

CENSUS OF INDIA, 1921.

VOLUME XV.

PUNJAB AND DELHI.

PART I.

REPORT

BY

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INTRODUCTION.

1. Previous census reports of the Punjab have dealt in great detail with matters connected with religion, marriage customs, caste structure, languages and other subjects not necessarily directly connected with the statistics which it has been the object of the census to collect. Preface.

In view of the mass of information on these subjects which has been collected in census reports, gazetteers and reports of ethnographic and linguistic survey, it was considered unnecessary to deal with them again in great detail and in their place enquiry has been directed towards the economic and industrial conditions of the two provinces.

The census operations have taken place at a time when Deputy Commissioners and other local officers, already overburdened by the elaboration of their routine duties during the last decade, were concentrating all their energies in guiding the country through a critical period of change. At former censuses such local officers had responded nobly to calls upon them for the provision of masses of facts and information on subjects which were dealt with in the census reports: I have felt that it would be impossible for them to respond to any such call at this time, and have endeavoured to cast as little additional work as possible upon them in connection with the actual census and to refrain from calling upon them to send in reports on subjects of general interest. I find that I have issued only thirty-nine general circulars throughout the operations, and that of these only three asked for general information, the rest being entirely concerned with administrative details of the enumeration and preparation of statistics.

The inevitable result is that this report, following the lines of those prepared for European countries, will be confined in the main to an explanation of the figures which have been tabulated.

I have spared no endeavour to render these as accurate as possible, and where there are any reasons for suspecting inaccuracies, I have no hesitation in pointing them out, so that as far as is possible the statistics may form a solid basis on which statisticians may base arguments and test theories. Not being a trained statistician myself I have tried to resist the fascinating temptation of building up theories from the statistics, though I have suggested lines of enquiry that might be taken up by those qualified for such work.

2. The dates of previous censuses are given in the margin, a short account of them will be found in paragraphs 20 to 22. Some of the Tables published in Part II of this report repeat figures for previous censuses back to that of 1881: the two which had been taken before that dealt with such totally different administrative divisions that comparison with them is practically useless; where figures for previous censuses have been reproduced in this report they have been adjusted so as to refer to existing divisions and not to the divisions which were in being at the time they were originally prepared; they are thus already in a form suitable for comparison with the newly recorded statistics. Previous Censuses.

3. Changes in the boundaries of administrative units that have taken place since the census of 1911 are detailed in paragraphs 2 and 3 of this report, the only two important changes are the creation of the Delhi Province from portions of the old Delhi District of the Punjab and the Meerut District of the United Provinces, and the creation of the new district of Sheikhpura from portions of the surrounding districts of Lahore, Gujranwala and Lyallpur. Changes in Boundaries and Areas.

4. A full description of the census operations is published in the Administrative Volume, Part IV, of this report; that volume being intended only for departmental and local use, a very brief note on each stage of the operations is given below. Very little change was made in the procedure gradually evolved and improved at previous censuses. Operations of the Present Census.

5. I took over charge of my duties on the 31st March 1920, and took the organisation in hand immediately. A preliminary circular together with the first three chapters of the Provincial Census Code was issued on the 27th April; District Census Officers in every district and Census Superintendents in every Initial Arrangements.

State were appointed forthwith, and general village and town registers were prepared on which to base the formation of census divisions.

Census
Division and
Agency.

6. The whole countryside was parcelled out into blocks in which the enumeration could be carried out by one enumerator; these blocks were grouped in circles under supervisors, and the circles again grouped in charges under charge superintendents. The existing revenue divisions were very generally followed in fixing the boundaries of charges and circles, and the revenue agency was largely employed as Superintendents and Supervisors. These divisions were first fixed roughly and then revised after the completion of house-numbering showed where mistakes had been made in estimating the suitable boundaries for blocks; ultimately at the time of the final census there were 172,044 blocks, 13,943 circles and 1,017 charges, and the enumeration was carried out by 164,425 enumerators under the direction of 13,913 supervisors and 999 charge superintendents. Most of the supervising staff was recruited from amongst officials, whilst the enumerators were in the main voluntary non-official workers; all were appointed individually under the Census Act and thus all gained the status of public servants.

House-
Numbering.

7. The Census Divisions having been tentatively fixed the next step was the numbering of all houses, this work was commenced on 15th September and completed within two months. Each house which might be occupied on the census night was clearly marked with a number, a separate series of numbers being kept for each circle. This work was carried out by the supervisors. As a result just over eight million houses were numbered, but to ensure that no person should escape enumeration many buildings were numbered which were not inhabited on the census night, and on that night it was found that only a little over five and a half million were inhabited. This numbering formed a reliable basis for the supply of forms, and after it was completed the census divisions were revised and fixed finally.

The Pre-
liminary
Enumeration.

8. In July a complete issue of the Census Code had been published and this was followed in August by a pamphlet of instructions for Charge Superintendents and Supervisors; short instructions for enumerators were printed on the covers of the actual enumeration books.

During the progress of house-numbering the whole staff received training in their duties; starting from the top each census officer instructed the officers immediately subordinate to him so that the instructions drifted down from the Provincial Superintendent to the enumerators. Test enumerations formed the main part of the training.

The preliminary enumeration took place between the 1st February till the 1st March in rural tracts, in towns it was both commenced and finished a fortnight later. At this enumeration all persons likely to be in residence on the 18th March were entered up in the enumeration books; this procedure allowed ample time for the careful recording and checking of all entries and reduced the work at the final census to a minimum. The enumeration book consisted of a cover, containing instructions and forms of summaries to be filled up and detached after the census; a block list, which was a detailed list of the houses in the block and served to prevent any buildings being overlooked either at the preliminary or final enumeration; and a sufficient number of general schedules on which the actual particulars concerning each person were recorded.

The Final
Census.

9. The final census took place between 7 and 12 o'clock on the night of the 18th March, every enumerator visited all the houses in his block and corrected his enumeration book by striking out entries referring to people who were found to have left since the preliminary record had been prepared and by adding entries for all new-comers. This having been completed every entry in the book was given a serial number—the number of occupied houses, persons, males and females was totalled for the block, then for the circle and then for the charge. The charge summaries were totalled for the district or town at district headquarters and then telegraphed to Lahore and Simla.

Use of
Household
Schedules.

10. The general schedule was a tabular statement of lines and columns with a line for each person enumerated and a column for the record of each particular regarding him. In a few places, where Europeans were numerous and it was possible to obtain the services of an English-speaking enumerator, these forms were used in English for the recording of Europeans; but in general Europeans are found in small numbers in blocks containing many Indians and in such cases the enumerator could not be expected to fill up entries concerning them in a

general schedule; to meet this difficulty Europeans were supplied a few days before the census with an English form termed a "household schedule" on which to fill in for themselves the entries regarding themselves and other members of their households. In spite of very detailed instructions for filling them up, these household schedules were often carelessly completed and their collection and correction was accompanied by much difficulty.

11. A few outlying portions of the Province are cut off by snow-covered passes which render them completely inaccessible in March; in these a census was held in the autumn of 1920 and the results of it treated as part of the March Census. The dates of such non-synchronous censuses are given in the margin. In addition to these there were other tracts where the preliminary enumeration had to be held in the autumn of 1920, though it was found possible to hold the final census at the normal time. In yet other tracts the presence of wild beasts rendered night-work unsafe, and the final census was held at daybreak on the 19th March instead of the previous night.

Non-Synchronous Census in Inaccessible Tracts.

<i>Rangra District—</i>	
<i>Kothis Kodh and Sogar</i> ..	20-9-20
<i>Lahul and Spiti</i> ..	29-8-20
<i>Chamba State—</i>	
<i>Pangi and Lahul</i> ..	15-9-20
<i>Bashahr State—</i>	
<i>Chini and Dodra Kuar</i> ..	15-12-20

12. Special arrangements were made to enumerate the persons travelling on the census night and as each was enumerated he was provided with a pass which prevented his being enumerated a second time; the work of this sort of the greatest magnitude was the census on the railways. All railway stations were made into separate blocks or circles in the district in which situated, a special enumerating staff was posted to each at 7 p.m. on the night of the 18th March and remained on duty till 6 a.m. next morning or until the last train had passed through and the station was closed for the night; this staff enumerated everyone found on the station at 7 p.m. and thereafter enumerated everyone arriving at the station either by road or rail who could not produce a pass showing that he had already been enumerated. In this way everyone entering or leaving a train during the night was accounted for; there remained a few people on trains running long distances who had entrained before the station enumeration started and had not left the train next morning; to ensure that these people were also counted it was arranged that all trains running throughout the night should carry an enumeration staff; this staff spent the night enumerating the passengers and at 6 a.m. all such trains were stopped and a final enumeration carried out of all those who had not got passes.

Arrangements for Railways, Fairs and Migratory Population.

The District census authorities were responsible for the station enumeration which was however usually carried out through the agency of the station staff; the running train enumeration was conducted entirely by the railway authorities themselves.

The instructions issued provided for all contingencies, and it is unlikely that more than a very few railway travellers escaped enumeration; the above description only indicates the broad lines on which arrangements were made. Enumerating staffs were appointed to 762 stations in the two provinces and 69 running trains.

Especial arrangements for fairs and other large concourses of people were put in train beforehand and were necessitated in thirty places.

All main roads were patrolled by enumerators, staffs were posted to ferries, especial arrangements for troops on the march were made with officers in charge of such units. There remained such persons as were temporarily absent from their houses, guarding their fields or doing other casual work in the immediate vicinity; the orders contemplated that these should be recorded as though present in their houses, and it is probable that very few escaped enumeration.

13. As explained in paragraph 9, the totals for each district, State and town were added up as soon as possible after the census; these totals included all persons whether enumerated at their houses or whilst travelling; their collection from outlying tracts was one of considerable difficulty and motor-cars, horse-men, camel-riders, and runners were employed in bringing them in.

Provisional Totals.

The Kapurthala, Pataudi and Nabha States were all able to telegraph their provisional totals on the 19th March; in British Territory the Delli Province was the first unit to report its totals which it did on the 20th; the great majority of totals had been got in by the evening of the 22nd March, but the last district, in which work had been delayed owing to a mistake in a cantonment, was not able to wire its total till the 27th. The figures as reported by telegram

are compared with those finally tabulated below, and show a high standard of accuracy for so hurried an operation.

				Occupied houses.	Persons.	Males.	Females.
PUNJAB.							
Provisional Total	..	..	..	5,623,073	25,093,794	13,726,146	11,367,648
Final Totals	..	..	..	5,532,305	25,101,060	13,732,048	11,369,012
DELHI.							
Provisional Totals	..	..	..	112,835	486,741	280,709	206,032
Final Totals	..	..	..	114,683	488,188	281,633	206,555

Slip copy-
ing.

14. The next stage in the operations was to copy the entries concerning each person enumerated on to a separate slip. These slips were issued in five different colours, one for each of the main religions and one for all other religions; a distinctive symbol was printed on each to distinguish between males and females, and between unmarried, married and widowed persons; there were thus five different colours and six different symbols giving a total of thirty easily distinguished slips; in addition special slips were issued for the recording of infirmities; the other particulars recorded about each person were recorded by hand on the slips, a previously arranged system of abbreviations being adopted.

This work was done as in 1911 by the supervisors who were collected at tahsil headquarters for the work immediately after the census; as the period available was very short owing to the majority of supervisors being patwaris who were required in their circles for crop-inspection, an option was given to local authorities to have slips prepared from the preliminary record before the final census. The intention of this option was that slips should be prepared according to the provisional entries in the enumeration books so that the only copying work to be done after the census would be to destroy slips for cancelled entries and prepare new ones for the entries made on the actual census night. 21 districts and 10 states adopted the option and prepared slips beforehand, in only a few of these was the experiment justified by the result; slip-copying after the census was carried on by a staff collected together and constantly under supervision, that done before the census was done by supervisors in their circles and was only the subject of supervision by charge superintendents when they visited the circles; it was very generally found that the slips prepared before the census had to be corrected or prepared afresh after the census and the experiment did not result in the saving of time and led to a considerable additional wastage of slips. Although very careful estimates of the numbers of slips required in each tahsil had been made beforehand and a supply sent allowing a liberal excess for wastage, yet in many centres slips of particular varieties ran short and a break-down in printing arrangements occurring at the critical time much delay resulted; in many districts it was found impossible to complete the copying before letting the patwaris return to their urgent revenue duties and in such districts the copying had to be finished after the crop-inspection was over. It was hoped to complete the slip-copying by the 27th March and this could have been done in most centres had not the supply of slips broken down; actually the slips came in very slowly and a considerable number of units had not sent in slips by the middle of May whilst the last to be received arrived at the beginning of July.

Sorting.

15. Central sorting offices were opened at Karnal, Ludhiana, Lahore and Lyallpur; and the completed slips were sent to these offices where large staffs sorted them according to the various heads required for each table of the report.

The maximum staff employed and the dates of commencing and completing

Office.	STAFF.			Commencement.	Completion.
	Inspectors.	Supervisors.	Sorters.		
Karnal ..	3	18	186	7th April 1921.	21st August 1921.
Ludhiana ..	4	23	224	1st April 1921.	22nd August 1921.
Lahore ..	5	22	260	1st April 1921.	18th July 1921.
Lyallpur ..	4	22	211	6th April 1921.	17th July 1921.

the work in each of these offices is shown in the margin. The Phulkian States, Patiala, Jind and Nabha, carried out their own sorting and tabulation, but with this exception

all the sorting was carried out at the four central sorting offices.

16. The results of the sorting were set forth on sorters' tickets which were sent to the compilation office in Lahore where they were compiled into District or other units totals, and then finally arranged in the form in which they appear in the Tables Volume of this report. This office was in charge of my Personal Assistant who had a large staff of Inspectors and Compilers working under him. The office opened on 1st May 1921, the first table was sent to the press on 17th September 1921 and the last table was finally printed off on 17th January 1923. The process of tabulation is a long and complicated one; any errors in the previous operations, which have escaped detection, come to light at this stage when their correction involves long and careful investigation which is extremely difficult to carry out. Compilation.

17. The results of the census are published in four parts, the months in which these were issued or in which it is expected that they will issue are as follows:— Publication.

Part I. The Report	..	..	during June 1923.
Part II. The Imperial Tables	..	..	May 1923.
Part III. Appendices to the Imperial Tables	..	..	May 1923.
Part IV. The Administrative Volume	..	..	June 1923.

18. The census of the two provinces has cost Government Rs. 3,59,224 which works out at Rs. 14-0-8 for every 1,000 persons enumerated; this compares with Rs. 1,23,907 or Rs. 5-1-11 per 1,000 in 1911. In addition to this sum of Rs. 3,59,224, the total cost of the census includes Rs. 23,112-1-3 recovered from Municipalities on account of cost of tabulation, Rs. 11,550-7-7 recovered from Indian States on account of the cost of forms, sorting and compilation; whilst Indian States have reported a cost of Rs. 50,977-12-10 for the enumeration that they themselves carried out. The Phulkian States have been omitted altogether in reckoning these figures as they carried out the whole of the operations themselves. Cost of the Census.

19. First and foremost a very grateful acknowledgment is due to the official and non-official census staff that carried out the enumeration and slip-copying. With few exceptions this enormous body of workers gave its services freely and without expectation of payment of reward; the non-officials were honorary volunteer workers, whilst the officials undertook the heavy extra duties without additional payment. All are deserving of the sincerest thanks and of congratulations on the public spirit they exhibited, especial praise is due to the patwari staff. Patwaris are hard-worked officials and many miscellaneous duties beyond those directly connected with the revenue administration fall to their lot; they undertook the severe strain of census duty with very little grumbling and carried it through as efficiently as they were able to do; in addition to forming the backbone of the enumeration staff they carried through the slip-copying, which is a monotonous and uninteresting work which has to be carried through at high pressure. Some small acknowledgment of the services of the enumerating staff has been made by the presentation of *sanads* (certificates) for good work, these were issued in three classes, and the numbers issued were 1st Class 242, 2nd Class 1,218 and 3rd Class 7,641; in addition at the close of the financial year 1921-22 I devoted all funds available for the purpose towards giving rewards for slip-copying, but I only had Rs. 16,000 available and only Rs. 15,047 were actually distributed, which only allowed small rewards being given to the best of the men. Acknowledgments.

Deputy Commissioners and District Census Officers, throughout the provinces, directed the operations in their respective districts; their work has increased during the last decade and it could not be expected that they would find much time available for personal superintendence, but so far as their time permitted they all contributed to the success of the operations; amongst Deputy Commissioners I would especially wish to mention Mr. Harcourt in Gurdaspur and Mr. Gordon Walker in Rohtak who took much personal interest in the work in their districts. The work of Mr. Lane Roberts, who was in charge in the Delhi Municipality, and of Mr. Blacker, who conducted operations in the trans-frontier tract of Dera Ghazi Khan, deserves particular notice; both these officers had exceptional difficulties which they surmounted with enthusiasm.

The darbars of the Punjab States appointed Census Superintendents to take charge of census operations, in many cases these officers were able to devote their whole time to the census, and all had more time to give to it than the busy

officials who had to undertake the work in British districts without any diminution in their other duties. Amongst a group of very capable and helpful officials I would single out Sardar Bachittar Singh in Patiala, Syed Abdul Majid in Kapurthala and Syed Altaf Hussain in Jind, but with one exception the work of all was so good that I feel considerable diffidence in specially mentioning any by name.

Five Extra Assistant Commissioners worked under me in the Census Department; Lala Arjan Das worked as my Personal Assistant between 21st January 1921 and 31st August 1921 and was succeeded by Sheikh Abdul Majid who had already been in charge of the Lahore Sorting Office. The Personal Assistant was in general charge of the tabulation work; and both incumbents of the office worked well, Lala Arjan Das giving me material assistance in the preliminary stages and Sheikh Abdul Majid preparing and checking the tables; the whole work was new to Sheikh Abdul Majid, but he organised both the sorting and tabulating work on sound lines and justified his selection. The other three sorting offices were also under men new to the work; they were Syed Abdul Haq at Ludhiana, Lala Bishamber Dayal Singh at Karnal, and Malik Chiragh-ud-din at Lyallpur; the newness of the work led to several mistakes being made which caused much trouble to rectify but on the whole the work was satisfactory, that of S. Abdul Haq being rather more dependable than that of the others.

Change of
Superin-
tendent.

20. Owing to ill-health I was obliged to take leave from the 21st September 1922; previous to that date ill-health had delayed my work, and on relinquishing my charge I had only written so much of the Introduction to the Report which precedes this paragraph and Chapter I, but Parts II and III of the Report had been completed and were with the Press. I relinquish charge without information as to the identity of my successor who will write the major portion of the Report and complete this introduction.

L. MIDDLETON.

20-9-22.

INTRODUCTORY NOTE CONTINUED.

21. I took over as Superintendent, Census Operations, on the 3rd October 1922, Sheikh Abdul Majid, B.A., LL. B., having remained in charge of the Office after Mr. Middleton's departure. As he has noted Mr. Middleton had completed Chapter I of the Report, and this chapter alone contains a comprehensive survey of nearly all the subjects dealt with in the census. Mr. Middleton also took to England and completed there the whole of the Administrative Volume, Part IV.

22. My own task has been to see a great portion of Parts II, III and IV through the press and to write the eleven remaining chapters of Part I. Two months were spent in gaining familiarity with all the phases of census work, and in the remaining five months the chapters have been written rather faster than at the rate of one a fortnight, so as to complete the report by the end of April. Under these circumstances I have had strictly to limit the time devoted to the investigation of those fundamental principles without which it is impossible to understand the problems of migration, birth and death-rates, and age-distribution.

23. Throughout the chapters for which I am responsible I have sought, wherever possible, to express results in a precise statistical form with due regard to the probable errors of enumeration. Neglect of this consideration has led to the formulation of many utterly unproven and even demonstrably false propositions. Every census report in fact bristles with dogmatic statements and I should hesitate to estimate how many are contained in the chapters written by myself. I am fully aware that that to make such unqualified statements is contrary to the spirit of scientific progress, and would ask the reader to believe that the limitations to which most of the statements are subject were in many cases present to my mind even when they are not explicitly set forth.

Nothing, in fact, is more conducive to dogmatic statement than the masses of statistics contained in a census report, yet no where is dogmatic statement less justified or the critical spirit of present-day statistical doctrine more necessary. Indeed modern statistical methods probably indicate more often what conclusions are false than what conclusions are true and even this seemingly negative result may be reached only after patient and abstruse enquiries.

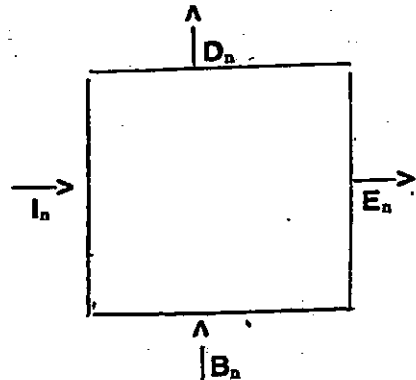
24. In addition to the gentlemen whose services have been acknowledged by Mr. Middleton, I wish to express my thanks to those who have specially assisted me, in particular, to Colonel W. H. C. Forster, I.M.S., Director of Public Health, Punjab, whose constant advice and criticism has been of the utmost value in all matters relating to vital statistics and deaths from disease ; to Mr. G. Anderson, C.I.E., I.E.S., Director of Public Instruction, who kindly devoted many hours together with several departmental officers to the discussion of the problem of education and its bearing on the general-literacy of the province ; to Colonel Ward, I.M.S., Inspector-General of Prisons, who furnished me with some special jail mortality statistics ; to Mr. Calvert, I.C.S., Registrar, Co-operative Credit Societies, whose unrivalled knowledge of the industrial and rural economics of the Punjab has been freely placed at my disposal in the form of notes on my draft chapter on occupation ; to Mr. R. Sanderson, M. A., I. E. S., Inspector of Schools, Lahore Division, who has kindly supplied me with certain data regarding Albinos ; to Mr. H. L. O. Garrett, M.A., I.E.S., for a note on recruitment in the Ludhiana district ; to Rai Bahadur Sir Ganga Ram, Kt., C.I.E., C.V.O., for information regarding the Vidhva Vivah Sahaik Sabha, Lahore ; to Mr. Faqir Chand, Auditor of Statistics, North-Western Railway, for information supplied regarding the number of passengers and density of traffic on the North-Western Railway ; to Mr. Labha Mall, Assistant Librarian of the Punjab University Library, for bringing to my notice several interesting books on population statistics ; to the authorities of the "Civil and Military Gazette" Press, and in particular, to Mr. Gilbert, whose unfailing courtesy and energy has smoothed the task of getting so much material into print ; to Mr. K. C. Vidyarthi, Manager of the Bharat Insurance Company, for his kind treatment of the Census Department which rented offices in the Bharat Buildings. Finally, I must acknowledge the great services rendered by my Personal Assistant, Sheikh Abdul Majid, B.A., LL.B., but for whom the task of completing the report within the short time allotted would have been well-nigh impossible. The Chapters IV and IX on religion and language are almost entirely his own, and I did little more than edit them. Both my computers, Mr. Abdul Majid, M.A., and Mr. Balwant Singh, B.Sc., gave great assistance in many laborious computations and both of them put up many valuable notes. Good work was done by all members of the staff of whom Mr. Barkat Ali, Head Clerk ; Sheikh Mohammad Abdul Wahid, Recordkeeper ; Inspectors Ata-ur-Rahman and Fazal Din, and my Stenographer Bawa Jagat Singh may be specially mentioned.

S. M. JACOB;

APPENDIX 1.

THE ERROR IN VITAL STATISTICS AS DETERMINED FROM CENSUS ENUMERATIONS, ON A PROBABLE HYPOTHESIS AS TO THE ERRORS OF THE CENSUS.

Let us call the number of persons recorded as immigrants at any census as I'_n , where n is the year of the Census. We will call the recorded number of emigrants E'_n .



Let I_n be the number of immigrants in the n th year.

- E_n " " emigrants " "
- B_n " " births " "
- D_n " " deaths " "

Then if the inter-censal rise in population is R ,

$$R = \text{Sum } (I_n + B_n - E_n - D_n)$$

$$B - D = R - n(I - E). \tag{I}$$

provided that I_n and E_n are constant throughout the decade and equal to I and E respectively.

Now assume migrants enter at the mid-point of the year, we have

$$I'_{n+10} = I'_n s^{10} + I_{n+1} s^5 + I_{n+2} s^5 + \dots + I_{n+10} s^{\frac{1}{2}}$$

where s is equal to the proportion of survivors after one year, and assuming a constant death-rate.

Hence

$$I'_{n+10} = I'_n s^{10} + s^{\frac{1}{2}} (I_{n+10} + s I_{n+9} + \dots + s^9 I_{n+1})$$

assuming that immigration is constant from year to year and equal to I per annum.

$$I'_{n+10} = I'_n s^{10} + I s^{\frac{1}{2}} \frac{s^{10} - 1}{s - 1}$$

$$\text{or } I = \frac{s^{10} - 1}{s^{\frac{1}{2}} (s^{10} - 1)} (I'_{n+10} - I'_n s^{10}). \tag{II}$$

Similarly

$$E'_{n+10} = E'_n s^{10} + E_{n+1} s^5 + E_{n+2} s^5 + \dots + E_{n+10} s^{\frac{1}{2}}$$

assuming as before equal survival rates, and again assuming constant emigration,

$$E'_{n+10} = E'_n s^{10} + E s^{\frac{1}{2}} \frac{s^{10} - 1}{s - 1} \tag{III}$$

Where E is the annual rate of emigration.

$$\text{Thus } I - E = \frac{s - 1}{s^{\frac{1}{2}} (s^{10} - 1)} \left\{ I'_{n+10} - E'_{n+10} - s^{10} (I'_n - E'_n) \right\}$$

Call the inter-censal gain by migration M ,

$$\text{Then, } M = \frac{10 (s - 1)}{s^{\frac{1}{2}} (s^{10} - 1)} \left\{ I'_{n+10} - E'_{n+10} - s^{10} (I'_n - E'_n) \right\} \tag{IV}$$

This result (IV) gives the calculated gain from migration from the number of persons recorded at each census as having been born inside a given area and enumerated outside it (E') and born outside it and enumerated inside it (I').

The assumption made of a survival proportional to the number of persons living at each age is probably not so true as the assumption of a definite constant decrement of population, especially between the ages of 36—76 (vide page 92, Census Report of England and Wales 1911). Call the annual decrement δ . Then our equations become

$$I'_{n+10} = I'_n (1-10\delta) + I_{n+1} (1-9\frac{1}{2}\delta) + I_{n+2} (1-8\frac{1}{2}\delta) + \dots + I_{n+10} (1-\frac{1}{2}\delta).$$

Writing as before

$$I_{n+1} = I_{n+2} = I_{n+3} = I_{n+4} \dots = I \text{ for the annual}$$

immigration

$$I'_{n+10} = I'_n (1-10\delta) + I (10-50\delta)$$

therefore

$$10 I = \frac{I'_{n+10} - I'_n (1-10\delta)}{1-5\delta} \tag{II A}$$

and

$$10 E = \frac{E'_{n+10} - E'_n (1-10\delta)}{1-5\delta} \tag{III A}$$

these equations give the total migration (emigration and immigration) during the decade. If we put $\delta = 20/1000 = 1/50$

$$10 I = (I'_{n+10} - I'_n \cdot 4/5) / (9/10) = 10/9 \cdot I'_{n+10} - 8/9 \cdot I'_n = 1/9 (10 \cdot I'_{n+10} - 8 \cdot I'_n).$$

We have seen how an approximate calculation of the immigration and emigration during an inter-censal decade may be made, leading to formulae II and III based on a geometric decrease of population, and to formulae II A and III A based on an arithmetic decrease of population, with age (Middleton's assumption.)

Let us write the total immigration and emigration in a decade as i and e respectively, then if b and d are the true number of births and deaths and R the inter-censal rise in population

$$R = b + i - d - e \tag{IV}$$

so that $b - d = R - (i - e)$

Let B and D be the total number of inter-censal births and deaths from the records of vital statistics. Then in general the recorded number of births and deaths will be less than the true number of births and deaths, so that $b > B$ and $d > D$, and we may write

$$b = B + k \quad \text{and} \quad d = D + k',$$

where k and k' are both greater than zero.

Hence $k - k' = (b - d) - (B - D)$

Thus the error in $(B - D)$ is $k - k'$; but this alone gives us no information as to the error of B or D separately, and the deduction (made in para. 25 of Chapter I of the Report) that when $k - k'$ is positive k' is zero, and when $k - k'$ is negative k is zero, is not justified.

It is now necessary to re-examine the whole question from the point of view of the probable errors of the census returns.

For convenience let us write the total number of immigrants and emigrants during the decade as ' i ' and ' e ' respectively, and the immigrants and emigrants enumerated at the two censuses as i_0, i_1, e_0, e_1 . Then we have from the previous equations (II A and III A.)

$$i = \frac{i_1 - i_0 (i - 10\delta)}{1 - 5\delta} = li_1 - mi_0$$

and

$$e = \frac{e_1 - e_0 (i - 10\delta)}{1 - 5\delta} = le_1 - me_0$$

where $l = 1/(1 - 5\delta)$ and $m = (1 - 10\delta)/(1 - 5\delta)$,

then

$$b - d = R - l(i_1 - e_1) + m(i_0 - e_0) \tag{IV}$$

Call the excess of immigrants over the emigrants s_0, s_1 at the respective censuses.

$$b - d = R - ls_1 + ms_0$$

or $b - d = p_1 - p_0 - ls_1 + ms_0$

Call θ_x the standard error of any variable x , then (r being the correlation between the errors in any pair of variables)

$$\theta_{b-d}^2 = \theta^2 p_1 + \theta^2 p_0 + l^2 \theta^2 s_1 + m^2 \theta^2 s_0 - 2r\theta p_1 \theta p_0 - 2rl\theta p_1 \theta s_1 + 2rm\theta p_1 \theta s_0 + 2rl\theta p_0 \theta s_1 - 2rm\theta p_0 \theta s_0 - 2lmr\theta s_1 \theta s_0$$

then we get (i) if $C > 0$
 $E_B > C$
 (ii) if $C < 0$
 $E_D > C$

Hence if we take together all those districts for which $C > 0$, we find on the average that $E_B/B > 0$ say; and if we take together all the districts for which $C < 0$, we find on the average that $E'_D/D' > C'$.

Now it seems to be a reasonable assumption that in those districts where we know nothing about the error in the death-rate, that it amounts to a fraction 'k' of the lower limit of the error in the districts for which we have such knowledge.

Thus

$$\frac{E_D}{D} = k \cdot \frac{E'_D}{D'} \quad \text{and} \quad E_B = E_D + C$$

and approximately $B = D$ and $B' = D'$

$$\begin{aligned} \text{Hence,} \quad \frac{E_B}{B} &= \frac{C}{B} + \frac{E_D}{B} \\ &= \frac{C}{B} + \frac{E_D}{D} \\ &= \frac{C}{B} + k \cdot \frac{E'_D}{D'} \end{aligned}$$

Similarly

$$\frac{E'_D}{D'} = \frac{C'}{D'} + k \cdot \frac{E_B}{B} \quad \text{and} \quad E'_D = E'_B + C'$$

$$= \frac{C'}{D'} + k \cdot \frac{C}{B} + k \cdot \frac{E_D}{D}$$

or

$$\frac{E'_D}{D'} (1 - k^2) = \frac{C'}{D'} + k \cdot \frac{C}{B}$$

$$\frac{E'_D}{D'} = \frac{\frac{C'}{D'} + k \cdot \frac{C}{B}}{1 - k^2}$$

(1V)

If we assume that $k = \frac{1}{2}$, this is equivalent to saying that the error in the death-rate in the districts where the birth-rate error is in excess is *half* the error in the death-rate in those districts in which the death-rate error is in excess, and the birth-rate is assumed to be wholly free from error.

$$\begin{aligned} \text{Putting } C'/D' &= 7.4 \quad \text{and} \quad C/B = 4.0 \\ \frac{E'_D}{D'} &= 9.4 / \frac{3}{4} = 37.6 / 3 = 12.5 \% \quad (\text{error in death-rate}) \\ &\quad \text{and } E'_B/B' = 5.1 \\ \frac{E_B}{B} &= (4.0 + \frac{1}{2} \times 7.4) / \frac{3}{4} = 10.3 \% \quad (\text{error in birth-rate}) \\ &\quad \text{and } E_D/D = 6.3 \end{aligned}$$

thus the percentage errors in the birth- and death-rates in the districts where the birth-rate is more in error are 10.3 and 6.3, and in the districts where the death-rate is more in error are 5.1 and 12.5.

The average error of birth and death-rates is thus

$$\frac{10.3 + 6.3 + 5.1 + 12.5}{4} = \frac{34.2}{4} = 8.5 \%$$

Another alternative is to assume that where the birth-rate is more in error than the death-rate, the error of the latter is k times ($k < 1$) the former, and *vice versa*.

We shall then have,

$$\begin{aligned} \frac{E_B}{B} &= \frac{C}{B} + k \cdot \frac{E'_D}{D'} \\ \frac{E'_D}{D'} &= \frac{C'}{D'} + k \cdot \frac{E_B}{B} \\ \frac{E_B}{B} &= \frac{C}{B} \cdot \frac{1}{1 - k} \\ \frac{E'_D}{D'} &= \frac{C'}{D'} \cdot \frac{1}{1 - k} \end{aligned}$$

Assuming that in the districts where the birth-rate is more in error than the death-rate that the latter is half the former, we get

$$\begin{aligned} k &= \frac{1}{2} \\ \frac{E_B}{B} &= 2C/B \\ \frac{E'_D}{D'} &= 2C'/D' \end{aligned}$$

and assuming the same values of C and C' as before, we get

	Errors in	
	Birth-rate	Death-rate
In Districts where the error in birth-rate is greater	8.0 %	4.0 %
In Districts where error in death-rate is greater	14.8 %	7.4 %
The mean of these results is	$\frac{8.0 + 4.0 + 14.8 + 7.4}{4} = \frac{34.2}{4} = 8.5 \%$	

On an average therefore 1 birth or death in 13 is not recorded.

The figures given below are the percentage errors on the recorded births. The actual births will number 108.5 to 100 recorded.

The percentage errors on the actual births will be

$$8.5/108.5=7.8\%$$

that is about 1 in 13.

Thus we reach the conclusion that the vital statistics of the Punjab are likely to be about 7 or 8 per cent. in error, and that, provisionally, errors of about 11 per cent. in the birth-rate and of say 5 per cent. in the death-rates may be adopted as probable. Finally it is clear that the census figures of 1911 and 1921 do not establish the accuracy of the vital statistics to a greater degree of accuracy than 7 or 8 per cent. of error.

Since making the above deductions slight arithmetical errors were discovered in Mr. Middleton's table on page 54, and the following revised table must be adopted instead:—

Calculation of the percentage errors of the birth and death returns on the assumptions that in any one district one at least of the returns is absolutely correct.

Districts.	Percentage excess error of	
	Birth-rate C positive.	Death-rate C negative.
1 Hissar .. .. .	..	3.4
2 Karnal .. .. .	..	1.2
3 Jullundur	0.9	..
4 Ludhiana .. .. .	..	3.8
5 Ferozepore	0.09	..
6 Lahore	1.7	..
7 Amritsar .. .. .	..	0.48
8 Simla	145.2	..
9 Kangra .. .. .	..	4.4
10 Ambala .. .. .	..	0.26
11 Hoshiarpur .. .. .	..	4.27
12 Gurdaspur .. .. .	..	8.5
13 Sialkot .. .. .	..	8.0
14 Gujrat .. .. .	..	12.61
15 Jhelum .. .. .	..	9.36
16 Rawalpindi .. .. .	..	6.18
17 Attock .. .. .	..	16.6
18 Montgomery	22.6	..
19 Shahpur	25.4	..
20 Mianwali .. .. .	..	9.8
21 Lyallpur .. .. .	..	9.7
22 Jhang .. .. .	..	8.0
23 Multan .. .. .	..	5.79
24 Muzaflagarh .. .. .	..	7.29
25 Dera Ghazi Khan .. .. .	..	13.3
Total	195.89	132.94
Average	32.65	7.0

If we adopt the corrected values of the excess errors in the birth and death-rates instead of Middleton's values, then excluding Simla, the percentage excess error is

10.14 % for the birth-rate

7.00 % for the death-rate.

Let us take these as 10 % and 7 % respectively,

i. e., $C/B=10$ and $C'/D'=7$

- (i) Then on the assumption that the error in the death-rate in the districts where the birth-rate error is in excess is half the average error in the districts where the minimum can be fixed.*

$$E_B/B = C/B + \frac{1}{2} E'/D'$$

$$E'_D/D = C'/D' + \frac{1}{2} E/B$$

We get

$$E_B/B = 18, \quad E_D/D = 6, \quad E'_D/D' = 12, \quad E'_B/B' = 9$$

$$\text{Average} = \frac{18+12+6+9}{4} = 11.25\%$$

- (ii) On the assumption that the error in the birth-rate, where the death-rate error is in excess, is $\frac{1}{2}$ the error in the death-rate, and *vice versa*.

$$E'/D' = C'/D' + \frac{1}{2} E'_D/D'$$

$$E_B/B = C/B + \frac{1}{2} E_D/D$$

We get

$$E_B/B = 20, \quad E_D/D = 10, \quad E'_D/D' = 14, \quad E'_B/B' = 7.$$

$$\text{Average error} = \frac{20+14+10+7}{4} = 12.75\%$$

Taking the mean of the two results we may say that the average error of the birth and death-rates, assuming the censuses are correct, is 12 %.

If we treat this as the standard error and adopt an estimate of 1 % for the standard error of a census, the standard error of the birth- and death-rates is given by

$$E_v^2 = (12)^2 + (1)^2$$

$$= 144 + 1 = 145$$

$$E_v = 12.04\%$$

This is the percentage error on the recorded births and deaths. Assuming the errors are always in defect the percentage error on the actual births and deaths is

$$\frac{12.04 \times 100}{112.04} = 10.74\%$$

This result is still more unfavourable to the accuracy of the vital statistics, and it may exaggerate their incorrectness.

However it is clear that whatever the standard error in the vital statistics is, whether 5, 8, or 11 per cent., we are very far from being justified in assuming these statistics to be really close to the truth.

* Note that dashes indicate that we are dealing with districts in which the death-rate error is in excess.

APPENDIX 2.

The relationship between density of rural population per square mile with the District percentage of cultivated area.

Briefly, there is, as Mr. Middleton states a clear association between density of rural population and percentage of cultivated area in each District, but the conclusion that density of population increases faster than the percentage of the cultivated area, can hardly be said to be established without a laborious analysis. Speaking statistically the law of density could only be accepted, if it were shown—

(a) that the regression of density of population on percentage of cultivated area is not linear.

(b) that the regression curve is concave upwards.

Now, the testing of these points, making allowance for the errors due to the smallness of the sample, is a considerable task; but we can get an approximate result by fitting the data with second and third order parabolæ. If this is done we find (calling "D" the rural density per square mile, and "k" the percentage of cultivated area)

$$D = -23.260 + 6.989k - 0.26k^2$$

$$D = 23.741 + 4.005k + 0.23k^2 - 0.002k^3$$

These equations show that—

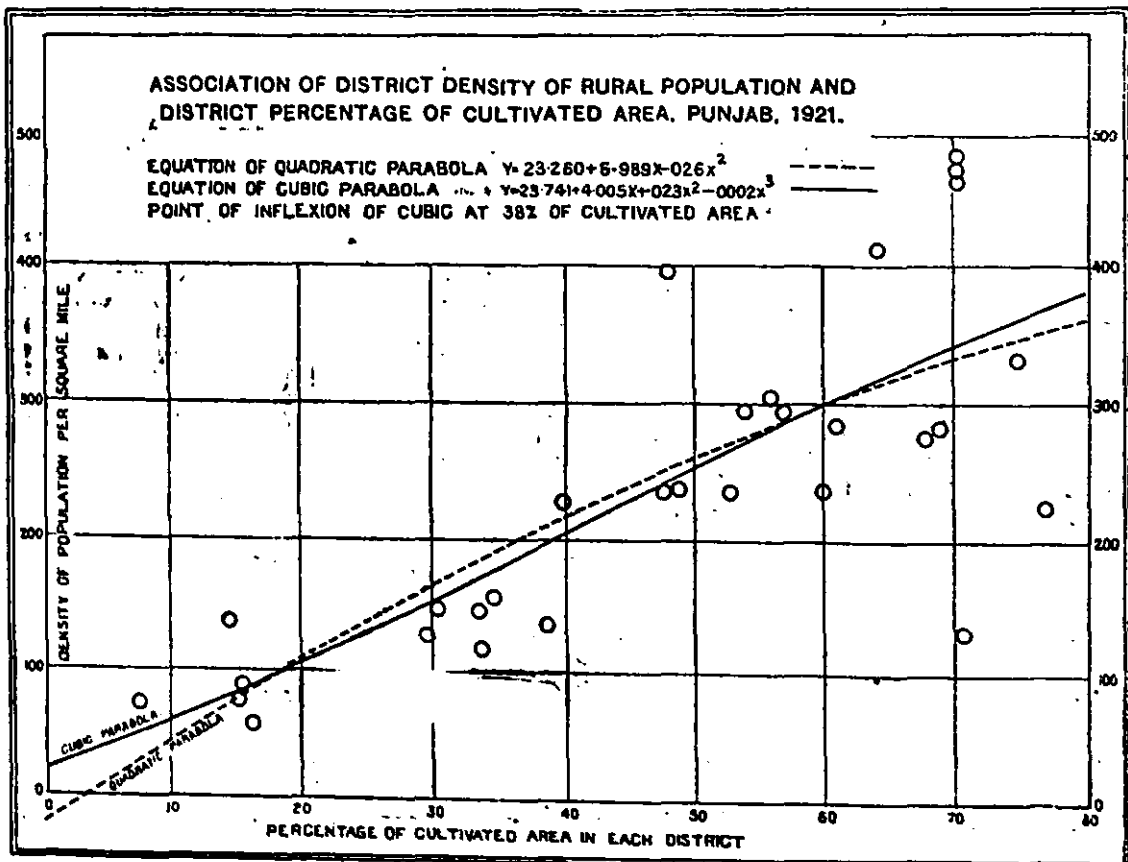
(a) the relation of density to cultivated area is expressed very nearly by a straight line, both the square and cubic terms being small up to a percentage of 80 for the cultivated area, which is above the limit found in this data;

(b) as judged by the quadratic the curvature is convex upwards, which is exactly the opposite conclusion to that reached in paragraph 18;

(c) as judged by the cubic, there is an almost negligible concavity upwards for values of k less than 38 per cent., but that for higher values of k the curve is once more convex upwards.

It is by no means certain, without a much fuller analysis, whether the curvature would be positive or negative, if the errors of random sampling could be eliminated, and it is not intended to set up any law in opposition to that of Mr. Middleton. Unless, however, he has used other and wider material than that discussed here, judgment as to the nature of the divergence from linearity of the association of density of population and cultivated area must be suspended. In fact one might in slang phrase say that the data give a very good imitation of linear relationship.*

The data and the quadratic and cubic parabolæ are shown in the diagram below—

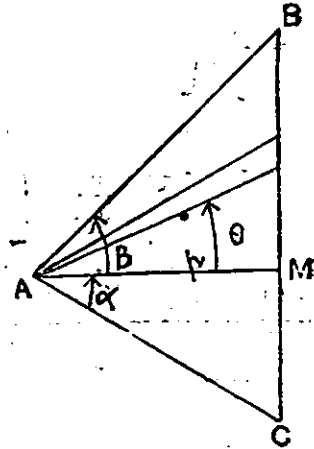


*This does not mean, of course, that there is alone one correspondence between density and percentage of cultivated area. Even if the correlation is skew, it is certainly not perfect—a point no doubt which Mr. Middleton implied, though he did not state it.

APPENDIX 3.

MEAN SCALAR DISTANCE.

Let us find the mean scalar distance of a triangle
 ABC from the Apex A.



The value is given by

$$\bar{S} = \frac{\iint r^2 d\theta dr}{\iint r d\theta dr}, \text{ integrated over the area of the triangle.}$$

The limits of r are 0 and $p \sec \theta$, for $0 < \theta < \beta$

The limits of r are 0 and $p \sec \theta$, for $0 < \theta < \alpha$

where α and β are the angles which the perpendicular p makes with the sides AC and AB respectively.

Call the area of the triangle A , then

$$\begin{aligned} A\bar{S} &= \int_0^\beta \int_0^{p \sec \theta} r^2 dr d\theta + \int_0^\alpha \int_0^{p \sec \theta} r^2 dr d\theta \\ &= \int_0^\alpha \frac{p^3 \sec^3 \theta}{3} d\theta + \int_0^\beta \frac{p^3 \sec^3 \theta}{3} d\theta \\ &= \frac{p^3}{3} \left[\int_0^\alpha \sec^3 \theta d\theta + \int_0^\beta \sec^3 \theta d\theta \right] \end{aligned}$$

$$\begin{aligned} \text{Now } \int \sec^3 \theta d\theta &= \int \sec \theta d \tan \theta \\ &= \sec \theta \tan \theta - \int \tan \theta \sin \theta \sec^2 \theta d\theta \\ &= \sec \theta \tan \theta - \int \sin^2 \theta \sec^3 \theta d\theta \\ &= \sec \theta \tan \theta - \int d\theta \sec^3 \theta + \int \sec \theta d\theta \end{aligned}$$

$$\therefore 2 \int \sec^3 \theta = \sec \theta \tan \theta + \log \tan \left(\frac{\pi}{4} + \frac{\theta}{2} \right)$$

Thus

$$\frac{A\bar{S}}{A\bar{S}} = \frac{p^3}{6} \left[\sec \alpha \tan \alpha + \sec \beta \tan \beta + \log \tan \left(\frac{\pi}{4} + \frac{\alpha}{2} \right) + \log \tan \left(\frac{\pi}{4} + \frac{\beta}{2} \right) \right]$$

$$= \frac{p^3}{6} \left[\sec \alpha \tan \alpha + \sec \beta \tan \beta + \log \tan \left(\frac{\pi}{4} + \frac{\alpha}{2} \right) \tan \left(\frac{\pi}{4} + \frac{\beta}{2} \right) \right]$$

If the triangle is isosceles $\alpha = \beta$, and the mean scalar distance is then

$$\bar{S} = \frac{p^3}{3A} \left[\sec \alpha \tan \alpha + \log \tan \left(\frac{\pi}{4} + \frac{\alpha}{2} \right) \right]$$

Now we have for the triangles formed by joining the terminals of a side to the centre the following values of α .

Figure.	α	$\sec \alpha \tan \alpha$	$\log \tan \left(\frac{\pi}{4} + \frac{\alpha}{2} \right)$	Sum cols. 4 and 3.	p^3/A^2	$3\bar{S}/\sqrt{A}$	\bar{S}/\sqrt{Q}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hexagon ..	30°	.666667	.5493061	1.216973	2.279507	2.771819	.377197
Square ..	45°	1.414214	.8813736	2.295588	1	2.295588	.382598
Equilateral triangle	60°	3.464102	1.3169577	4.781060	1/2.279507	2.097410	.403047

Now call Q the whole area of the figure,

i. e., $Q=6A$ for the hexagon

$=4A$ for the square

$=3A$ for the triangle (equilateral)

For a circle from the centre $\bar{S}/\sqrt{Q}=.376126$

Returning to the general formula, a graphic method of determining the mean scalar distance, applicable to an irregular boundary, will be developed.

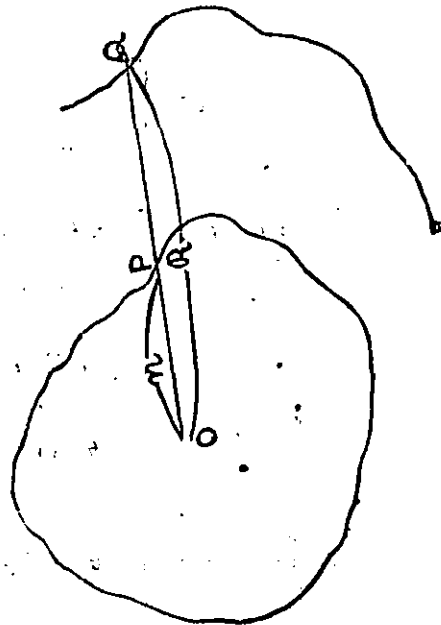
We have

$$\bar{S} = \frac{\iint r^2 d\theta dr}{\iint r d\theta dr}, \text{ integrated over the whole area of the figure.}$$

Let O be the point from which the mean scalar distance is to be determined.

Let P be any point in the boundary.

Let Q be a point on OP (produced if necessary), such that



$$OP^2 = l \cdot OQ^2$$

then if $OQ=R$, we get $3r^2 \delta r = 2l \cdot R \delta R$
and

$$\bar{S} = \frac{\iint l R \, d\theta \, dR}{\iint r \, d\theta \, dr}$$

where the integrals extend over the outer and the inner curves respectively.

Calling Δ the area of the original curve
 Δ' the area of the constructed curve

$$\bar{S} = \frac{2}{3} \frac{\Delta'}{\Delta} l$$

and the mean scalar distance can at once be obtained planimetrically.

Let l be the unit of length on which OP is measured

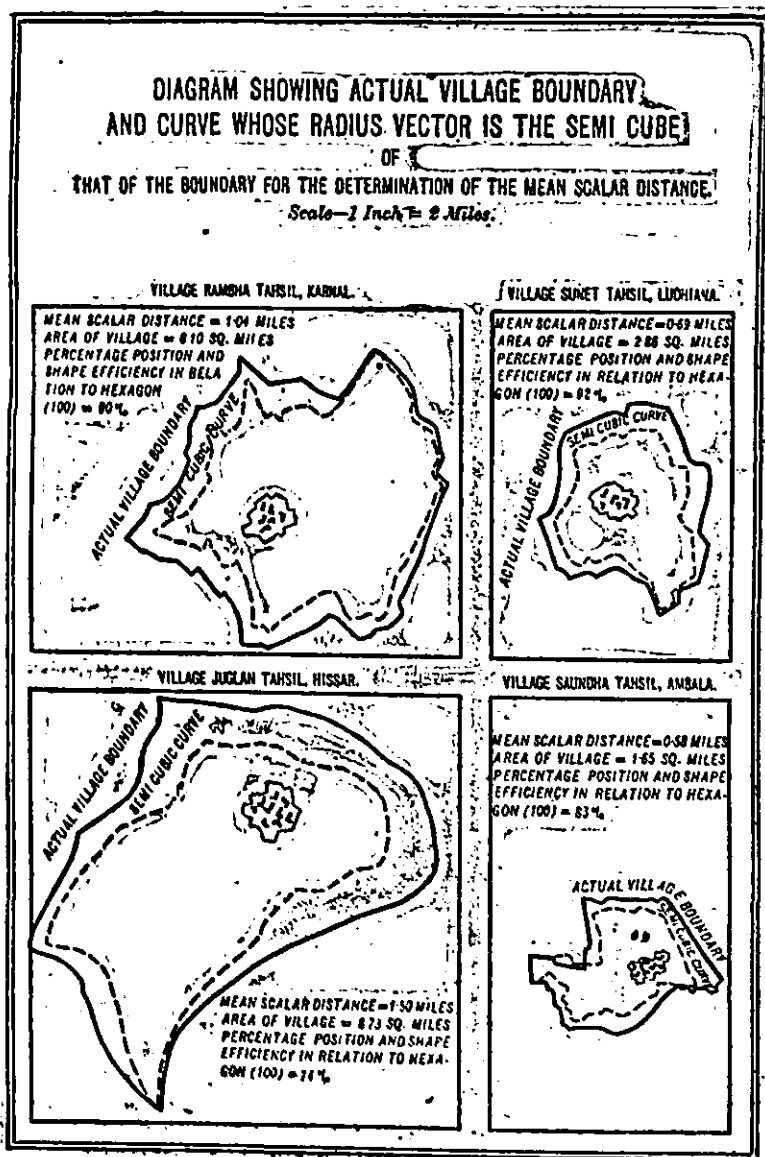
$$l = \frac{OP^2}{OQ^2}$$

and where $OP=OQ$ we get,

$$l = OP = OQ.$$

In order to calculate graphically the mean scalar distance for any contour from any point, it will suffice to measure the area of the two curves in the same unit, and multiply two-thirds of their quotient by the distance adopted as unity, for which the two radii vectors are equal.

The contours of 4 villages together with the semi-cubical curve for the calculations



of the mean scalar distance are shown in the attached diagram. The relative data for these, and 2 other villages are given in the statement below, and the figures in col. 7 of this statement show that the shape of the village boundary and the position of the abadi, is far from being as favourable to agricultural operations as they might be.

No.	Village.	District.	Tahsil.	Area in square miles.	$\cdot 377197/\bar{A}$ Mean scalar distance for hexagonal bound- ary of (A)	Actual mean scalar distance. \bar{S}_n	Percentage efficiency of shape and position of abadi($\bar{S}/\bar{S}_n \times 100$)	REMARKS.
1	2	3	4	5	6	7	8	9
1	Juglan ...	Hissar ...	Hissar ...	8.7324	1.114617	1.408937	74.8	
2	Rambah ...	Karnal ...	Karnal ...	6.0986	.931677	1.037739	89.8	
3	Sundah ...	Ambala ..	Ambala ...	1.6473	.483944	.579658	83.5	
4	Maina ...	Rohtak ...	Rohtak ...	3.1480	.657832	.718351	91.6	
5	Sunet ...	Ludhiana ...	Ludhiana ...	2.8618	.637840	.688661	92.4	
6	Ladbewali ...	Jullundhar ...	Jullundhar ...	1.1872	.402092	.445322	90.3	

APPENDIX 4.

MORTALITY FROM VARIOUS DISEASES.

(A). The annual death-rate from 1867 to 1921 (inclusive) from (1) cholera, (2) small-pox, (3) bowel complaints, (4) plague, (5) fevers, (6) all "other" causes, and (7) all causes. (B)—The seasonal variation of the deaths from the above causes for the 2 periods 1867—1896 (30 years) and 1897—1921 (25 years). (C)—A comparison of the urban and rural death-rates from the causes enumerated in (A) above.

The object of this Appendix is merely to summarise in convenient form the broad statistical features of the deaths as classified in the Public Health returns since 1867.

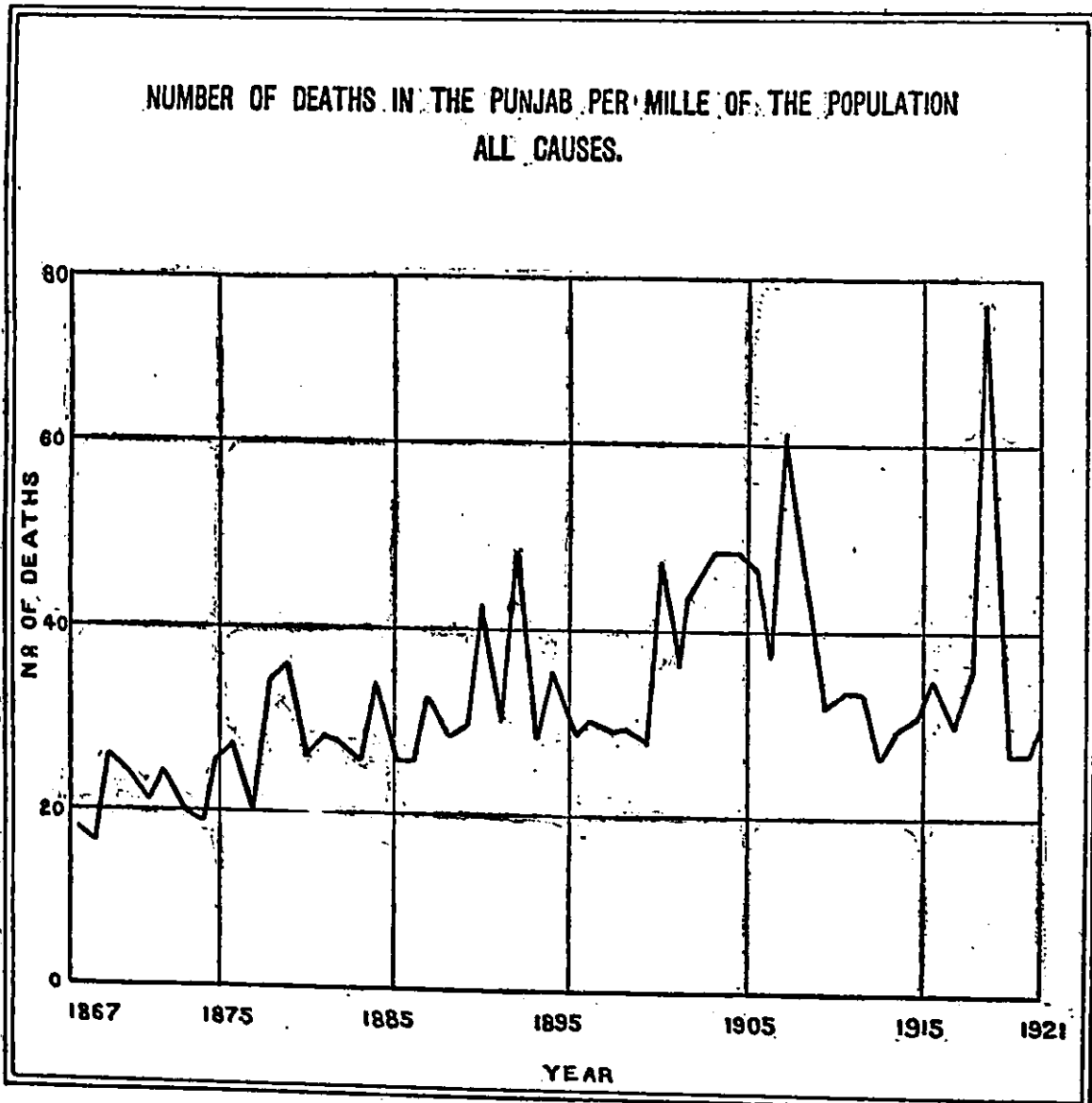
The three sections into which the Appendix is divided will be taken seriatim.

(A).—The annual death-rate from 1867 to 1921 (inclusive) from (1) cholera, (2) small-pox, (3) bowel complaints, (4) plague, (5) fevers, (6) all "other" causes, (7) all causes.

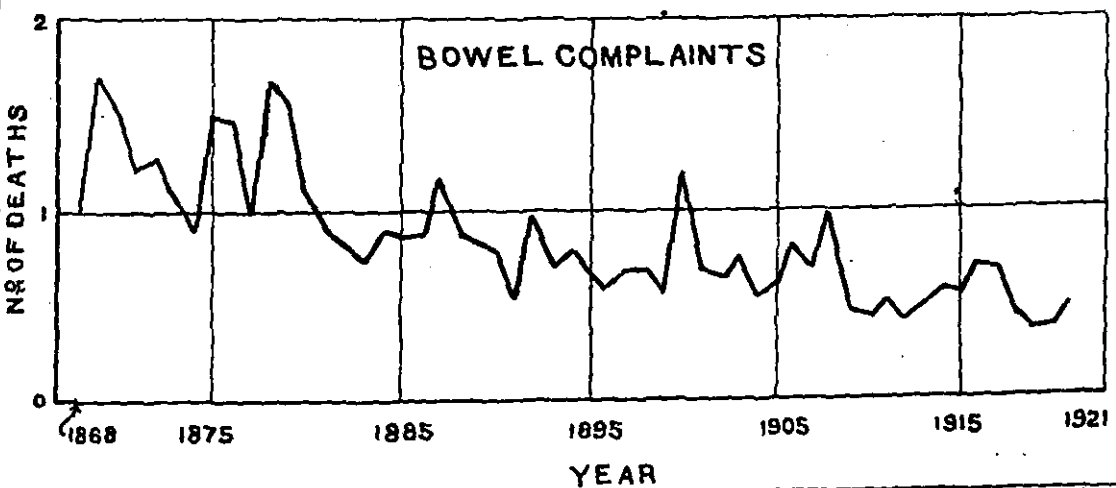
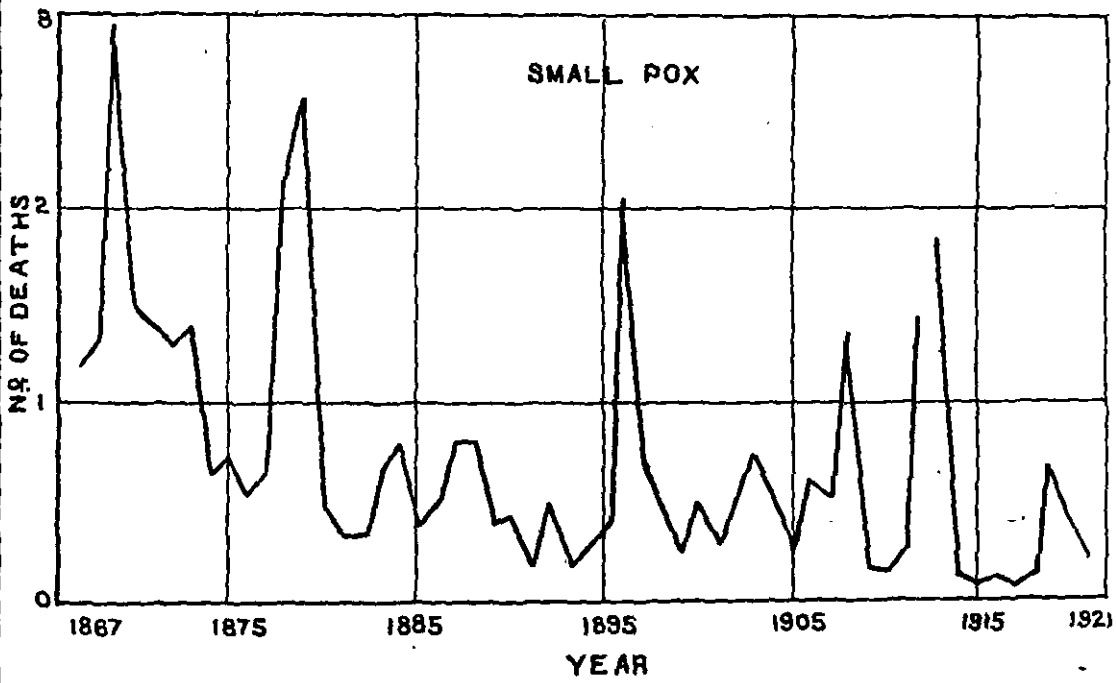
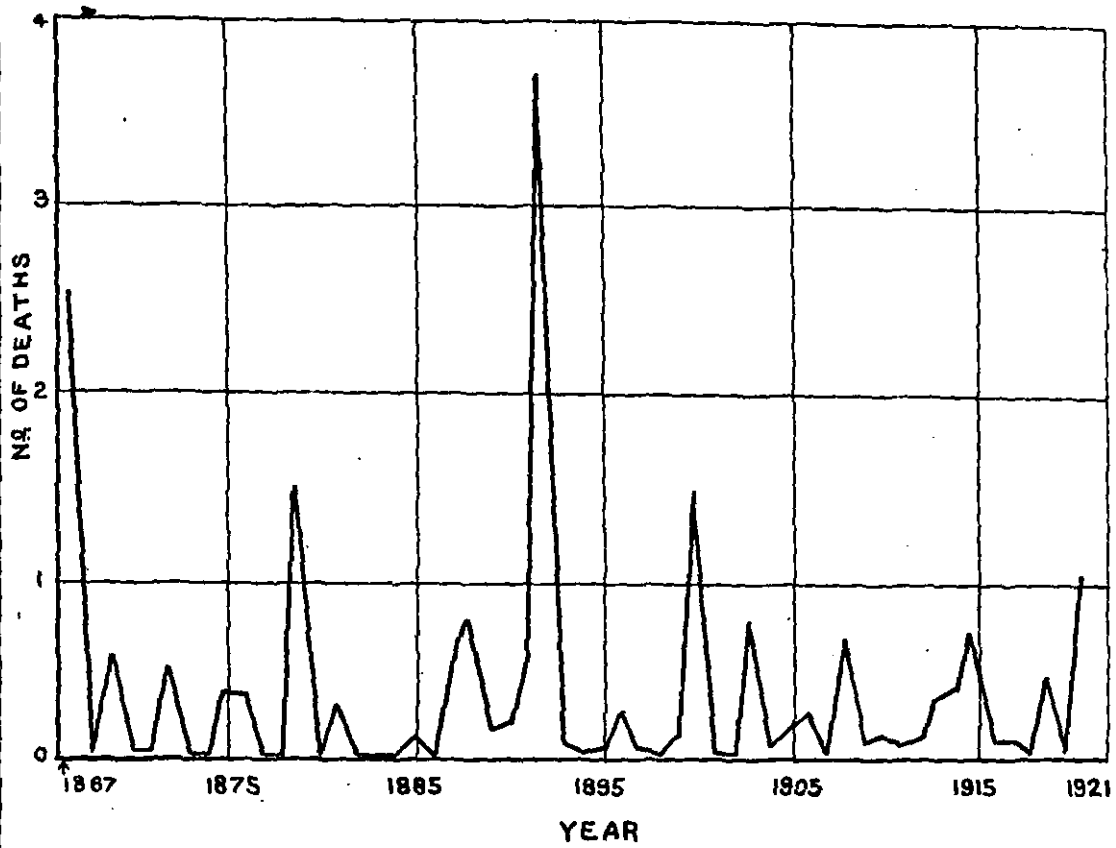
The death-rates have all been calculated afresh from the original data of mortality from each disease for the Punjab (British Territory) as constituted from time to time, the North-West Frontier Province being excluded from 1900 and onwards. The actual census returns for 1868, 1881, 1891, 1901, 1911 and 1921 have been used for the years named; but for the inter-censal periods the population has been found by intercalating geometric series, whose end terms coincide with the actual census populations. The whole set of enumerated and calculated populations is shown in the table in statement 1. For the sake of comparison of the growth of the population before and after the separation of the North-West Frontier Province the figures for the territory comprised in this Province have been added to the Punjab figures since 1900 (inclusive). The figures suffer from the defect (so far as comparison goes) of the exclusion since 1911, of the part of the Delhi population which lies to the west of the Jumna for which separate figures are not available in the tables.

The interpolated population will differ from the actual population, sometimes by large amounts, and it would have been better to use the vital statistics of births and deaths to determine the population at one census from that of the preceding census, and then apply a geometric progression to the residual differences between the calculated and observed populations at the later census.

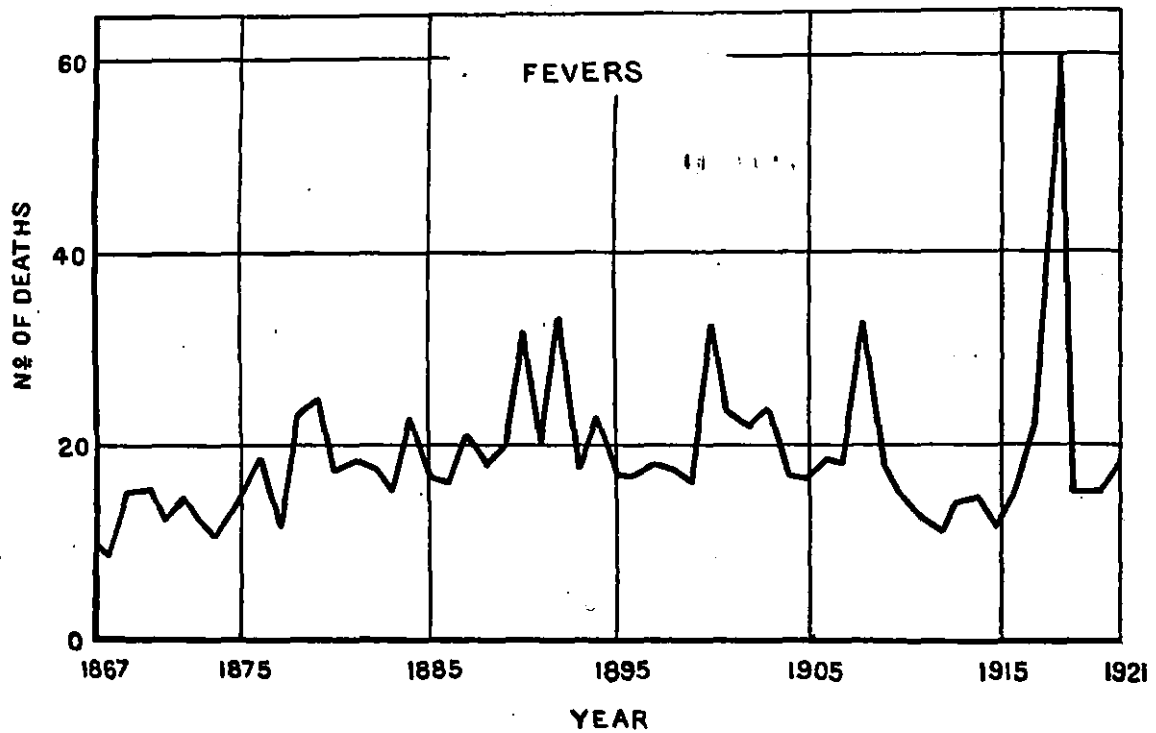
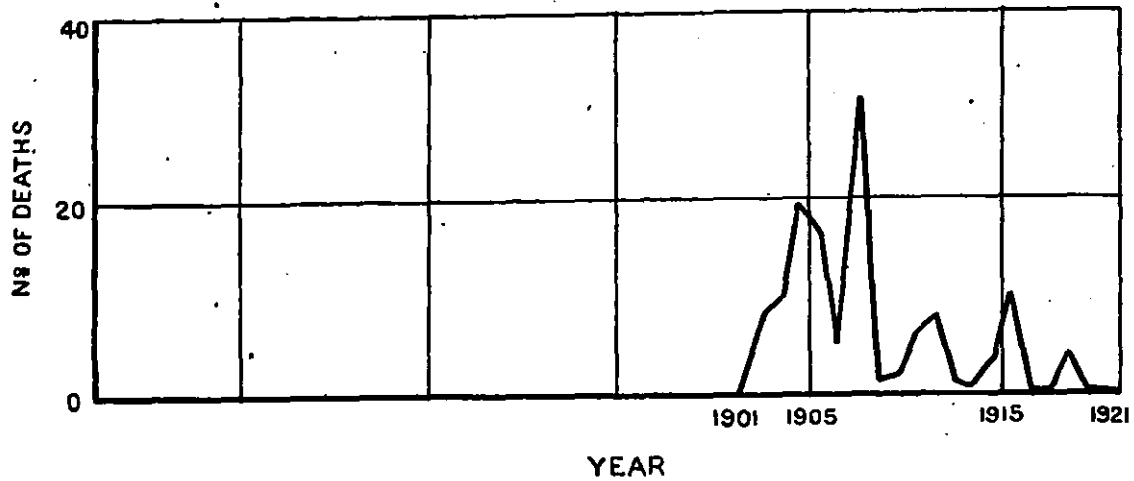
The diagrams may now be consulted.



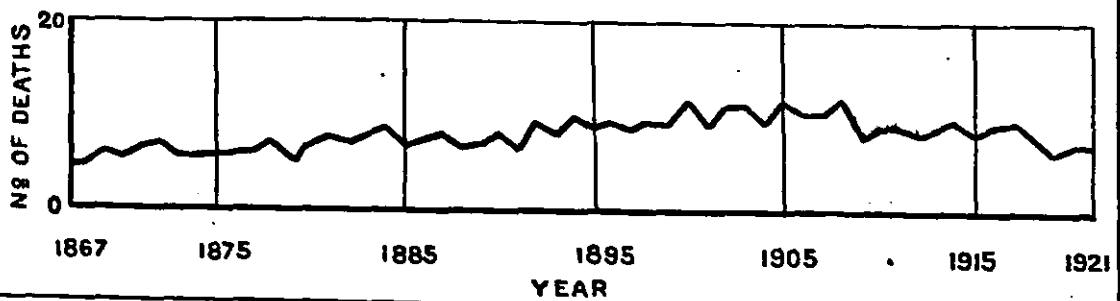
NUMBER OF DEATHS IN THE PUNJAB PER MILLE OF THE POPULATION
CHOLERA.



NUMBER OF DEATHS IN THE PUNJAB PER MILLE OF THE POPULATION
PLAGUE.



ALL OTHER CAUSES
THIS INCLUDES DEATHS FROM INJURIES & RESPIRATORY DISEASES ALSO.



(B)—The seasonal variation of deaths.

The seasonal mortality has been studied by Newsholme's method, in which the average daily death-rate is determined in two ways (1) by dividing the total mortality of the month by the number of days in the month, and (2) by dividing the total mortality of the year by the number of days in the year. The ratio of the quotient in (1) to the quotient in (2), expressed as a percentage gives a measure of the relative intensity of the disease month by month, as compared to the average intensity throughout the year. The percentages for each month, year by year, having been determined, the mean monthly intensity and the standard deviation are readily determined for any particular group of years. In the present case the statistics for 1867—1921 have been divided into two groups, namely, 1867—1896 (30 years) and 1897—1921 (25 years), the objects aimed at being (1) to obtain eventually a comparative series of groups each of 30 years' duration as the figures for future years become available; (2) to distinguish the pre-colony era from the colony era that was inaugurated by the starting in 1897 of the Lower Chenab Canal, and (3) to discriminate the seasonal variations which arise from chance from those which are basic, and may, therefore, be expected to be common to both groups of years.

The diagrams below give the means and co-efficients of variation of the mortality rates calculated in the manner described for each month for the two groups of years separately.

(C) Comparison of the urban and rural death-rates from various diseases.

The full statements of the deaths year by year from each disease in rural and urban areas are too lengthy to be reproduced. From the tables only the following results are noted :—

Disease.	AVERAGE OF THE ANNUAL DEATH-RATES per mille.	
	Rural areas.	Towns.
Cholera (1877—1921, excluding 1885—1888)	0·30	0·56
Small-pox (1877—1921, excluding 1885—1888)	0·01	0·04
Plague (1901—1921)	6·53	4·73
Fevers (1877—1921, excluding 1885—1888)	22·88	20·69
Bowel complaints (1877—1921, excluding 1885—1888)	0·66	2·51
Respiratory diseases (1902—1921)	2·32	5·77
Injuries (1877—1921, excluding 1885—1888)	0·35	0·40
All "other" causes (1877—1921, excluding 1885—1888)	6·80	11·26
All causes (1877—1921, excluding 1885—1888)	36·04	41·58

We may summarise the statistical conclusions indicated by the 3 classes of figures in respect of each disease. The medical expert must interpret them in the light of his own technical knowledge.

CHOLERA.

General trend.—The mortality from cholera shows no signs of general diminution in the 55 years 1867—1921.

Seasonal variation.—Cholera is most evident during the summer months; though there is a very marked difference between the seasonal variation in the 1st and 2nd group of years. During 1867—1896 the cholera mortality curve had a double hump, but is only singly humped in the later years 1897—1921. Light is thrown on this phenomenon by considering separately years of high, medium, and low cholera mortality, as it is found that the years of medium and low mortality exhibit a double hump, the first in May or June, the second in September; while years of high mortality have only a single maximum in August.

The variability of deaths from cholera (shown by the dotted lines on the diagrams) is very high, as might have been anticipated from its epidemic character.

Urban and rural areas.—Cholera produces a much greater mortality in towns than in villages. Out of 39 years the rural areas had a greater cholera mortality in only 7 years.

SMALL-POX.

General trend.—The seasonal variation curves for 1867—1896 and 1897—1921 agree very closely: so do their variabilities. Maximum mortality is to be expected in May. December is the month in which there is the greatest uncertainty as to an outbreak.

Urban and rural areas.—Small-pox causes $1\frac{1}{2}$ times the proportionate number of deaths in towns than it does in villages. In only 8 years out of 39 was there a greater rural than urban mortality.

BOWEL COMPLAINTS.

General trend.—There appears to be a very steady tendency for deaths from bowel complaints to diminish, and since 1900 the death-rate has not exceeded 1 per mille.

Seasonal variation.—The incidence of bowel complaints is greatest at two parts of the year, May and October. The variability is low, in no case exceeding 25 per cent., the causes which produce bowel complaints being apparently more or less similar in character and intensity from year to year.

Urban and rural areas.—Town dwellers are essentially more subject to bowel complaints than residents in rural areas. Out of 41 years 1877—1884 and 1889—1921, in no single year was the mortality in urban less than in rural areas from this cause.

PLAGUE.

General trend.—So far as any general tendency is exhibited by a disease which appears first in recent Punjab history in 1901, it might be supposed that plague is disappearing.

Seasonal variation.—The data are too limited for a secure determination.

Urban and rural areas.—Rural areas suffered more than urban areas in 12 out of 21 years ending 1921.

FEVERS.

General trend.—Since 1885 the general tendency appears to be for a constancy of the death-rate from fevers: the high mortality in 1918 is due to the Influenza epidemic.

Seasonal variation.—Two maxima appear in the seasonal chart. One in May-June is due to relapsing fever—the other in October-November to malaria. The variability is low, for the most part being below 30 per cent., consonant with the endemic character of these diseases.

ALL "OTHER" CAUSES.

General trend.—This appears to have been upwards from 1867 to 1908, with a slight tendency to diminish since.

Seasonal variation.—As might have been expected there is very little variation from month to month in the deaths from "other" causes, which includes deaths from all sources except cholera, small-pox, bowel complaints, plague and fevers. Agreeably with this the co-efficients of variation are very small; in February, July and August they are below 10 per cent. in both groups of years.

Urban and rural areas.—Deaths from "other" causes in towns always outnumber proportionately the numbers of deaths in rural areas.

ALL CAUSES.

General trend.—The general death-rate whether due to physiological causes or to a better reporting agency, rose, on the whole, from 1867—1890; since then it appears to be on the average fairly stationary, though there was great mortality in 1908 and 1918.

Seasonal variation.—Deaths from fevers constitute about 75 per cent. of all deaths in the Punjab, and the seasonal variation accordingly follows the fever chart fairly closely.

Urban and rural areas.—The general urban death-rate is greater than that in the rural areas in 37 out of 41 years.

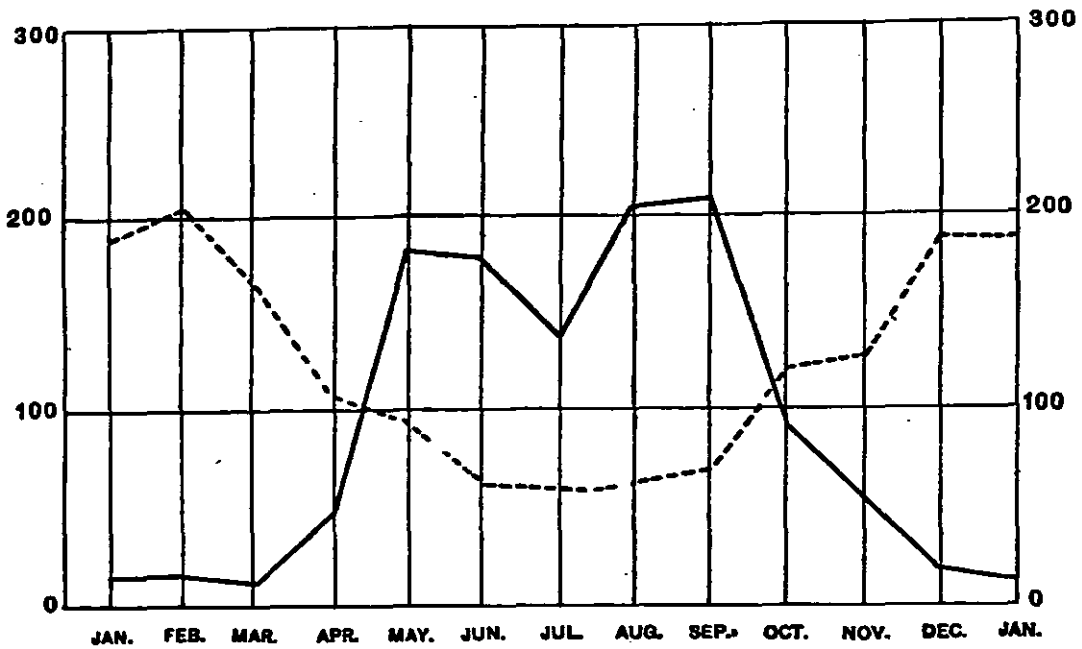
STATEMENT 1.

Statement showing the population of Punjab from 1867 to 1921 (calculated).

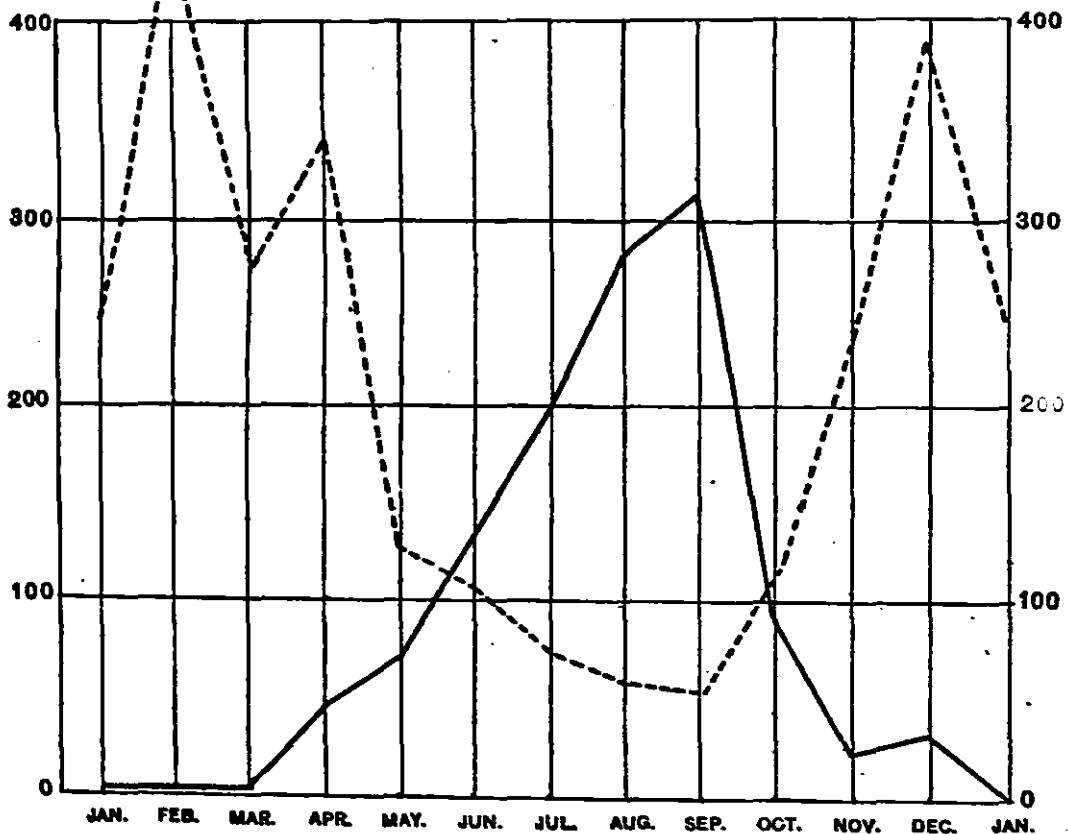
No.	Year.	Population of the British Punjab.	No.	Year.	Population of the British Punjab.	Population of Punjab as comprised prior to 1900.
1	1867	17,611,498	29	1895	21,488,470	
2	1868	17,611,498	30	1896	21,646,766	
3	1869	17,703,839	31	1897	21,806,210	
4	1870	17,796,665	32	1898	21,966,822	
5	1871	17,889,971	33	1899	22,128,624	
6	1872	17,983,770	34	1900	20,330,339	22,291,614
7	1873	18,078,079	35	1901	20,330,339	22,455,819
8	1874	18,172,864	36	1902	20,294,517	22,586,175
9	1875	18,268,143	37	1903	20,258,756	22,717,295
10	1876	18,363,932	38	1904	20,223,056	22,849,155
11	1877	18,460,214	39	1905	20,187,437	22,981,802
12	1878	18,557,006	40	1906	20,151,859	23,115,212
13	1879	18,654,310	41	1907	20,116,362	23,249,408
14	1880	18,752,107	42	1908	20,080,926	23,384,367
15	1881	18,850,437	43	1909	20,045,531	23,520,113
16	1882	19,042,975	44	1910	20,010,217	23,656,644
17	1883	19,237,493	45	1911	19,974,956	23,793,983
18	1884	19,434,000	46	1912	20,044,848	23,983,764
19	1885	19,632,514	47	1913	20,115,000	24,175,091
20	1886	19,883,045	48	1914	20,185,372	24,367,918
21	1887	20,035,631	49	1915	20,256,004	24,562,291
22	1888	20,240,271	50	1916	20,326,895	24,758,210
23	1889	20,447,022	51	1917	20,398,028	24,955,677
24	1890	20,655,866	52	1918	20,469,356	25,154,737
25	1891	20,866,847	53	1919	20,541,026	25,355,392
26	1892	21,020,552	54	1920	20,612,896	25,557,641
27	1893	21,175,384	55	1921	20,685,024	25,761,500
28	1894	21,331,364				

**DEATHS IN THE PUNJAB FROM CHOLERA
THEIR SEASONAL VARIATION & STEADINESS OF RECURRENCE
FIRST GROUP OF 30 YEARS 1867-1896.**

MEAN PERCENTAGES —————
COEFFICIENTS OF VARIATION - - - - -

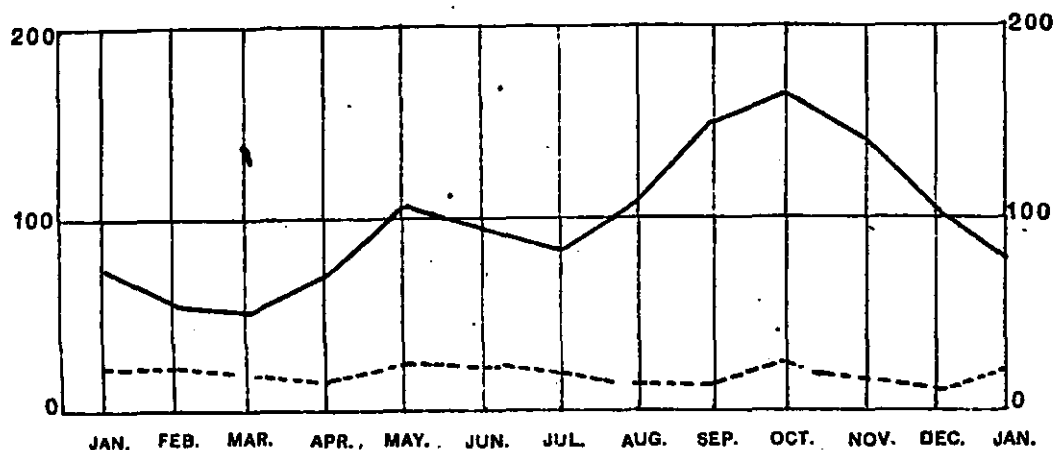


SECOND GROUP OF 25 YEARS 1897-1921.

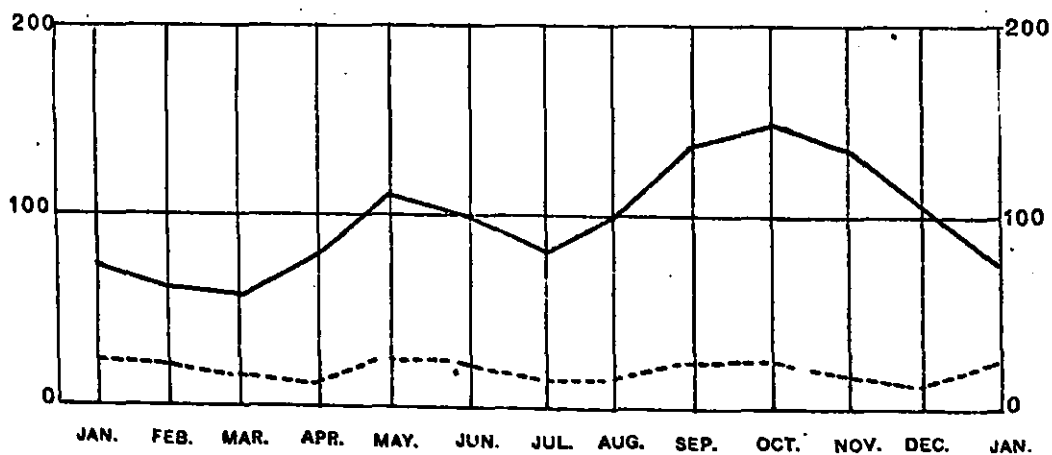


**DEATHS IN THE PUNJAB FROM BOWEL COMPLAINTS
THEIR SEASONAL VARIATION & STEADINESS OF RECURRENCE
FIRST GROUP OF 29 YEARS 1868-1896.**

MEAN PERCENTAGES ————
COEFFICIENTS OF VARIATION - - - -

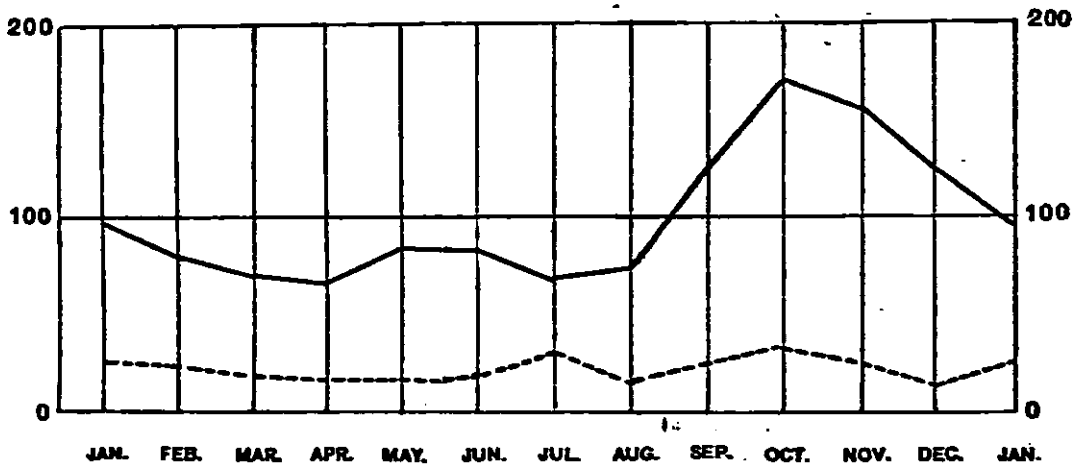


SECOND GROUP OF 25 YEARS 1897-1921.

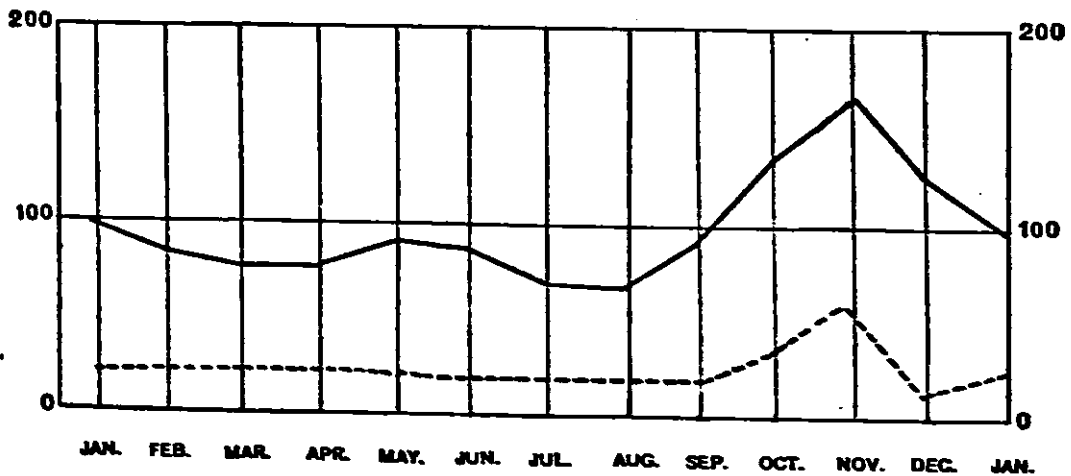


**DEATHS IN THE PUNJAB FROM FEVERS
THEIR SEASONAL VARIATION & STEADINESS OF RECURRENCE
FIRST GROUP OF 30 YEARS 1867-1896.**

MEAN PERCENTAGES —————
COEFFICIENTS OF VARIATION - - - - -

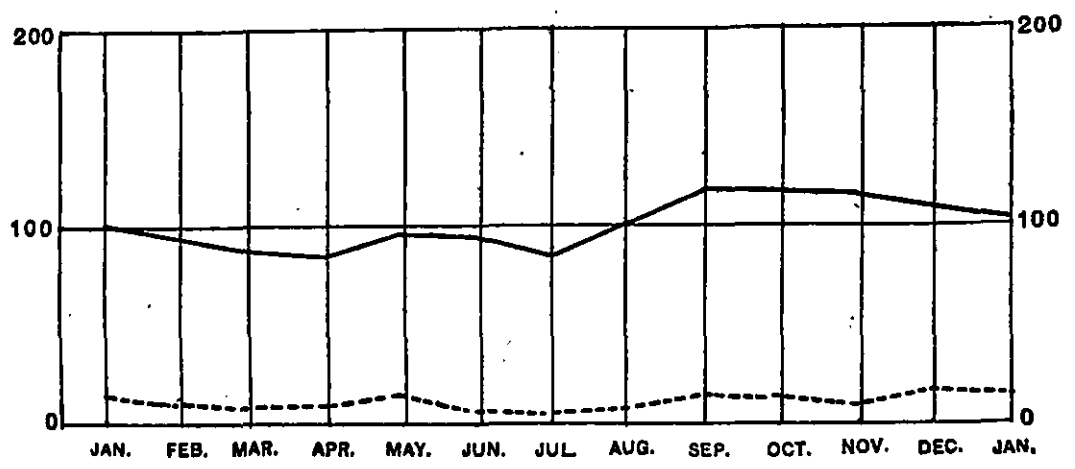


SECOND GROUP OF 25 YEARS 1897-1921.

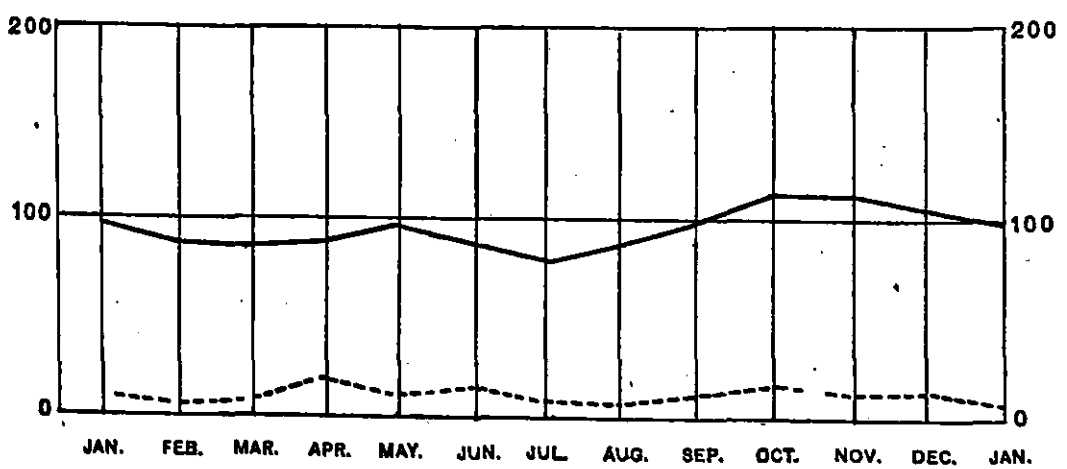


**DEATHS IN THE PUNJAB FROM ALL OTHER CAUSES
THEIR SEASONAL VARIATION & STEADINESS OF RECURRENCE
FIRST GROUP OF 30 YEARS 1867-1896.**

MEAN PERCENTAGES
COEFFICIENTS OF VARIATION

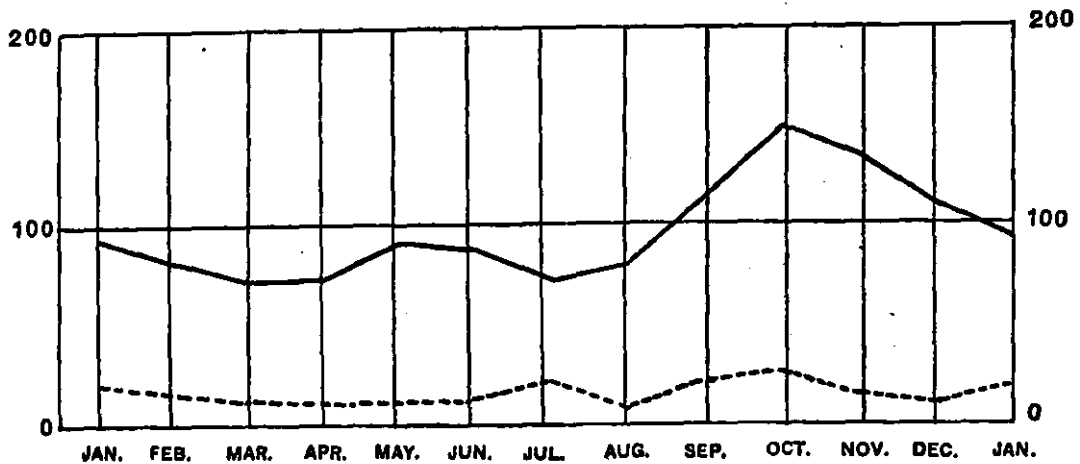


SECOND GROUP OF 25 YEARS 1897-1921.

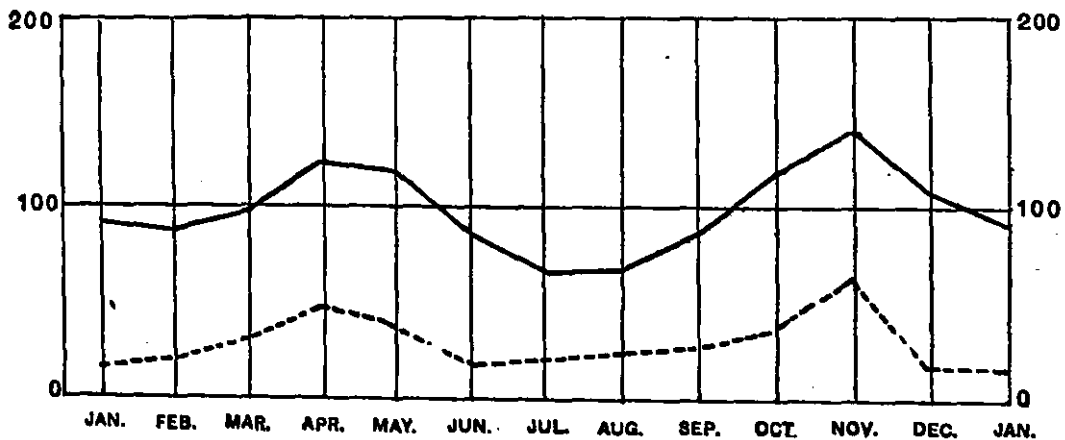


**DEATHS IN THE PUNJAB FROM ALL CAUSES
THEIR SEASONAL VARIATION & STEADINESS OF RECURRENCE.
FIRST GROUP OF 30 YEARS 1867-1896.**

MEAN PERCENTAGES / ————
COEFFICIENTS OF VARIATION - - - -

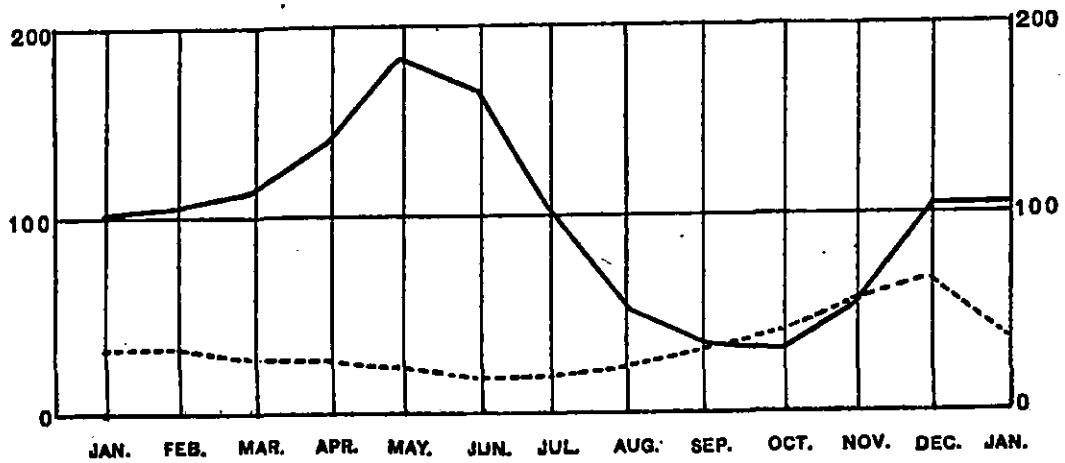


SECOND GROUP OF 25 YEARS 1897-1921.

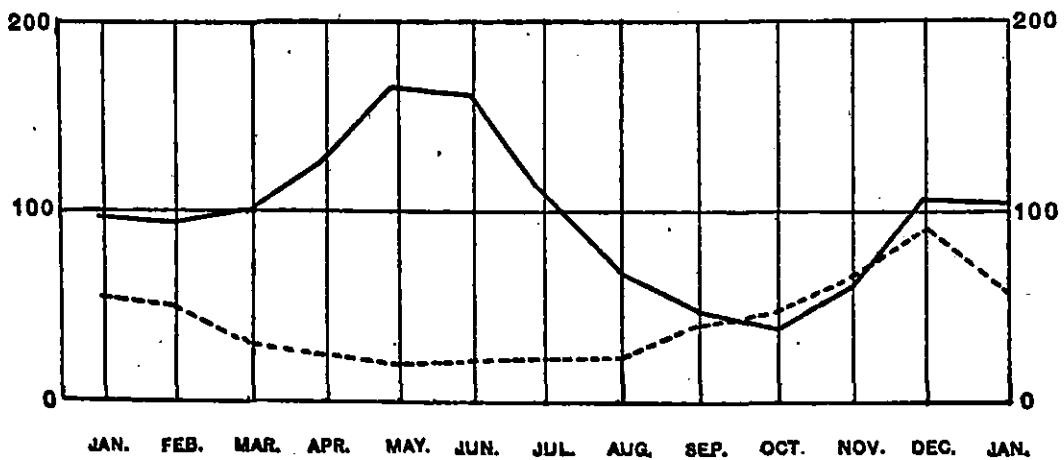


**DEATHS IN THE PUNJAB FROM SMALLPOX
THEIR SEASONAL VARIATION & STEADINESS OF RECURRENCE
FIRST GROUP OF 30 YEARS 1867-1896.**

MEAN PERCENTAGES —————
COEFFICIENTS OF VARIATION - - - - -



SECOND GROUP OF 25 YEARS 1897-1921.



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Density of rural population	32	Number of men who served in the War	50-51
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