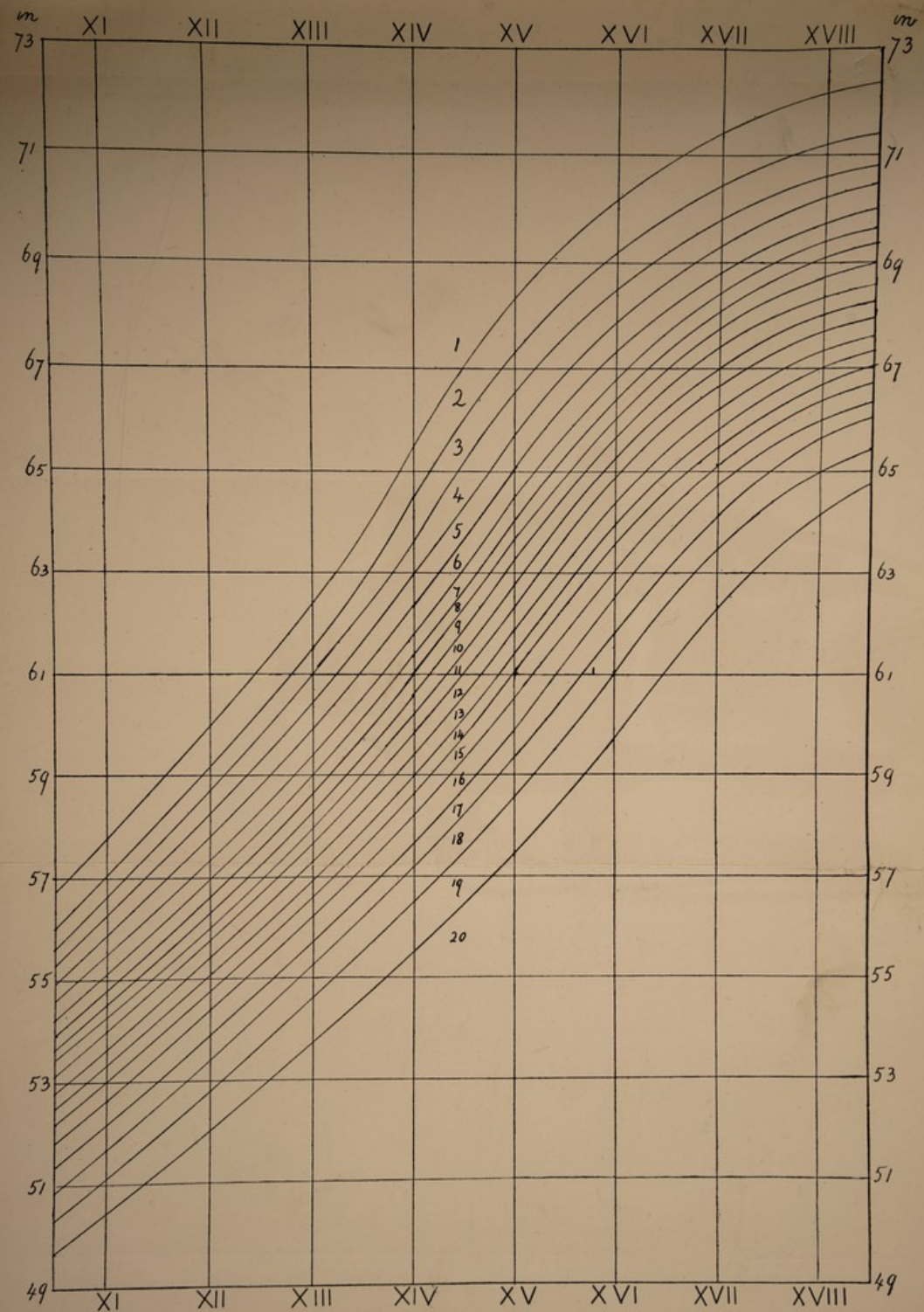
in
73
71
69
67
65
63
61
59
57
55
53
51
49
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Fig. 4.

flowing curve, and the lowest line is obtained. All boys whose measurements fall below this line are in grade 20. I then form the next curve in a similar manner, so as to represent the lower limit of grade 18. The standard boy of grade 19 should grow in such a manner that his height is always between these two curves. Continuing in this way, I get the whole series of 19 curves enclosing 18 spaces, within which spaces the growth of the 18 standard boys of grades 2 to 19 should take place. The numbers in the centre of the diagram indicate the grades corresponding to the various spaces. There is no lower limit to grade 20, or upper limit to grade 1. The most exceptional boys I have measured myself were, at the age of 14, 52 in. and 71 in. in height respectively, a difference of 19 in. Of course very much more remarkable cases are occasionally found.

If we study this diagram closely we may observe the following points :—

(1) The closeness of the curves in the neighbourhood of the mean line, which separates grade 10 from grade 11, and the manner in which the spaces between the curves widen out as we get farther from the mean in either direction. This is due to the fact that so large a percentage of boys resemble the mean boy within very narrow limits.

(2) The regular manner in which the curves follow one another, so that the shape of each curve at any given age very closely resembles that of the curve above it a few months earlier. Now, the rate of growth of the standard boy growing along any one of these curves is measured at any age by the pitch of the curve at that age. Where the curve is steepest, there the growth of the boy is most rapid. Where two curves are parallel the rate of growth of the corresponding standard boys is the same. If we compare the two outside lines with the mean line, we see that the steepest pitch of the topmost curve is between the ages of $13\frac{1}{2}$ and $14\frac{1}{2}$, when it is equal to $3\frac{1}{2}$ in. per annum ; the corresponding steepest pitch in the mean line lies between the ages of $14\frac{1}{2}$ and $15\frac{1}{2}$, and is equal to $2\frac{3}{4}$ in. per annum ; while the

steepest pitch of the lowest line lies between 16 and 17, and is very slightly less than the corresponding pitch in the mean curve. At 16½ years of age the pitch of the topmost curve, which measures the rate of growth of the standard boy of grade 2, is about half the pitch of the bottom curve, which measures the rate of growth of the standard boy of grade 19 at the same age. The vertical distance between the two outside curves, which measures the extreme limit of variation between grades 2 and 19, is about 7 in. at the age of 10½, increases up to the age of 15, when it reaches its maximum of about 11 in., and then decreases, being about 7½ in. at the age of 18½. The general lesson to be learnt from this diagram is that the standard boy of a high grade is earlier developed in height by about three years than the standard boy of a low grade, and that the rate of growth to be expected from a boy at any given age varies considerably, according to the grade in which he is, and may differ considerably from that of the average boy. At the period of most rapid growth, the rate of growth of the standard boy of each grade is more nearly the same than might have been expected; but this period arrives later and lasts for a shorter period in a lower grade than in a higher one. It must not be forgotten that the growth of 10 per cent. of the whole number of boys examined takes place either above or below the curves shown, with wide limits of variation from them.

Fig. 5 represents the corresponding series of curves for the detail of weight. It presents to the eye the same general characteristics as the diagram for height, the curves following one another in the same way, and the periods of most rapid growth in the topmost, median, and lowest curves coinciding almost exactly with the corresponding periods indicated in the previous diagram. The check in the rate of growth, which follows this period of most rapid growth, though occurring at approximately the same time as in Fig. 4, for each of the standard boys right down the diagram, is far less rapid and pronounced, and the period of slow growth, which is

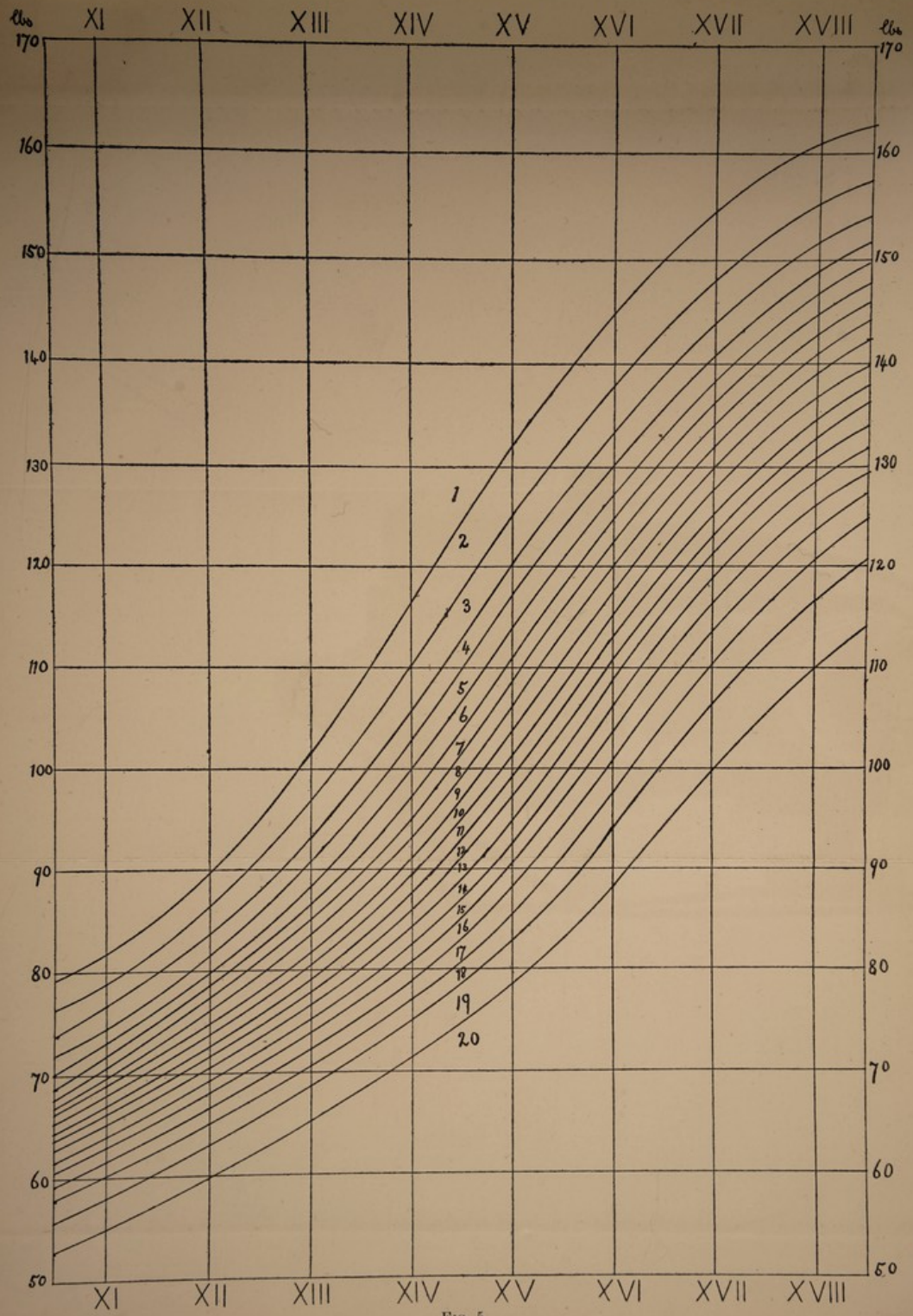
lbs
170
160
150
140
130
120
110
100
90
80
70
60
50
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Fig. 5.

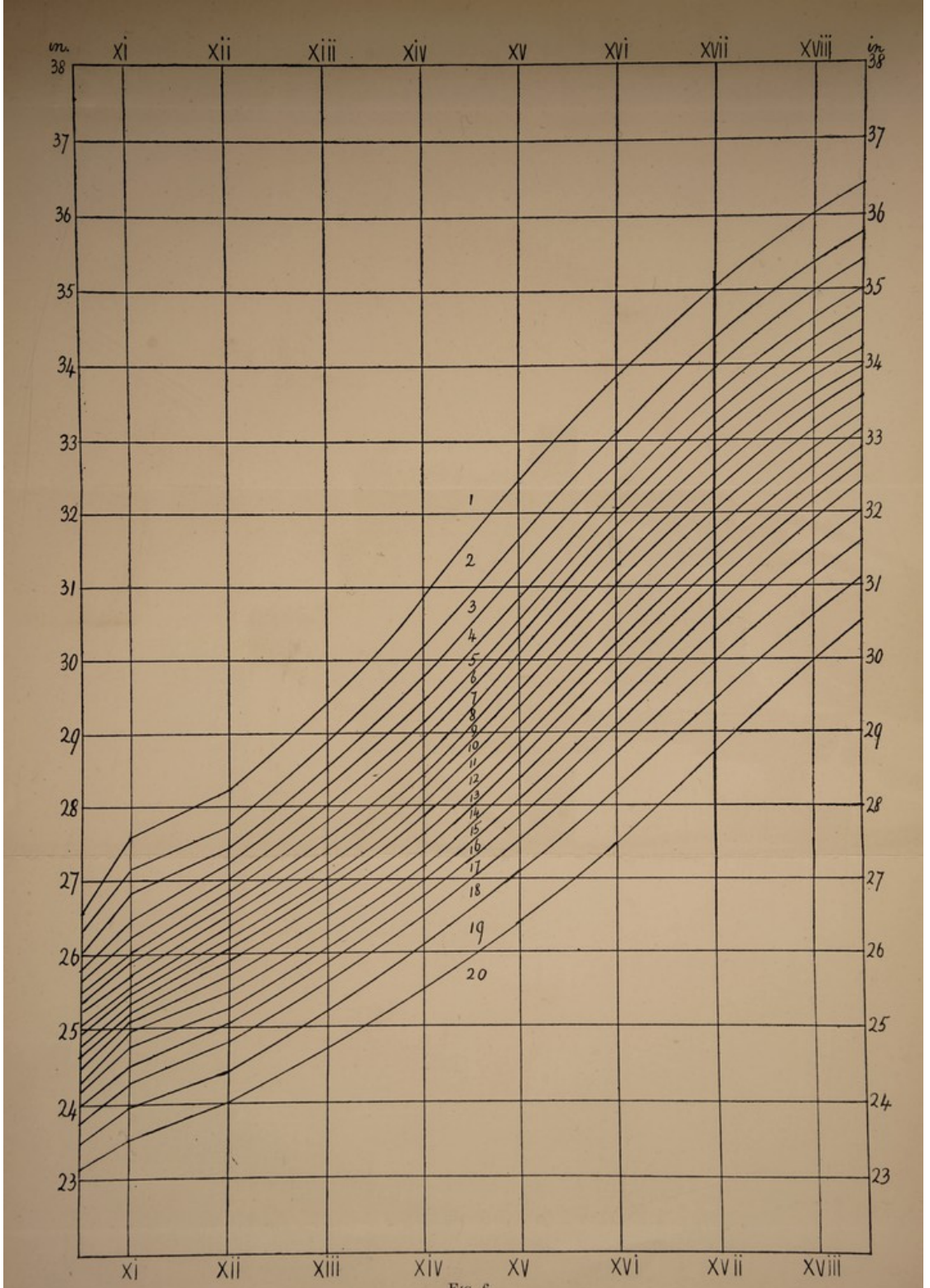
in.
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
23
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

FIG. 6.

indicated towards the right of every curve in Fig. 4, is only shown on the higher curves in Fig. 5, the lower grades not having reached that stage of their development at the age shown. Thus we see that development continues fairly rapid in weight for some time after it has become slow in height, so that the weight of boys of the same height may be expected to increase with the boy's age. The maximum variation between grades 2 and 19 continues increasing nearly up to the age of $16\frac{1}{2}$, $1\frac{1}{2}$ years longer than in height. This variation amounts to 26 lb. at the age of $10\frac{1}{2}$; 56 lb. at $16\frac{1}{2}$; and has decreased to 48 at $18\frac{1}{2}$.

The number of observations which have been utilised in the construction of each of these diagrams is between 14,000 and 15,000, and I consider the form of the curves to be fairly trustworthy between the ages of 12 and $17\frac{1}{2}$. Outside these limits I have not much confidence in them, though the upper portion shown is probably substantially correct. The extreme lower portion I can only describe as the best guess that I can make with the material at my command.

Fig. 6 gives the grades of chest-girth, constructed from observations recorded at one school only. The same general characteristics may be seen, but the period of most rapid growth comes a few months later in each curve than in the corresponding curve of Fig. 4. The period of slow growth has not been reached by any one of the curves. The extreme variation between grades 2 and 19, which is $4\frac{1}{4}$ in. at 12, increases up to the age of $16\frac{1}{2}$, when it reaches its maximum of nearly $6\frac{1}{2}$ in. The curves appear to show that development in chest-girth is as a rule spread over a longer period than development in height or weight.

The irregularity which may be seen at the lowest part of the curves in Fig. 6 will serve to illustrate what I mean by saying that the lowest part of my curves are not to be relied on. I have not attempted to smooth the irregularities out because I have not sufficient data to show how this ought to be done. The chief causes which make curves untrustworthy are (1) insufficient number

of observations, and (2) selection. Of these two the action of the latter is much the more subtle and hard to detect. We must not forget that what we have called the growth of the mean boy is in reality the increase in the mean of a number of boys. Now suppose, to put an extreme case, that we deduced the height of the mean boy of 18 from the measurements of 100 boys who had all stopped growing; suppose that 50 of these boys left school before they were 19, that these 50 were selected to be the 50 shortest of our 100, and that the height of the mean boy of 19 was deduced from the measurements of the remaining 50. It is obvious that our mean boy would show very remarkable growth between the ages of 18 and 19, although the boys from whose measurements the result was deduced had made no growth whatever. Now selection of this kind is going on at both ends of our curves. There is a constant tendency to send strong, forward young boys to school at an earlier age than their more delicate and less developed brothers. There is also a constant tendency amongst private schoolmasters to keep boys of marked superiority of physique until the extreme limit of age at which public schools will admit them. There is a similar constant tendency at public schools, more especially schools which have a great name for athletics, to keep their most robust members as long as possible. Constant tendencies of this kind have the effect of weakening some of our curves of distribution and strengthening others at the two ends of the period examined; consequently, I have no great faith that the curves of grades, deduced from these curves of distribution, represent the actual growth to be expected from school-boys at the ages affected. In order to get our curves correct in form between the ages of ten and twelve, we *must* have more observations, and unselected observations, and I now appeal to the masters of private schools to institute general and regular observations of their boys, if for this purpose alone.

The curves in Fig. 6 were constructed from the observations supplied by one school only, the reason being that I have no great faith in the result obtained by combining the observations of chest-girth supplied by different

schools into one common scheme. It seems to be certain that, whether owing to difference of class or of race in the boys, difference of climatic influence, difference of reputation for athletics in the schools, or to a combination of all these causes, the boy animal supplied as raw material to our various schools is of a much finer type at some schools than at others. It is equally certain that some schools do more to improve the type than others, though this does not appear to affect the relative position of the corresponding curves derived from different schools to the same extent as the difference of type of the raw material. In the details of height and weight the difference is not sufficiently marked to make it difficult to combine all together in a general scheme; though the inclusion of a greater or less proportion of school A or school B would appreciably affect our results, if we wished to arrive at—what I believe to be unattainable—an absolute, as distinguished from a slightly arbitrary, standard. In chest-girth, on the other hand, though the general form of the curves of grades, and the range of variations of the various grades from the mean, are almost identical for the various schools observed, yet the actual position of the mean curve differs so much at different schools, that a scheme of grades constructed from observations made at any one school would be of very little practical use when members of some other schools were to be examined. This also applies, though in a less degree, to the scheme constructed from all the schools combined. The difference of methods of observation is largely responsible for this. Wishing to compare our own method of measurement with that adopted by another school, at whose record I was working, I once got hold of the first 173 boys I could see, and had their chests measured according to the two different methods. The differences recorded were very irregular, and may be tabulated as follows:—

Under ½ in.	..	..	..	..	..	..	..	6	per cent.
½ in. and under 1	in.	..	..	..	..	..	15	,,
1 ,,	,,	1½	,,	..	..	..	..	..	24	,,
1½ ,,	,,	2	,,	..	..	..	..	..	23	,,
2 ,,	,,	2½	,,	..	..	..	..	..	14	,,
2½ ,,	,,	3	,,	..	..	..	..	..	9	,,
3 ,,	,,	3½	,,	..	..	..	..	..	8	,,
3½ ,,	,,	4	,,	..	..	..	..	..	2	,,

The magnitude and irregularity of the differences observed show the supreme importance of adopting a uniform system of measurement. But even if the same method is used there is still a good deal of variety in the results obtained by different observers, partly because one man is a good deal heavier-handed than another, and naturally draws the tape tighter, which may cause a considerable difference, and partly because a certain amount of authority is required to make boys stand right, and produce the degree of deflation required, and some men have more authority with boys than others. To get over the first difficulty the Americans use a tape with a spring balance at the end, by means of which all measurements are taken at a uniform tension of 6 oz. They also take the precaution to have a mirror behind the person observed, so that the operator may see that the tape is in the right position all round. I think that it is very important that both these plans should be generally adopted. Most misleading results, especially with weak, or fat, or angular boys, may be obtained owing to undue tension of the tape, or a slight error in its position, which cannot be detected from the front. The question of physical training is also a large factor ; I once examined the growth in chest-girth of 255 boys, consecutive entries, who had passed through the compulsory course of three terms' gymnastics which every new boy has to undergo when he enters Haileybury. The percentage of boys who had made relative improvement as evidenced by their grades of chest-girth was as follows :—

Improvement	of	1	grade	..	..	..	..	11 per cent.
„	„	2	„	..	..	..	..	11 „
„	„	3	„	..	..	..	..	12 „
„	„	4	„	..	..	..	..	10 „
„	„	5	„	..	..	..	..	7 „
	„	6	„	..	..	..	..	6 „
	,	7	„	..	..	..	..	4
„	„	8	„	..	..	..	..	4 „
„	„	9	„	..	..	..	..	1 „
„	„	10	„	..	..	..	..	4 „
„	„	11	„	..	..	..	..	1 „

Of course I cannot prove that all this increase is due to physical training, but a boy's chest must as a rule be

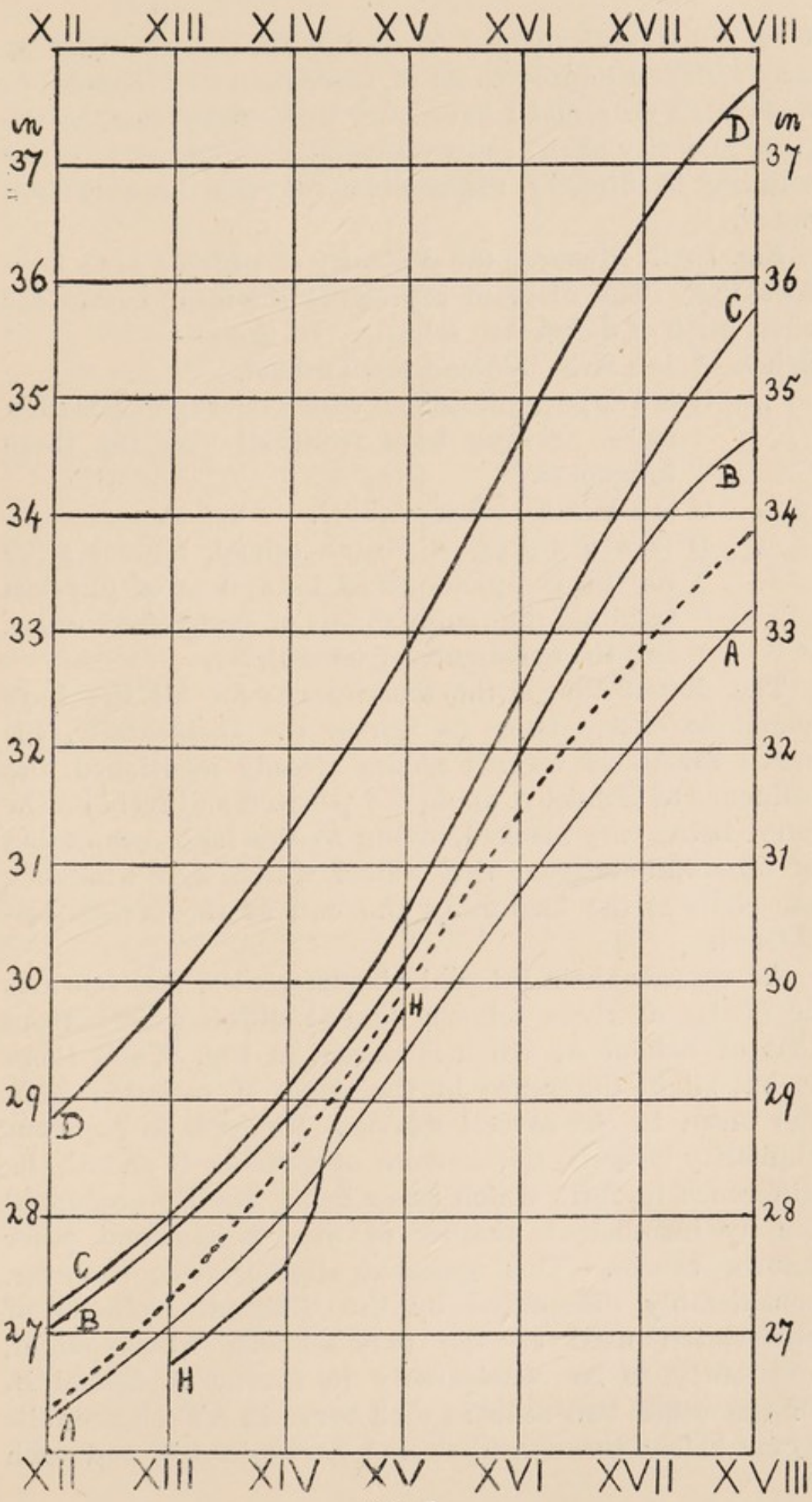
XII XIII XIV XV XVI XVII XVIII
in
37
36
35
34
33
32
31
30
29
28
27
D
C
B
A
H

FIG. 7.

very much undeveloped to start with, in order that he may make an improvement of more than 2 or 3 grades in less than a year, and I have very little doubt that, in the great majority of the cases observed, compulsory physical training is directly responsible for the improvement noted.

Fig. 7 will illustrate the difficulty of which I have been speaking. The diagram represents the mean curves for chest-girth of 5 different schools. Of these—

School A is a large midland town school.

„ B is a large public school with strict superannuation rules, drawing boys from all over the three kingdoms.

„ C is a North-country school.

„ D is a well-known Scotch school, famous alike for the completeness of its system of physical training, the thoroughness of its hygienic rules, and the excellence of its athletes.

The dotted line is the mean curve for all the boys examined except those in School D. Incidentally, this curve illustrates various points already mentioned, the influence of School A upon the position and form of the curve being very marked, owing to the large proportion of observations from that school which were available, especially at the beginning and end of the period considered.

As regards their internal characteristics, the schemes of grades of these schools do not differ widely from that of School A, which is shown in Fig. 6, and there is but slight difference in the range of variation from the mean in the several schools. There is an apparent similarity between the schemes of Schools B and C, the difference in form which exists being readily accounted for by insufficient number of observations and other known causes. This apparent similarity is, however, considerably discounted by the different methods of observation used at the two schools, which ought, apparently, to be considerably in favour of School B. Of the other two schools, each curve in A's scheme falls so far below the corresponding curve in B's, and each

curve in D's scheme so far above the corresponding curve in C's, while the difference of pitch is so considerable between A's scheme and D's, that it seems impossible to apply our method satisfactorily to the four schools except by adopting a special scheme for each school.

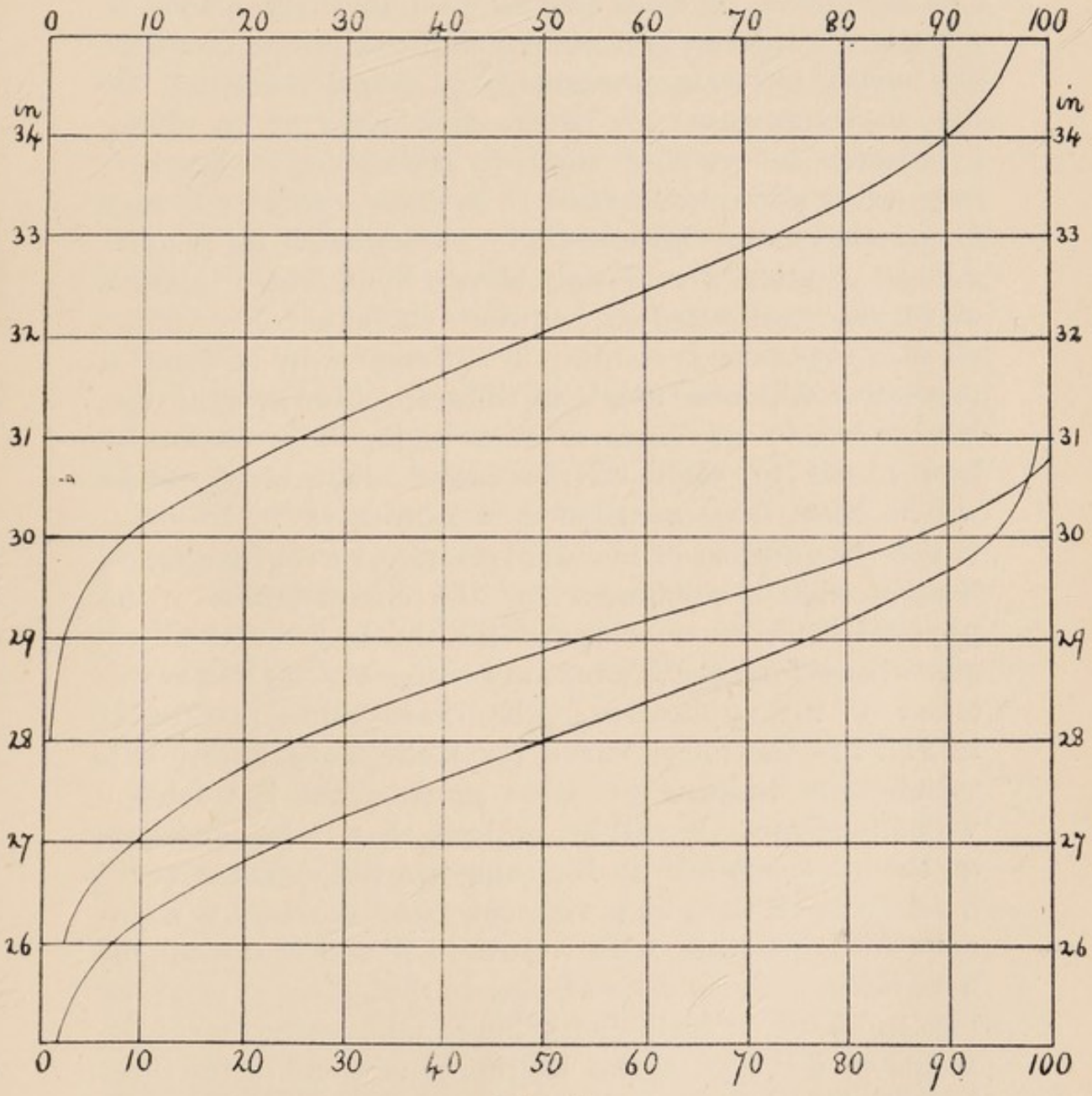

FIG. 8.

The extraordinary superiority of School D in record of chest-girth is even more strikingly exhibited in Fig. 8, in which the curves of distribution of chest-girth for boys of the height of 5 ft. 2½ in. is shown. The lowest

curve is formed from boys who were that height on entering Haileybury. The second curve is from Haileybury boys of the same height who have been through the three terms' gymnastic course. It lies about an inch above the first curve for the left hand half of its course, where improvement in chest-girth is most necessary. The difference becomes less as we follow the curves to the right, until the two curves coincide at a point where the lowest curve is presumably principally affected by the measurements of boys who have been doing gymnastics before they came to Haileybury. The corresponding curve for School D is shown above; it runs 4 in. above the lowest curve throughout its length. Almost identical results were shown by similar triple sets of curves constructed at two more heights. How much of this superiority is due to difference in method of measurement, how much to difference in average age, how much to difference of race in the boys examined, how much to each of the other disturbing causes which have been mentioned, I cannot say. In order to test the question of racial superiority, I wrote to another Scotch school, celebrated for the completeness of its physical records, and begged for the loan of their register for a few weeks; but, unfortunately, no notice was taken of my application. The short curve marked H in Fig. 7 is the mean curve for Haileybury boys. It is valueless to indicate probable growth, but it teaches a valuable lesson. It will be noticed that it begins below all the other schools at 13, runs parallel to the A curve from 13 to 14, then by a vigorous twist darts up to a corresponding position with regard to B and C during the next six months, and continues in that position until we lose it. Now, at Haileybury I only take general measurements of the boys, at the beginning and end of the three terms' course of physical training to which I have already alluded; almost all Haileybury boys enter the school between the ages of 13 and 14, hence the first half of this curve is taken almost exclusively from boys entering the school, the latter part from boys who have done their three terms' course. Here again the danger of selection

in altering the form of curves is apparent, as the pitch of the curves between 14 and 14·6 does not really represent the rate of growth of the boys examined. The boys measured at 14·6 would have been previously measured nearly a year before, and the extra increase put on would in reality be distributed over that period.

Before applying our various results to estimate the physical progress of individuals, it is necessary to answer the question: How far does the growth of the standard boy of any grade represent the probable growth of the corresponding healthy boy? In order to obtain an approximate answer I have used exclusively the records belonging to school A. I first selected all the records which I could find, which appeared to cover a sufficient number of the years included in my tables, viz., $12\frac{1}{2}$ to $18\frac{1}{2}$. This gave me 161 boys, whose records included 1,459 observations in each of the three details examined, an average of slightly over 9 observations to each boy, the observations being recorded half-yearly. I next determined what each of these boys' records became when every detail was expressed in grades. The tables used were constructed from the curves shown in Figs. 4, 5, and 6. On examination I found that I could classify the growth of the boys somewhat roughly as follows:—

The growth followed that of a standard boy within moderate limits of variation in ...	31	per cent.	of the boys.
There was a steady rise relative to the standard boys throughout the period examined in...	17	,,	,,
A similar fall in	10	,,	,,
A period of rise, followed by one of fall, or *vice-versâ*, in...	18	,,	,,
The variation struck me as distinctly erratic in... ...	9	,,	,,

The remaining 15 per cent. did not strike me as falling into any of these classes; they would probably belong to the first class, but not within the limits of variation which I allowed.

As regards the manner in which the three details varied in standard, I find that:—

In 50 per cent. of the boys examined the *variation* in all three details corresponded roughly throughout their growth.

In 18 per cent. the variation in the details of height and weight only corresponded.

In 7 per cent. the variation in the details of chest and weight only corresponded.

In 20 per cent. the chest was relatively improved.

If we take the maintenance of a constant relation between height and weight to indicate that a boy retains the same general type of structure throughout his growth, this will give 68 per cent. in whom the type is stable. I find that, speaking roughly, 17 per cent. of the whole coincide as nearly as possible with the same standard, both in height and weight. Including these 17, there are 50 per cent. whose height and weight do not differ by more than 3 grades during any part of the period of growth examined. This leaves about 18 per cent. in whom the type of structure remains stable, but the relative position of height and weight shows a marked difference throughout. The mean difference in the most exceptional stable cases examined was as high as 8 grades. This classification is rough, and I do not wish the figures to be regarded as more than a very rough approximation; but they seem to me to make it clear that so large a percentage of boys differ more or less widely in structure throughout their growth from the proportions fixed by averages, that any conclusion concerning a boy's healthy development, based upon the statement that his height being so and so his weight ought to be so and so, must be received with great caution. I am very doubtful whether the actual proportions of a boy, ascertained by a single observation of his height, weight, and chest-girth, will, as a rule, reveal anything as to his constitution.

I have examined the measurements of 109 boys, selected by our medical officer as being delicate, out of a list of 1,026. I compared the grades of these delicate

boys with those of the general run of boys who enter Haileybury by a method which I explained in the March number of *The Journal of Education*, and I found out nothing. I do not say that there was nothing there, but there was nothing sufficiently obvious for me to detect without a more elaborate analysis. On comparing them with themselves, however, I found that, when measured the second time, the delicate boys had made markedly less improvement in chest-girth than is usually the case during the first three terms at Haileybury. The negative nature of these observations seems to emphasise the desirability of continuous and skilled observation. The general analysis of the records examined appears to show that the causes which arrest development are liable to do so in the details of height, weight, and chest-girth alike, so that no marked peculiarity of conformation is produced. On the other hand, the plan of growth of a perfectly strong and healthy boy may be such that his weight and chest-girth will naturally compare unfavourably with those of a normally developed boy of the same height. In order to detect, by measurements, unsatisfactory development due to removable causes, it is essential, except in extreme cases, to have a continuous record of each boy's growth, so that the general scheme of his growth may be determined, and any sudden fluctuation may be observed and accounted for. Such a record should be begun as early as possible, and I hope I may have said enough to induce school doctors to take this matter up, and preparatory schoolmasters to make a practice of keeping such a record regularly, and imparting each boy's record, in confidence of course, to the boy's housemaster, or the medical officer in the school to which the boy is sent. In conclusion, I venture to suggest that, in order to secure uniformity, the Medical Officers of Schools Association should appoint a committee to consider the best measurements to be taken, and the best method of taking them, and to authorise a form of record to be universally used at schools. I hope that some directions will be issued as to the facts to be noted under the heading of "Remarks," as this most important column hardly ever contains a remark which is

likely to be of service. I append a few typical examples of records expressed in grades. Each record consists of three columns, the first showing the grade of height, the second that of weight, and the third that of chest-girth. The details are recorded half-yearly.

I.			II.			III.			IV.			V.		
Ht.	Wt.	Ch.	Ht.	Wt.	Ch.	Ht.	Wt.	Ch.	Ht.	Wt.	Ch.	Ht.	Wt.	Ch.
3	4	9	19	19	19	12	18	8	7	7	5	14	6	11
3	3	4	19	19	19	13	18	8	9	8	6	12	6	8
2	3	2	19	19	19	15	19	8	10	10	7	10	5	6
2	3	2	18	19	19	15	19	11	12	10	7	9	5	8
3	3	1	18	17	18	16	19	13	13	13	10	9	4	7
2	3	1	18	17	18	17	19	14	15	14	12	8	4	8
3	2	2	17	16	18	18	20	15	15	17	13	10	4	7
4	3	2	17	18	19	18	20	17	17	17	14	10	6	8
4	2	2	16	17	18	19	20	18		—		12	8	9
4	4	2	16	18	17	19	20	18		—		14	8	9
4	2	2		—		19	20	19		—		15	8	9
	—			—			—			—		16	11	11

VI.			VII.			VIII.			IX.			X.		
11	11	9	9	12	13	12	9	14	8	10	9	14	13	12
6	8	5	11	12	11	11	7	10	8	10	9	15	16	10
7	9	5	10	14	11	11	6	9	10	12	8	15	14	12
8	13	8	11	14	10		—			—		17	17	13
10	14	9	12	14	11	16	12	13		—		17	17	15
10	17	9		—		16	13	9	11	15	15	17	17	16
12	17	11	13	16	15	17	15	10	13	16	16	16	16	16
14	19	13	13	14	16	17	15	11	13	16	17		—	
15	20	15	9	12	16		—		11	15	17		—	
	—		8	12	15		—		9	14	16	11	13	15
	—		7	9	12		—		7	13	15	11	13	14
	—		7	8	12		—		6	13	15		—	

I. Is a case of steady growth; the chest at first is underdeveloped, but soon comes up to as good a standard as the other details.

II. Steady, with upward tendency.

III. Strong downward tendency, weight weak throughout.

IV. Strong downward tendency, illustrates stability of general proportions.

V. Rise in type, followed by fall.

VI. Sharp rise, followed by steady fall.

[A steady rise or fall in type will, as a rule, be a sign of late or early maturity; *e.g.*, suppose a boy in Grade 4 to have practically completed his growth at 16, he will fall steadily, relatively to other boys, and become a man of less than medium size.]

VII. The blank half-year is explained by the entry "whooping cough." The drop in chest-girth is very obvious, and is persistent for two years.

VIII. Here the absence is due to "inflammation of the lungs." The drop in height and weight is more obvious and persistent than that of chest-girth.

IX. and X. a year's absence, followed in one case by a decided deterioration of type, in the other by the reverse. No remark is given in either case to account for the absence, though the form of the record in each case would lead one to expect that a remark might be useful.

I have no intention of generalising as to the effect of whooping cough or pneumonia in the above remarks, but they illustrate the manner in which valuable generalisations might be obtained by this method of keeping records, if we only had a sufficient number of carefully kept records in which all illnesses, or other known causes likely to influence development, were regularly entered in the column for remarks. It is important that such entries should be made independently of the effect produced, and not merely inserted to account for observed fluctuations, otherwise the analysis of observed effects might be very misleading. To ensure the general insertion of such remarks as are likely to lead to valuable results, it is essential that a list of the various points upon which information is required should be made out and disseminated by some central authority. I venture to suggest that the central authority which is best qualified to undertake this work is the Medical Officers of Schools Association.

To sum up briefly, I have endeavoured to show that the regular and systematic measurement of growing boys is highly desirable, both to advance our knowledge on the subject of healthy growth in general, and to enable us to utilise this knowledge in the observation of particular cases.

That in order to read the signs which may be contained in the record of any particular boy, a more extended system of standards than the one generally employed is necessary. I have suggested such a system, and shown how a more extended series of observations is required in order to make this system cover the whole range in which we are interested.

That in order to secure the best results, a central authority is required to authorise a uniform method of observing and recording facts, to settle what details are to be systematically observed and recorded, and to devise a system by which the records obtained can be most usefully employed both for general purposes and for the good of the individuals observed.

I have suggested that the M.O.S.A. is the right authority to undertake this work, and I will conclude by reiterating my appeal to the Association to undertake it without delay.

UNWIN BROTHERS, PRINTERS, PILGRIM STREET, E.C.