

MORTALITY OF INDIAN ASSURED LIVES

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IT is now nearly a decade since the author had the honour of submitting a paper on the mortality of assured lives in India, and the manner of its reception by the members of the Institute has emboldened him to make a second venture. Particular impetus was given to the writing of this paper by the fact that, in the discussion that followed the reading of the earlier paper, several speakers observed that they would be interested to know the results of an analysis of the mortality prevailing in the large subcontinent of India, subject to varying climates and other conditions of life, according to geographical situation, and an attempt has now been made to give this information as revealed by the statistics of the "Oriental". The words, "the more investigations were made into mortality in various parts of the world and in various types of business the better", with which Sir (then Mr) William Elderton closed his observations on the earlier paper, are typical of the attitude of the Institute towards papers on mortality investigations, particularly as applied to countries like India, which are becoming very important from a life assurance point of view. Information concerning the mortality to which the various parts of the country are subject is, however, still very meagre.

The earlier paper was based on the mortality experience of the "Oriental" for the period of 20 years 1905-25, and the present one relates to the experience of the company during the decade 1925-35. This is the fifth investigation into the mortality experience of the company. The first three, however, referred to overlapping periods from the inception of the company in 1874 to 1897, 1902 and 1913 respectively. In accordance with the modern tendency to trace mortality over successive short periods it was decided on the last and on this occasion to limit the enquiry to periods of 20 and 10 years respectively, and the latter, covering the years 1925-35, immediately follows the former.

The decennium 1925-35 under consideration contained no abnormal features affecting mortality such as those which unfortunately characterized the previous period of two decades 1905-25 relating to the fourth investigation of the company, in which the influenza epidemic took a large toll of lives, estimated at nearly 6 millions in the whole of India. Life Offices experienced high mortality due to the visitation of this pestilence during 1918-20. About the middle of the period 1918-20, when the scourge ravaged at its maximum intensity, very nearly half the deaths experienced by the company were due to this epidemic alone. It is more or less a matter of common knowledge that the constitutionally weak, whose deaths would otherwise be recorded a few years later in a subsequent period, are mostly claimed as victims during the prevalence of any disease in epidemic form. For that reason a period immediately succeeding one of high mortality has always been found to exhibit low mortality in both insurance and census statistics. The Indian Census of 1931 showed a great increase in population over the 1921 enumeration, and recorded low rates of mortality as revealed by actuarial analysis, due largely to saving in deaths during the intercensal period following a period of very heavy mortality. The extremely light mortality of the "Oriental" as revealed by the present investigation should therefore be interpreted with a certain amount of reserve till the results of one or more investigations have confirmed that the trend towards lighter rates of mortality is permanent.

The first three investigations were made on the basis of policies, while the fourth was made on the basis of the number of lives assured with the company, by the elimination of duplicate policies on the same life. In the present investigation, owing to the utilization of Powers cards and machines, the elimination of duplicate policies on the same life was not an easy matter, and it was decided to conduct the enquiry on the basis of policies alone, thus making it fall in line with the first three investigations. The enquiry was confined to policies accepted at ordinary rates. As in the previous investigations of the company, rates of mortality were obtained for age next birthday, which is the age for which premiums were charged by the company till recently. In order to gauge the magnitude of the error introduced by adopting the age next birthday, an investigation was made on this occasion with the help of 1297 policies

which became claims by death in the year 1935, and in which the ages had been admitted since claims on all these policies had already been settled. This analysis showed that the age next birthday assumed in the mortality investigation was in excess of the true age by 4.236 months on an average.

The data employed during the investigations are available for all but the first, and are summarized in Table 1.

Table 1. Summarized comparison of data available at four investigations

Investigation no. ...	II	III	IV	V
Numbers of lives or policies contributing to the experience	24,609	61,729	99,737	299,334
Ultimate disposal into:				
Existing	15,516	37,292	57,620	205,119
Withdrew	6,198	16,599	28,718	81,299
Died	2,895	7,838	13,399	12,916
Percentage of:				
Existing	63.05	60.41	57.77	68.53
Withdrew	25.19	26.89	28.79	27.16
Died	11.76	12.70	13.44	4.31
Aggregate years of life at risk	189,482	496,817	846,796	1,330,003
Average:				
Age at entry	36.62	31.2	30.29	31.37
Duration of membership	7.70	8.05	8.49	4.44

It will be seen from Table 1 that although the period now under consideration was only 10 years, or half the length of the previous period, nevertheless owing to the very rapid increase in the volume of new business transacted by the company, it yielded an aggregate number of years of life exposed to risk of 1,330,003 as compared with 846,796 relating to the previous investigation. The volume of data is thus 57% larger than that for the immediately preceding investigation and substantially larger than the earlier ones. The results of the present investigation should therefore be vested with a degree of reliability far greater than that attaching to the preceding investigations. The average age at entry which rapidly diminished from 36.62 at the second investigation to 31.2 and then further to 30.29 during the third and fourth investigations respectively has

now increased to 31.37. The diminution during the third and fourth periods indicates that from 1902 onwards the age at which the insuring public began to realize the necessity for insurance continued to diminish. Since there is nothing to indicate that this insurance consciousness has shifted from an earlier to a later age in the period now under consideration, the increase in the average age at entry is partly to be attributed to the insuring habit persisting for a longer time with the present generation than was formerly the case, and partly to the fact that the maximum age of acceptance of proposals was extended from age 40 to 50 in 1928 for whole-life policies, and from 50 to 55 in 1930 for endowment assurances.

Table 2. Percentage of policies effected with the company by lives of the five different communities

Community	Percentage of policies effected by healthy male lives				
	I	II	III	IV	V
Europeans	6.2	5.7	3.1	1.2	.3
Christians	10.0	9.7	8.8	10.2	7.7
Hindus	72.6	73.0	76.9	78.6	81.3
Parsis	8.1	8.5	7.1	6.0	2.6
Mahomedans	3.1	3.1	4.1	4.0	8.1

It will be observed that the percentage of Europeans has steadily decreased from 6.2% in 1897 to practically nothing, while that of the Hindus has steadily increased from 72.6% in 1897 to 81.3% at the present investigation. The percentage relating to the Parsi community shows a very steep decline to 2.6% in the period under investigation from 6% which was the figure during the previous period. The rather steep increase in the percentage of policies on Mahomedan lives from between 3% and 4% for the first four investigations to 8% for the period under investigation is very gratifying. It appears that a section of them no longer takes the view formerly held that insurance was against the tenets of their religion, and the little propaganda made amongst the members of the community through some of their enlightened religious leaders, for which the company was to a large extent responsible, has borne fruit.

CLASSIFICATIONS EMPLOYED IN THE
INVESTIGATION

Two different types of classification were employed in the investigation, as it was considered desirable on this occasion to trace the mortality attributable to the areas served by the different branches of the company, in addition to the classification according to community used in previous investigations. The investigation of the mortality by branches would serve a double purpose for, apart from indicating to the company whether the business secured by individual branches was of a profitable type or otherwise from the mortality point of view, it would make it possible for the company to render social service, which the public have a right to expect, by drawing the attention of the public health authorities of the localities subject to high mortality to the facts, so as to enable them to trace the causes of high mortality and take any possible remedial measures.

The classification according to communities deals with five groups, viz. Hindus, Mahomedans, Christians, Parsis and Europeans. Each of these above groups was taken separately, and participating and non-participating policies under whole-life and endowment assurances were combined to provide the experience of each group. As regards the second classification, a separate investigation was made of the Hindu experience of each of the following branches, viz.:

Head Office	Delhi	Madras
Ajmer	Gujerat	Mombasa
Bangalore	Karachi	Nagpur
Calcutta	Kuala Lumpur	Rangoon
Colombo	Lahore	Rawalpindi
Deccan	Lucknow	Trivandrum

The decade under investigation witnessed the formation of a large number of new branches. The statistics contributed by these branches during the first few years of the period under consideration could not be distinguished from those of the parent branch from which they bifurcated. Towards the close of the period they would have contributed a few years' experience as separate branches, the investigation of which was not undertaken, as it would have meant a considerable addition to the clerical labour, and the results

produced would not have been commensurate with the amount of work involved.

STANDARD TABLE ADOPTED

Where, as in the case of the "Oriental", so many heterogeneous groups make up the total experience analysed, it is essential that a homogeneous group should be chosen as a standard which can be safely adopted for the financial operations of the company, such as premium calculations and the periodical valuations. Since the standard is to be used in connexion with life assurance business as contrasted with annuity business, it should satisfy the essential criterion of not understating mortality. If the data relating to all the communities composing the experience had been combined, the resulting table would not have satisfied the essential requirement of a standard, because the various communities are subject to different rates of mortality, and unless in the new business underwritten from year to year these groups enter in the same proportions as existed in the experience analysed, the rates of mortality to which the new entrants would in the aggregate be subject would deviate substantially from the experience of the past simply by reason of the disturbance of these proportions. It will, of course, be to the advantage of the company if the groups that are subject to lighter mortality predominate as compared with those subject to heavier rates of mortality, but should the reverse hold, as Table 2 would lead us to infer, there would result tangible loss from mortality to the office. It would therefore be safe only if the Standard Table is based on the experience of the group which exhibits the heaviest mortality. During all the previous investigations into the mortality of the office, as also in the current one, Hindus have been found to be subject to the heaviest mortality, and therefore the Standard Table has been based on the Hindu experience only of all the provinces relating to the two staple classes of policies, viz. whole-life and endowment assurance, whether with premiums limited or with premiums payable till the policy becomes a claim.

Table 3 gives the "exposed to risk" and the actual deaths of the Standard Table and the comparison of actual deaths with those expected by other tables.

Table 3. Standard table

(Includes whole-life and endowment assurances both participating and non-participating policies on Hindu male lives accepted at ordinary rates with constant and limited premiums)

Ultimate Section

Age group	Exposed to risk	Actual deaths	Expected deaths by $O^{M(s)}$	Ratio of actual deaths to expected deaths	Expected deaths by the Company's 1905-25 experience	(3) ÷ (6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
-19	34	—	.2	—	.2	—
20-24	28276	147	189.9	.774	220.0	.668
25-29	114806	532	819.1	.649	976.1	.545
30-34	177151	830	1382.9	.600	1639.1	.506
35-39	177130	1118	1571.5	.711	1930.1	.579
40-44	145643	1365	1535.8	.889	2075.9	.658
45-49	103067	1387	1356.0	1.023	2066.2	.671
50-54	60305	1312	1038.8	1.263	1749.6	.750
55-59	24136	830	570.3	1.455	1007.3	.824
60-64	12801	629	430.9	1.460	725.5	.867
65-69	7314	446	356.8	1.250	539.2	.827
70-74	4241	369	304.1	1.213	401.4	.919
75-79	1845	191	195.7	.976	228.9	.834
80-84	575	77	90.5	.851	95.8	.804
85-	152	23	36.1	.637	34.5	.667
	857476	9256	9878.6	.937	13690.0	.676

It will be found that in the aggregate "Oriental" policyholders experienced in the decade under consideration only 93.7% of the deaths expected according to the $O^{M(s)}$ rates of mortality, i.e. the mortality relating to lives assured with British Life Assurance Companies nearly half a century back. The expected deaths on the basis of the $O^{M(s)}$ Table with a rating up of 7 years to the age, which is the table of mortality that is being used by the company for its periodical valuations, were as many as 14,026 as compared with only 9,256 actual deaths, showing that the latter were only 66% of the expected deaths.

The trend of the figures appearing in column (7) enables very interesting conclusions to be drawn as to the course of mortality of the lives assured with the "Oriental" during the decade under consideration. It will be seen that, in the aggregate, Hindus experienced only 67.6% of the mortality of period IV, viz. 1905-25. It will

be shown later that the mortality of the other communities in India also underwent a more or less similar improvement. Although the great improvement in mortality during the decade under consideration should be interpreted in the light of the reservation to which attention was drawn earlier, as a natural consequence of the high mortality that prevailed during the influenza epidemic of 1918-20, yet a substantial part of this improvement, if not the whole, should be due to natural causes producing a general lightening of mortality. The figures appearing against each quinquennial age group reveal further interesting results. It would appear that during the decade under consideration the greatest improvement in mortality occurred in the age period 25-40, and that during the middle of this age period, i.e. during the early thirties, mortality was so low as only about 50% of that prevailing at the corresponding ages in the 1905-25 period. It is very gratifying to be able to report that the maximum improvement in mortality has occurred, according to the "Oriental" experience, in the age period 25-40 at which death would mean enormous financial loss to dependents. From age 40 onwards mortality tends to approach that prevailing at corresponding ages during the earlier period, yet keeping substantially lower than the latter; even in the early fifties it is in the aggregate only about 75% of what it was in the period 1905-25, and although at the older ages it has been slowly taking a turn upwards nowhere is the ratio equal to unity. Although Table 3 relates only to Hindus, the fact cannot be over-emphasized that lives assured with the "Oriental" generally have been subject to substantially lower rates of mortality in the decade under consideration as compared with the earlier period of 20 years, 1905-25, and the further fact that the maximum improvement has taken place between ages 25 and 40 is a matter for gratification.

SELECTION

Before the rates of mortality according to the Standard Table were graduated, an investigation was made to ascertain the period during which selection persisted. For how many years lives selected for insurance after medical examination would continue to experience lighter mortality than the general average would depend, *inter alia*, upon the strictness of the medical examination and upon the care and conscientiousness with which medical examiners have

performed their duty. Where the standard of examination is of a high order, the effect of medical selection has been observed to persist for about 5 or even 6 years. Although in certain investigations it was found that lives selected after medical examination continued for a period of over a decade to experience lighter mortality than others of the same age but who did not undergo medical examination, it was established subsequently that a significant part of this selection was due to what is called "class selection". This has been attributed to the element of heterogeneity introduced in the statistics due to the fact "that the mortality depends on the year of entry rather than on the year in which the age is attained". This will be referred to as selection due to "secular trend" in mortality, particularly noticeable where the period covered by the investigation is a fairly long one, as was the case with the British Offices' Experience 1863-93. It will be shown in what follows that at least during the past 30 years the trend of the mortality of the lives assured with the "Oriental" has been one of steady improvement, and although the period covered by this investigation is by no means very long, it is nevertheless long enough to produce an illusion of the persistence of temporary selection, which is due in reality to secular trend, particularly as the mortality of the decade under investigation has been found to be progressing substantially towards lightness. This is revealed by the trend of the figures shown in Table 4.

Table 4. Comparison of actual to expected deaths by the $O^{M(5)} q_{x+7}$ based on policies

Year	Percentage of actual to expected deaths	Year	Percentage of actual to expected deaths
1925	72.8	1930	61.3
1926	68.7	1931	58.0
1927	64.2	1932	50.9
1928	62.6	1933	51.2
1929	58.9	1934	52.1

This feature of apparent persistence of selection is further accentuated by the very large weightage attaching to the policies effected in the decade under consideration in the experience analysed. Of the total number of 228,730 policies which provided

the experience relating to the Standard Table as many as 179,715 or nearly 79 % relate to policies effected during the period 1925-35, and of those the policies effected during the later years would have provided in the aggregate very nearly the same weight as those effected during the earlier years, for, although the latter would on the average naturally contribute a larger number of years to the experience, this would have been substantially compensated by the very rapid increase in the volume of new business transacted by the company from year to year as the following Table 5 will show. It will be seen that the new business both by policy and amount increased nearly fourfold from the commencing to the closing year of the period.

Table 5. New business transacted by the "Oriental" in those classes included in the investigation

Year	No. of policies	Sum assured (Rs.)
1925	11,262	23,647,200
1926	15,765	34,870,575
1927	20,137	43,565,650
1928	26,157	55,749,932
1929	30,279	62,996,155
1930	25,888	53,047,175
1931	25,819	51,779,038
1932	29,126	57,246,252
1933	37,324	68,352,770
1934	41,378	73,798,993
1935	47,834	86,602,091

Further, in the case of Indian mortality statistics a third element of heterogeneity is introduced due to the fact that mortality in India is substantially more sensitive to economic status than in countries in temperate regions, as is evident from the comparison of mortality of insured lives with that derived from census material both in India and in England and Wales shown in Table 6. Apart from the evidence contained in the table, it is more or less evident from general reasoning that in the tropics, where the flesh is heir to so many ills peculiar to climate, prompt diagnosis and treatment of an attack of a disease is imperative, and this can be secured only with money. If an attack is neglected, as is usually done in poor families, even if it does not itself kill it leaves a weakened system highly

susceptible to attack by one or other of the several diseases which abound in hot countries.

Table 6

Age	q_x		Ratio (2) ÷ (1)	Age	q_x		Ratio (2) ÷ (1)
	"Oriental" 1925-35 Ultimate (1)	1931 Census All India males (2)			A 1924-29 Ultimate (1)	England and Wales 1926 males (2)	
25	·00428	·01530	3·57	22	·00235	·00309	1·31
35	·00552	·02410	4·37	32	·00253	·00381	1·51
45	·01176	·03490	2·97	42	·00439	·00700	1·59
55	·02903	·04810	1·66	52	·00906	·01282	1·42
65	·06039	·07270	1·20	62	·02394	·02916	1·22

The persistence of selection is therefore largely influenced by the introduction of this feature tending to heterogeneity, i.e. the mingling together of persons in various grades of economic status. Of late this element of heterogeneity has assumed a measure of importance due to the fact that most Indian companies have reduced the lower limit of insurance under a single policy to as small a sum as Rs. 500, though by the terms of the Indian Insurance Act, 1938, it will no longer be permissible for life assurance companies to issue policies assuring Rs. 500 or less.

Selection is therefore, according to the experience of the company, due to the cumulative effect of four forces, viz.

- (1) medical selection or temporary selection,
- (2) that due to progressive improvement in mortality, i.e. due to secular trend,
- (3) that due to the large weight given to recently effected assurances combined with (2), the "Oriental" having been transacting a progressively increasing volume of new business during the decennium, and
- (4) that due to the mingling in the statistics of policies on lives with low economic status, as a result of the company having reduced the minimum sum assured under a single policy from Rs. 1000 to Rs. 500.

The second and third forces would cause the temporary selection due to (1) to appear to persist for a duration longer than it actually does, while the fourth would act in the contrary direction. The counteracting effect of (4) is not, however, very pronounced,

as the volume of these policies is not large nor will it be so in the future, as the company has recently decided not to issue policies for sums less than Rs. 750.

Table 7 gives the results of experiments designed to show how long selection persisted with respect to the statistics analysed during this investigation. In order to eliminate any obscurity in the statistics due to grouping, two different types of age groups have been adopted.

Table 7. Full aggregate rates of mortality and rates excluding the first few years

Age group next birthday	A	A ⁽¹⁾	A ⁽²⁾	A ⁽³⁾	A ⁽⁴⁾
Grouping I					
23-27	·00396	·00447	·00448	·00439	·00435
28-32	·00432	·00457	·00472	·00474	·00485
33-37	·00563	·00584	·00589	·00592	·00593
38-42	·00733	·00744	·00741	·00741	·00754
43-47	·01167	·01176	·01195	·01190	·01204
48-52	·01855	·01897	·01908	·01902	·01906
53-57	·02527	·02553	·02570	·02579	·02581
58-62	·04414	·04416	·04416	·04419	·04435
Grouping II					
20-24	·00460	·00520	·00471	·00479	·00412
25-29	·00419	·00463	·00471	·00477	·00491
30-34	·00446	·00469	·00486	·00486	·00490
35-39	·00626	·00631	·00629	·00629	·00635
40-44	·00910	·00937	·00937	·00942	·00950
45-49	·01335	·01346	·01365	·01359	·01380
50-54	·02136	·02176	·02189	·02196	·02182
55-59	·03409	·03439	·03462	·03474	·03494

The column headed A relates to full aggregate rates of mortality, that headed A⁽¹⁾ to aggregate rates excluding the first year and so on. The differences between two consecutive columns and the average values of the differences are given in Table 8, to enable the persistence of selection to be appraised at a glance.

It will be evident, from the fact that the figures in the column headed A⁽¹⁾ in Table 7 are significantly larger than those in the column headed A in both groupings, that lives assured did experience lighter mortality during the first year after medical selection. But when we come to the column headed A⁽²⁾ we find the

Table 8. Differences

Age group	$10^5 \{A^{(1)} - A\}$	$10^5 \{A^{(2)} - A^{(1)}\}$	$10^5 \{A^{(3)} - A^{(2)}\}$	$10^5 \{A^{(4)} - A^{(3)}\}$
Grouping I				
23-27	51	1	-9	-4
28-32	26	15	2	9
33-37	21	5	3	1
38-42	11	-3	0	13
43-47	9	19	-5	14
48-52	42	11	-6	2
53-57	26	17	9	3
58-62	2	0	3	16
Total	188	65	-3	54
Average	23	8.1	-0.4	6.7
Grouping II				
20-24	60	-49	8	-67
25-29	44	8	6	14
30-34	23	17	0	4
35-39	5	-2	0	6
40-44	27	0	5	8
45-49	9	19	-6	21
50-54	40	13	7	-14
55-59	30	23	12	20
Total	238	29	32	-8
Average	30	3.6	4	-1

difference between the $A^{(2)}$ and the $A^{(1)}$ rates in both groupings substantially less. There are a few stray cases of age groups like 43-47 in grouping I and 45-49 and 55-59 in grouping II, where the $A^{(2)}$ rates are significantly larger than the $A^{(1)}$ rates, showing thereby that in these groups selection persisted even up to 2 years. But as against these there are other age groups in which the difference between $A^{(2)}$ and $A^{(1)}$ is practically nothing, and in a few cases the $A^{(2)}$ rates are even smaller than the $A^{(1)}$ rates. The difference is further reduced when we compare $A^{(3)}$ rates with $A^{(2)}$ and further still when $A^{(4)}$ rates are compared with $A^{(3)}$. Even assuming that selection persisted so long as 2 years, although its force after the first year was very feeble, bearing in mind that this is due to the cumulative effect of three forces of which one is medical or temporary selection (the counteracting effect of the fourth force being negligible), it appears reasonable to infer that medical selection by itself did not persist for more than 1 year, and that any persistence

of the forces of selection beyond 1 year and up to 2 years in certain age groups may be due to the effect of the other two forces.

The comparatively short period during which selection persists is a matter for serious consideration, and unless it could be assumed that Indian lives deteriorate very rapidly and merge in the general class of non-select lives very soon after they are subjected to a strict medical examination for life assurance purposes, the only explanation that suggests itself is that the majority of medical examinations in India have not given the measure of protection that Life Offices have a just right to expect, if the experience of other companies transacting business in India is the same as the "Oriental's".

It would be of interest to devise a measure of the magnitude of selection secured for the company by the play of these forces influencing selection. A reasonable numerical value for this quantity, it was thought, would be given by the ratio $\frac{q^{3 \text{ and over}} - q}{q^{3 \text{ and over}}}$, where $q^{3 \text{ and over}}$ means ultimate rates of mortality after 3 years and q denotes rates of mortality at duration 0. A period of 3 years is taken so as to ensure that no period may be excluded during which even a vestige of selection may continue according to the experience of the company. The ratios have been computed for groups of five ages, and for the sake of comparison are given in Table 9 alongside the corresponding ratios based on A 1924-29 rates of mortality.

Table 9

Age group	A 1924-29 $\frac{q^{3 \text{ and over}} - q}{q^{3 \text{ and over}}}$	"Oriental" $\frac{q^{3 \text{ and over}} - q}{q^{3 \text{ and over}}}$
16-20	.321	—
21-25	.431	.262
26-30	.392	.373
31-35	.372	.240
36-40	.396	.079
41-45	.431	.255
46-50	.432	.212
51-55	.413	.499
56-60	.451	
61-65	.493	
66-70	.565	

It will be seen that even the magnitude of selection is small as compared with A 1924-29 experience, and will be considered more

so if it is realized that in the absence of separate tabulation of the q 's in the latter the experiences of both medical and non-medical sections were combined, while the "Oriental" statistics relate entirely to medically examined lives, as the company does not transact non-medical business. The results in this respect are practically the same as those disclosed by 1905-25 experience of the company. At that investigation the actual deaths in the first year after entry were 75.2% of those expected by the ultimate rates of mortality excluding the first year, while at this investigation the corresponding percentage is 78.0.

It appears that these two aspects of temporary selection, viz. its short duration and its low intensity, make out a strong case in favour of the introduction of non-medical business in India, at least amongst persons in selected services about whom the employers would be in a position to supply leave records for a few years prior to the date of proposal for insurance, provided that, as a safeguard, certain limits are imposed on the maximum risk to be accepted on each life, which should be substantially smaller than in the medical section. There appears to be no room for the fear that the excess mortality during the first year, if any, would be such as to produce a strain in excess of the saving in medical fees.

GRADUATION

After several futile attempts, which it would take many pages of the *Journal* to describe in detail, it was finally decided to graduate the ultimate section of the Hindu experience with reference to a Standard Table, and the $O^{M(s)}$ Table, without any addition to the age, was adopted as the standard. The subject of graduation was the ratio of actual to expected deaths (ψ_x), and for reasons described below it was decided to graduate this function in three sections according to the following mathematical formulae:

For ages 20 to 36:

$$\psi_x = .6200 + .1 \sin^2 \theta + .9 \sin^4 \theta, \quad \dots (A)$$

where

$$\theta = \frac{x-27}{30} \cdot \frac{\pi}{2}.$$

For ages 36 to 60:

$$\psi_x = .6000 + .0867 \sin \theta + .4942 \sin^2 \theta + .2861 \sin^4 \theta, \quad \dots (B)$$

where

$$\theta = \frac{x-30}{30} \cdot \frac{\pi}{2}.$$

For ages 60 to the end of the table:

$$\psi_x = .8573 + .6097 \sin^4 \theta, \quad \dots (C)$$

where

$$\theta = \frac{x-15}{45} \cdot \frac{\pi}{2}.$$

ERRORS IN AGE

These errors do not reveal the features found in census material, viz. exhibiting cluster round ages ending in 5 and 0 and preference for particular digits as against others, for the simple reason that errors in the former are not due to careless and indifferent return, but to a deliberate attempt to obtain the advantage of a few years. It is only during recent years that municipalities have made registration of births compulsory. The machinery set up for this purpose in rural areas is yet very defective. Even when the dates of birth could be proved from municipal registers, it is very rarely that lives assured offer to prove their ages by extracts from them which, in view of the fact that entries have to be made soon after birth, are unquestionably authentic. But what is usually offered in proof of age is a horoscope supposed to have been cast soon after birth. Where this is really so it no doubt provides an authentic proof, but, more often than not, it is manufactured for the occasion when life insurance is to be effected or on entering government service and specially written on old paper or paper held over smoke to look old. Even a horoscope is not sometimes available, and when this is the case or when the horoscope is rejected as unreliable, Life Offices have no alternative but to accept a declaration from an elderly member of the family. In a large majority of cases, particularly where the level of education is fairly high, ages are given correctly, yet the numbers "proving" incorrect ages are a significant proportion of the total at each age, and the errors due to deliberate misstatement add substantially to the errors inherent in the ungraduated rates of mortality. The graduation formula adopted should be capable of dealing with both errors. It is suggested that, bearing in mind the features described above, the results produced by a graduation formula should not be considered as deviating significantly from the observed data if the deviations between the actual and expected deaths are equal to or sometimes even exceed the

theoretically allowed limit at several ages. In other words, under-graduation has as much to be guarded against as overgraduation.

Younger ages. At the younger ages the errors in the actual deaths appeared to be mainly due to understatement of age, and there would be practically no errors due to omission to report deaths. But instances of understatement of age amongst the early deaths would be relatively more numerous, not only because of the smaller numbers involved at these ages but also because of the stock from which early deaths are mainly drawn. This more or less explains the high values of the ratios of the actual deaths to those expected by the $O^{M(s)}$ Table at the younger ages. Mention was made by some speakers, in the discussion on the author's earlier paper, of the high mortality at the younger ages, particularly in the 20-24 group, and Mr Williamson referred to the same feature of extraordinarily high mortality in this group in the case of a small experience that he had analysed. It appears that a substantial part of the heavy mortality at the younger ages should be due to understatement of age, which has brought about transference of deaths from a later age group to an earlier one.

Ages above 60. At ages above 60 the irregularities in the statistics were due mostly to unreported deaths, and those due to errors in age were relatively unimportant. This was evident from the tendency of the q_x curve to sag substantially below the main one for ages below 60. Further colour was lent to this inference by the fact that the progression of the rates between ages 60 and 80 was far less steep than would be expected from a comparison with other investigations, in spite of the fact that policies credited as paid up for an amount less than Rs. 150 were assumed to have withdrawn on the date on which the paid up amount was secured. The average of the ungraduated values of q_{74} , q_{75} and q_{76} treated as one group is $\cdot 11005$, while for all ages from 77 to 92 the average value is $\cdot 11608$, showing an increase of only 5.5%. It will be of interest to note that in the $O^{M(s)}$ Table the average value of q for ages 77 to 92 is as much as 68.5% larger than that for ages 74 to 76.

There is ample evidence leading to the conclusion that not an inconsiderable number of deaths has been unreported at the older ages, and the extreme irregularity with which the values of q_x progressed at these ages lent further support to this inference. Instances have occurred when a grandson on attaining the age of

discretion finds amongst the old family papers a policy on the life of his grandparent dead long since. Ignorance of the fact, that after payment of a certain number of premiums a policy secures an automatic paid-up value, is possibly the main cause of this omission to report deaths. Quite recently an acquaintance of the author, fairly well educated, while talking of the salient provisions of the Indian Insurance Act, 1938, laid special stress on the one compelling companies to give a paid-up value provided premiums had been paid for at least 3 years and certain other conditions had been fulfilled. On being told that a similar provision finds a place in the prospectus of the company concerned, he expressed great surprise and said he would try to search out an old policy of his which he had laid aside with indifference on the ground that it was valueless. It is very unlikely that a death at the younger ages, which would mean a great financial loss to the family, would be unreported. Deaths under endowment assurances, even though made paid up for small amounts, would generally come to light at least on the date of maturity of the policy, for the company gives intimation of maturity. As a matter of fact, instances are not rare when discharge forms sent to lives assured on maturity have been returned with the remark "Dead". Again, in a number of cases claimants choose to intimate deaths a few years after these have occurred, with a view possibly to put a rival claimant off the scent. Meanwhile, the existence of the insurance policy would be in the exclusive knowledge of this claimant and if anything untoward happens to him before he intimates it, the claim may remain unreported unless he has taken his son or someone else into his confidence. As a matter of interest, on an examination of the death intimations received in 1937 in which the claim had been notified to the company 2 years or more after the actual date of death, the author found that there were as many as thirteen in which the period between death and intimation ranged from 2 to 16 years. In two of these cases, with intervals of 15 and 16 years respectively, which were endowment assurances, it was the maturity of the policies that revealed the death of the lives assured at ages 43 and 35 respectively. The policies had been reduced to paid-up contracts for the respective amounts of Rs. 800 and Rs. 533. Again, two out of the thirteen cases related to whole-life assurances, wherein the lives assured died at ages 60 and 65 respectively. It appears that quite an

appreciable number of deaths has not been reported, and although a few of these may be at ages below 60, the bulk would relate to whole-life assurances under which the policies had been reduced to paid-up contracts several years prior to the date of death, and that the proportion of unreported to reported deaths would progressively increase from age 60 onwards. This feature was revealed by the marked deflexion of the curve representing graduated q 's after age 60 from the course suggested by the flow of the curve up to that age and its sudden tendency to flatten out thereafter, quite contrary to the expected shape of the curve at ages above 60.

It was evident that the low values of ψ_x for ages above 60 yielded by equation (B), due to unreported deaths at these ages, were quite unsuitable and that the values of this function would have to be increased at all ages above 60. This was considered essential as the low values at the older ages would have meant understatement of both premiums and reserves under whole-life policies, whether subject to premiums throughout life or with limited payments. There was a further strong argument in favour of adopting this course, for a provision in the New Insurance Act gives little room for assuming that the future will reflect the past in this respect. In terms of this provision it is incumbent on companies to notify lives assured of the paid-up amounts secured by lapsed policies, and a paid-up value must be allowed where it amounts to even as low a sum as Rs. 100.

SELECT TABLE

After some investigation it was decided to take the select rate of mortality at each age as 78 % of the ultimate rate at the same age. The graduated q 's satisfied the usual criteria by which graduations are tested, viz. smoothness and fidelity to observed facts, after allowing for unreported deaths at the old ages, which were taken to be 140.7 as against a total of 9256 deaths actually reported. This represents an addition of 1.52 % to the aggregate actual deaths. Examining this result in age periods, it was found that up to age 60 the expected deaths exceeded the actual deaths by 6.3, which is .08 % of the actual deaths up to that age. This would probably allow for deaths even under endowment assurances which might not have been reported up to the date when the observations closed. Beyond age 60, the expected deaths exceed the actual deaths by 134.4, which

is 7.75 % of the actual deaths from age 60 to the end of the table. The graduated select and ultimate rates of mortality are given in Table 10.

Table 10. Graduated rates of mortality

Age	Select	Ultimate	Age	Select	Ultimate	Age	Select	Ultimate
19	·00328	·00420	46	·01004	·01287	73		·09911
20	·00328	·00420	47	·01102	·01413	74		·10502
21	·00328	·00420	48	·01208	·01549	75		·11123
22	·00328	·00420	49	·01326	·01700	76		·11777
23	·00328	·00421	50	·01434	·01864	77		·12465
24	·00331	·00424	51	·01593	·02042	78		·13191
25	·00334	·00428	52	·01743	·02234	79		·13961
26	·00338	·00433	53	·01906	·02444	80		·14776
27	·00343	·00440	54	·02080	·02667	81		·15645
28	·00349	·00447	55	·02264	·02903	82		·16572
29	·00355	·00455	56	·02460	·03154	83		·17562
30	·00363	·00465	57	·02668	·03420	84		·18625
31	·00372	·00477	58	·02884	·03697	85		·19765
32	·00382	·00490	59	·03108	·03985	86		·20991
33	·00395	·00507	60	·03342	·04285	87		·22310
34	·00412	·00528	61		·04599	88		·23730
35	·00431	·00552	62		·04928	89		·25258
36	·00454	·00582	63		·05280	90		·26899
37	·00484	·00620	64		·05647	91		·28659
38	·00517	·00663	65		·06039	92		·30542
39	·00555	·00712	66		·06446	93		·32550
40	·00599	·00768	67		·06874	94		·34683
41	·00648	·00831	68		·07326	95		·36939
42	·00705	·00904	69		·07795	96		·39315
43	·00768	·00984	70		·08288	97		·41800
44	·00837	·01073	71		·08803	98		·44384
45	·00917	·01176	72		·09346	99		·47050
						100		·49788
						101		·66667
						102		1.00000

SECULAR TREND IN MORTALITY

Mention was made, while considering the results of Table 3, of the improvement in mortality that has taken place since the company's fourth investigation relating to the period 1905-25. It will be desirable at this point to trace the variations in mortality over the long stretch of years since the foundation of the company in 1874 as revealed by the successive mortality investigations. This information is supplied in Table 11.

Table 11. Showing the mortality in all periods on the basis of 1000 deaths amongst Hindus in period I

Period	Comparative mortality figures among	
	Hindus	All communities
I (1874-1897)	1000	—
II (1874-1902)	1122	—
III (1874-1913)	1089	968
IV (1905-1925)	932	876
V (1925-1935)	627	634

In explanation of this table it has to be stated that the rates of mortality amongst Hindus during period I (which was the only experience analysed then) were taken as the basis, and these rates were multiplied by the exposed to risk amongst Hindus in the subsequent four periods to give expected deaths. These were compared with the respective actual deaths and proportions obtained on the basis of 1000 expected deaths. Similar figures were also prepared for the experience combining all communities in periods III, IV and V, but not periods I and II, as with respect to these two periods the statistics relating to different communities were not separately analysed.

Table 11 indicates a substantial improvement both in the Hindu mortality and in that of other communities during period V as compared with the other periods. By confining attention to figures relating to the Hindus, we are able to study the long-range variation in mortality over the past 61 years from the inception of the company to 1935. Mortality took a sharp upward turn from period I to period II, represented by as much as 12 %. This should have been due to the severe epidemic of plague which ravaged the Bombay Presidency (to which the company's business was mostly confined during the first few years after its inception) for a few years from 1896 onwards which are included in period II but not in period I. Period III recorded somewhat lighter mortality, but it was yet in excess of the mortality of period I by nearly 9 %. This is due to the fact that this period, while containing the years 1902-13 when mortality should have been somewhat light, included at the same time those years of heavy mortality of period II, as the first three investigations referred to overlapping periods. The fourth period

recorded mortality nearly 7% and 14% lighter than that of periods I and III respectively. Period V has exhibited the lightest mortality of all the periods considered. It is slightly over 37% lighter than the mortality of period I. As compared with the mortality of the immediately preceding period it is nearly 33% lighter.

The substantial improvement in the mortality of lives assured with the company during the period under consideration is very gratifying, and although during periods II and III mortality was in excess of the company's experience during the initial years of its operation, the rates have been falling rather slowly during the first few years and very significantly during the last decade of the long period of 30 years from 1905 to 1935, in spite of the influenza epidemic of 1918-20.

COMPARISON OF THE MORTALITY OF THE VARIOUS COMMUNITIES

Table 12 compares the mortality of the various communities in India both with that of the Hindus and *inter se*. The comparisons are effected on the basis of the ultimate experience alone as the select portion of the experience is very small in each sectional group.

Table 12. Ratio of actual to expected deaths by the
respective standard tables

(Ultimate experience)

Period	Mahomedans	Christians	Europeans	Parsis
IV	.921	.789	.750	.662
V	.958	.816	.615	.613

The mortality of the various communities relative to the Hindu mortality was more or less the same during the period under consideration as in period IV as would be evident from Table 12 above. Parsis and Europeans have had a larger improvement in mortality from period IV to period V than had Hindus. As between Parsis and Europeans, the large difference in favour of the Parsis which existed in period IV has now dwindled, but the European experience is very small, based as it is on 4758 years of life exposed to risk and 100 deaths only. It has been ascertained that the community that was on the last occasion called "Eurasians" should strictly be called

Christians. The mortality of the Christians during the period under consideration has not improved as much as that of the Hindus. The difference, however, is very small. As regards Mahomedans, they have exhibited mortality which is nearly 96 % of the Hindu mortality, whereas it was only about 92 % in the earlier period. It was indicated in the last paper that a substantial amount of the lighter mortality of Mahomedans as compared with the Hindus might be due to class selection. This is more or less confirmed by the fact that the Mahomedan mortality shows a tendency to approach the Hindu standard contemporaneously with the increase in the percentage of Mahomedans insuring with the company from 4 % during period IV to about 8 % in period V.

MORTALITY BY PROVINCES

As mentioned at the beginning of the paper, the mortality to which the various provincial units are subject was ascertained in this investigation. The chief importance of an enquiry of this type from an administrative point of view is the knowledge the office would thereby obtain as to the areas from which it secures business subject to light or heavy mortality. It will also be of value from the point of view of those interested in the influence on mortality of climatic and other conditions which vary so widely from one province to another. Although it is not suggested, nor would it be desirable, to have different tables of premiums applicable to the different provincial or other units of the vast Indian subcontinent, yet a knowledge of the relative salubrity of the different provinces will substantially help in the assessment of risks, for a substandard life proposing for assurance coming from an area subject to high mortality will be more closely scrutinized than a similar risk from another area subject to lighter mortality.

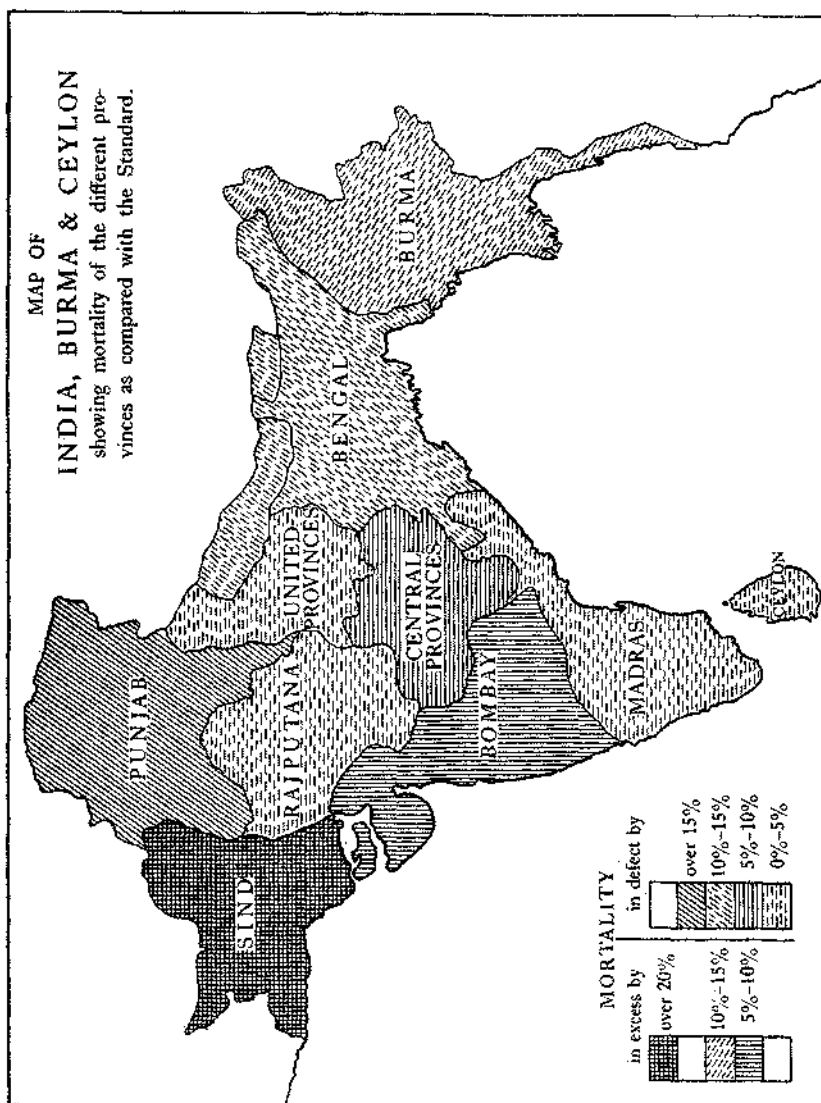
The company transacts business through a network of branch offices, except for two chief agencies in Ahmedabad and Poona. In most of the provinces there exist more than one branch office. The statistics relating to these branches were suitably combined to provide the experience of the various provincial units. The branches that provided the experience of each province are shown below. In some cases the provincial units are not strictly co-extensive with the corresponding political divisions. For instance, Delhi and a large

part of the area served by that branch do not form part of the Punjab as politically understood, although for the study of regional mortality Delhi has been grouped with the Punjab. Similarly, a part of the area allotted to Jalgaon branch, although politically forming part of the Bombay Presidency, has been combined with the Central Provinces for the purpose of the mortality study. This was rendered necessary by the fact that Jalgaon with the area under its control formed part of the company's Nagpur branch from which it bifurcated as a separate branch during the period under investigation. A map of India is submitted to give an easy method of appreciating the area comprising each of the several provincial units into which India (including the Indian States) was divided. The scheme of combination of the various branch organizations to provide provincial units is as follows:

Province	Branches included
Bombay	Head Office, Gujerat and Deccan including the largest of all Indian States, Hyderabad
Madras	Madras, Bangalore, Trivandrum, Trichinopoly and Vizagapatam
Punjab	Lahore, Rawalpindi and Delhi
United Provinces	Lucknow, Bareilly (Sub-branch) and Allahabad (Sub-branch)
Central Provinces	Nagpur and Jalgaon. Jubbulpore (Sub-branch)
Bengal	Calcutta, Dacca, Rajshahi, Ranchi, Gauhati and Patna
Sind and Baluchistan	Karachi
Rajputana and part of Central India	Ajmer
Burma	Rangoon
Branches outside India and Burma	Colombo, Kuala Lumpur and Mombasa

In order to eliminate from the comparison any effect of the element of heterogeneity, the Hindu experience only of each provincial unit was taken into account and ratios were obtained of actual to expected deaths according to the graduated standard table which is itself based on only the Hindu experience of all branches.

Table 13 gives a comparison of the mortality of the various provinces *inter se*. To give an idea of the degree of reliability attaching to the observations when subdivided according to the various provinces, the actual deaths and those expected by the standard table of mortality are given. In column (6) of this table the provinces are



arranged in order of heaviness of mortality as revealed by the actuarial analysis that was made in connexion with the 1931 census.

The striking feature of Table 13 is the great disagreement between the order of the provinces according to the experience of the company and that on the basis of the latest census analysis, when provinces are arranged according to the mortality to which they are subject. For an explanation of the divergence, other factors affecting mortality should be taken into account, and some of these as far as they could be gathered from the 1931 census are incorporated in Table 13.

The heaviest mortality, more than 23 % in excess of the standard, is exhibited, according to the company's experience, by the arid tract of Sind which includes Baluchistan. The same heavy, if not worse, mortality would be expected in the adjoining huge area of Rajputana, more arid, having within its bounds the vast expanse of sandy waste called Thar and without the advantage of a huge snow-fed perennial river possessed by Sind, which keeps the parts adjoining the river fertile and green. As a matter of fact, Rajputana exhibited the heaviest mortality of all the provinces according to census statistics, while according to the experience of the company it is subject to 4 % lighter mortality than the standard. Only in very rare cases does the company entertain proposals on the lives of illiterates, and if we assume that the insuring population is mostly drawn from the literate class, it would appear that the company has drawn its policyholders from a highly select class in this vast area. The inference is confirmed by the fairly large value of the average sum assured per policy effected in 1937 [*vide* Column (5)], and the low value of the number, per million of total males, that effected policies with the company in 1937 [*vide* Column (7)].

Burma, with an excess mortality of 12.3 % over the standard, comes next according to the company's experience. Yet it has been showing consistently the lightest mortality of all the provinces according to not only the 1931 census but also the earlier ones. The explanation is to be found in the fact that the company's experience shown in Table 13 relates only to the Hindu settlers in Burma, mostly confined to Rangoon. Due to an unfortunate error, the local population of Burma, who are mostly Buddhists and who according to the census analysis have been exhibiting the lightest mortality of all the provinces, have been mixed up with the Christian lives assured with the company. Although the local Burman population

Table 13

Province (1)	"Oriental's" experience Select and Ultimate				Particulars from census of India 1931			
	Actual deaths (2)	Expected deaths (3)	$100 \times \frac{(2)}{(3)}$ (4)	Average sum assured per policy (5)	Order according to census mortality (6)	No. of policies effected in 1937 per 1,000,000 males (7)	Literates % (Hindus aged 20 and over) (8)	No. per 1000 who live in towns (Hindus) (9)
Sind	335	272	123.4	Rs. 1974	Rajputana	145	9.1	109
Burma	193	172	112.3	2267	Bengal	202	19.3	65
Bombay	3748	3524	106.4	1966	Sind	Not available	Not available	Not available
Madras	2897	2928	99.0	1531	United Provinces	103	10.5	79
United Provinces	289	298	96.9	1882	Bombay	297	16.7	157
Rajputana	166	173	96.0	1914	Central Provinces	321	12.6	93
Central Provinces	647	687	94.2	1839	Madras	465	23.4	125
Bengal	1152	1319	87.4	1519	Punjab	432	16.1	137
Punjab	759	934	81.2	1985	Burma	241	36.1	542

is more rural than urban, as many as 542 per mille of the Hindu settlers live in urban localities, mostly in Rangoon, for business purposes. Generally speaking, those living in urban localities in India are not exposed to heavier mortality than those living in rural areas. Very few of the provincial towns are industrialized, and because the medical facilities, water supply, improved sanitation and other comforts of life available in towns are better than in rural areas, the mortality in towns of moderate size should not be heavier than in villages. The position is, however, different with highly populous cities like Bombay, Calcutta, Rangoon, Madras and some other industrialized towns of Northern India such as Cawnpore. The Indian settlers in Burma, concentrated as they are mostly in the city of Rangoon, have been subject to very heavy mortality according to the company's experience. Had it been possible to investigate separately the mortality of insured lives amongst the local population of Burma, it would probably have been found that they are subject to very light mortality in much the same way as the general population. The high economic status of the population as revealed by the average size of each policy, which has been computed for the branch as a whole, including Burmans, confirms this view.

Although 1% lower than the standard, the rather high rate of mortality to which Madras is subject, compared with some other provinces, is significant, particularly as Madras has been showing the lightest mortality of all the Indian provinces, with the exception of Burma, in all actuarial investigations after the censuses except the one undertaken after the 1931 census, according to which it appears to have lost only a little ground in favour of the Punjab. Although the most southerly of all the Indian provinces, a large part of the province is not subject to that extreme heat in summer which characterizes some of the more northerly provinces, particularly the Punjab. It has sufficient rainfall to keep the country fertile and green, and being washed on both sides by the ocean, the climate is kept equable throughout the year except for a short spell of summer which is broken by the westerly breeze as soon as the south-west monsoon breaks out. This may more or less explain why the province has been showing the lightest mortality of all the provinces included in India proper excluding Burma, according to the various censuses except that of 1931. The reason why it appears to have lost its pre-eminent position among the Indian

provinces according to the experience of the company is that insurance appears to have touched a stratum of society in this province much lower than in the case of the other provinces. As stated earlier, the company issued policies for sums as low as Rs. 500 till very recently, and Madras and Bengal appear to have taken full advantage of this. This will be evident from the average sum assured per policy in these two provinces, viz. Rs. 1531 and Rs. 1519 respectively. In the case of Madras this is further confirmed by the figure of 465 per million who effected insurance with the company in the year 1937, which is the largest figure for all provinces.

The interchange of position of Bengal from being a province experiencing the second heaviest mortality according to the census to the second lightest according to insurance experience, in spite of the fact that the average size of policy is the lowest in Bengal, is a significant factor. Bengal, particularly East Bengal, has been for a long time notorious for its high malarial mortality. The adjoining province of Bihar has been subject to lighter mortality than Bengal as revealed by the 1931 census analysis. In the company's experience, however, Bengal and Bihar have been combined, and this might to a large extent account for the light mortality of Bengal as revealed by the company's experience. The other provinces have not shown such significant alterations of their relative positions as to call for comment. On the whole it appears that the actuarial analyses undertaken in connexion with the census, in spite of their shortcomings and the great handicap attached to them due to unreliability of data, give a better indication of the influence of climate and geographical position on mortality than what is supplied by mortality analyses of insurance data.

In conclusion, the author desires to express his gratitude to the Board of Directors of the "Oriental" for having kindly given him permission to publish the results of this investigation. To Mr H. E. Jones, F.F.A., A.I.A., the manager of the Company, the author is indebted for guidance and help when this investigation was in progress. He has also to acknowledge with thanks the help he received from time to time from his colleagues, Messrs K. R. Srinivasan, B.Com., F.I.A., and S. N. Vaidya, B.Com., F.I.A. Amongst the assistants in the Actuarial Department of the Company special mention must be made of Mr D. D. Markan, B.Sc., a student of the Institute, who showed particular ability in applying in practice complicated formulae of graduation.

ABSTRACT OF THE DISCUSSION

Mr C. E. Puckridge, in opening the discussion, said that on page 23 the author had mentioned "class selection", arising from the fact "that the mortality depends on the year of entry rather than on the year in which the age is attained", and had decided to refer to it as "secular trend". But the author had subsequently used the term "secular trend" in a manner which seemed to be inconsistent with the meaning of "class selection" as above defined.

On page 25 the author had given four forces which he considered had contributed towards the selection shown by his data. He, the speaker, suggested that the type of spurious selection usually known as "class selection" was similar to the fourth of the four forces (although in that case the effect was in the opposite direction), while the second force which was called by the author "secular trend" was more commonly known as "generation mortality" and was in fact something quite different from "class selection". In an experience covering a period of years, progressive improvement in mortality would always produce an appearance of selection if the rate of increase of new entrants were rising rapidly, since the shorter the duration the greater would be the weight given to the mortality of the later years. It would appear that it was that feature which had produced the appearance of selection referred to in the author's second force, and, if that were the case, that type of spurious selection could be defined as due to the fact "that the mortality depends on the year in which the age is attained rather than on the year of entry" which was the exact opposite of the definition of "class selection". He was rather at a loss to know why the author had included force (2) as well as force (3), for it appeared to him that progressive improvement in mortality would not produce an appearance of selection unless combined with a changing rate of increase of new entrants.

He had not appreciated how the author had decided that the apparent selection shown by his statistics was largely spurious, and that temporary selection due to medical examination had been negligible. It seemed that, in order to arrive at that conclusion, it would be necessary to examine the experience in respect of the entrants during one or two calendar years and to follow them through successive durations; if necessary an adjustment could be made for the improving mortality. Perhaps the author had made a subsidiary investigation on those lines but had not referred to it in the paper.

It was stated in the paper that the short duration and low intensity of temporary selection made a strong case in favour of the introduction of non-medical business in India. He thought however that most underwriters would take the opposite view and say that, at a time when the existing safeguards were not producing that degree of selection to which the underwriter considered himself entitled, it was desirable to look for additional safeguards rather than to consider relaxing any of those at present employed.

He could not agree that Table 8 enabled the degree of selection to be appraised at a glance, and he wished that the author had followed the more orthodox course of giving percentages of actual to expected deaths at successive durations. In any event, it would have been better not to have shown unweighted averages at the foot of the columns. It was only necessary to look at the final column of Grouping II to see how misleading such averages could be. In that column, in spite of the fact that the differences were positive at all the important age groups, a large negative difference for the age group 20-24 had been sufficient to produce a negative average difference. The data available for the age group 20-24 for durations over 3 must necessarily be very small.

In order to show how mortality in India compared with that in Great Britain he had calculated expected deaths using the A 1924-29 Ultimate Table in conjunction with the exposed to risk shown in Table 3. The actual deaths were 214 % of the expected for ages up to 64, taking them in total; results in age groups were given in Table A.

Table A. Expected deaths by A 1924-29 Ultimate using q_x for the central age of each group

Age group	Exposed to risk from Table 3	Actual deaths	Expected deaths by A 1924-29 Ultimate	% Actual to expected
-19	34	—	·08	—
20-24	28276	147	66·45	221
25-29	114806	532	269·79	197
30-34	177151	830	448·19	185
35-39	177130	1118	566·82	197
40-44	145643	1365	639·37	213
45-49	103067	1387	622·52	223
50-54	60305	1312	546·36	240
55-59	24136	830	349·97	237
60-64	12801	629	306·46	205
All ages to 64	843349	8150	3816·01	214

It appeared that a good approximation to Indian mortality could be obtained by using the A 1924-29 equal-age joint-life functions. That was demonstrated by Table B overleaf.

The various tables in the paper could not be reconciled easily. Table 1 showed 299,334 policies contributing to the experience for investigation V and, in the previous column, 57,620 lives existing in 1925, so that presumably about 240,000 policies issued during the ten years had contributed to the experience. Table 5, however, showed the new business to be nearer 300,000. He had been unable to explain that discrepancy. Further, the number of Hindu lives exposed to risk shown in Table 3, which was headed "Ultimate Section", amounted to only 64 % of the total exposures for investigation V shown in Table 1, although from Table 2, where the percentage of new entrants was shown, it might reasonably be supposed that

Table B

Term	Age at entry	Net premiums at 3½ %		(1) + (2)
		by standard table given in paper (1)	by A 1924-29 equal-age joint-life functions (2)	
Whole life	20	12.35	12.30	1.004
	30	17.62	17.31	1.018
	40	27.04	26.22	1.031
Endowment assurance	15	52.32	52.43	.998
		53.00	52.96	1.001
		56.17	55.31	1.016
	20	36.67	36.78	.997
		37.72	37.63	1.002
		41.95	40.76	1.029
	25	27.60	27.71	.996
		29.16	28.95	1.007
		34.52	33.09	1.043

the Hindu exposures included in the experience would be nearer 80 %. Perhaps the author would say whether approximately 16 % of his total exposures occurred in respect of Hindu lives at duration 0, or whether the rates of withdrawal for Hindu lives were substantially greater than in other communities.

The author had explained that in his graduation he had endeavoured to take account of unreported deaths. Those mainly arose as a result of paid-up policies; in any future investigation it might be preferable to treat any policy which was converted to a paid-up policy as a withdrawal on the date at which the conversion took place, irrespective of the amount of the sum assured. That had been the custom of at least one of the established companies in Great Britain, and it would appear that the danger of unreported deaths was much greater in India.

On the basis of the standard table given in the paper he had attempted to test the adequacy of current premium rates in India. He had calculated, at 3½ % interest, net premiums loaded for a simple reversionary bonus of 15 per mille and had made a comparison with the average premiums of four of the leading companies with head offices in India. He had concentrated on participating endowment assurances for terms of 20-30 years which were the most popular policies in India. The results were shown in Table C.

The four offices in question (all well-established) were declaring simple reversionary bonuses of 16 to 20 per mille and their average expense ratio was 25 %. If allowance were made for 25 % expenses, the premiums would have provided for a simple reversionary bonus of only 5 per mille.

Table C

Term	Age at entry	Net premium at 3½ % loaded for simple reversionary bonus of 15 per mille	Average premium charged by four offices	Margin for expenses expressed as percentage of office premium
		Rs.	Rs.	%
20	30	48·09	54·06	11·0
	40	52·48	58·86	10·8
30	30	32·91	37·69	12·7

In view of the non-forfeiture schemes, which were general in India and would become compulsory under the new Indian Insurance Act, the profit likely to accrue from lapses and surrenders must be regarded as very small; the proportion of non-participating business in India was very small indeed, so that any considerable profit from that source could also be ruled out. Profits must therefore arise mainly from interest in excess of 3½ %. The average rate being earned by the four offices was slightly over 5 %, but when the Indian Insurance Act came into full force they would be fortunate if they could maintain that rate.

With regard to the comparison of the mortality of various communities, he was not quite clear as to the significance which could be attached to the percentages shown in Table 12. The ratio of actual to expected deaths for Mahomedans for investigation V was given in that table as ·958. He was not sure whether he would be right in assuming that the similar ratio for Hindus would be unity. At the bottom of p. 33 the author had explained that the allowance for unreported deaths at the old ages represented an addition of 1·52 % to the aggregate actual deaths: if the expected claims were worked out for Hindus would their ratio come to something like ·985, as compared with the figure of ·958 given for Mahomedans?

The last section of the paper was extremely interesting and provided a warning to less well-informed investigators, who might be tempted to draw unjustified conclusions from an examination of the mortality in different provinces.

Mr J. Jamieson remarked that the author had expressed an opinion in favour of the introduction of non-medical business, in India, only for certain persons, viz. those in selected services. It was necessary to note that limitation. It was evident from the ratios given in Table 6 that while in England the rates of mortality of the general population were not very substantially in excess of the rates derived from lives assured in British offices, the rates of mortality obtained from the 1931 All-India Census were very substantially in excess of the rates derived from the "Oriental" experience for the years 1925-35. It appeared, therefore, that it would be most unsafe to encourage non-medical business in India unless care were taken to obtain full information concerning each proposer and to limit the

business to persons of approved economic status. He had been able to compare the mortality experience of one Indian company which issued policies without medical examination with the expected mortality according to the new "Oriental" rates, and he had found that under both whole-life and endowment assurance non-profit policies the actual mortality was on the whole very considerably in excess of the expected. The greater part of the experience related to policies which assured less than Rs. 500, and the result appeared to confirm the author's suggestion that the mortality of lives assured for comparatively small sums was heavy.

In one comparatively small and conservative company, of which he had knowledge, most of the lives assured were Indian Christians from Western India, and he had compared the actual mortality experience of that company with the expected mortality according to the new "Oriental" experience. It was a little unfortunate that the new rates of mortality had been based upon a combination of four different classes of policy. In the case of the company he had referred to, the mortality under endowment assurance with-profit policies was only 54 % of the expected whereas the mortality experienced under whole-life with-profit policies was 77 % of the expected.

In the case of a much larger company where most of the business appeared to be in the northern half of India, he had compared the actual mortality during two successive periods of five years with the expected mortality according to the new rates given in the paper. During the years 1924-28 the actual deaths under endowment assurances with and without profits were 95 % of the expected and during the years 1929-33, 97 % of the expected. It would be observed that there was no indication of improvement in mortality during the ten years. Under whole-life policies, during each period of five years, the actual mortality was 123 % of that expected, which was considerably in excess of the additional mortality suggested in the author's previous paper. Although the comparison which he had given in respect of endowment assurances appeared to confirm the rates of mortality which had been produced by the author, it should be borne in mind that the experience in both cases covered a period which was apparently one of very light mortality.

Mr C. E. Kingham expressed the opinion that it would be dangerous to accept the new table as representing the mortality of Indian assured lives. The experience was so youthful; it had an average duration of only $4\frac{1}{2}$ years, and out of the aggregate of $1\frac{1}{2}$ million years of life approximately 20 % probably related to the first year of assurance. There were 81,000 withdrawals out of the 299,000 under observation, and he imagined that many of those withdrawals contributed only one year to the experience.

If an attempt were made to calculate premiums on that table, as the opener had done, and then to criticize Indian premiums on the ground that they could not possibly support the bonuses given, it should be remembered that the same conditions existed in England. The Indian bonuses were high, but there was no reason why they should not be reduced as interest earnings fell.

It seemed to him that a ten-year period, terminating with policy anniversaries in 1935, was too short because it excluded the full effect of the Quetta earthquake which occurred on 31 May 1935. When considering mortality in a country which was subject to great disturbances such as epidemics and earthquakes, the experience of one office, though a very large one and very well conducted, was a little dangerous if it were to be regarded as illustrative of the mortality of Indian assured lives as a whole, and there seemed to be need for the big offices at any rate to combine for the purpose. The "Oriental" company had published its Quetta earthquake claims as Rs. 2½ lakhs, an insignificant proportion of a year's death claims, whereas the Government Year Book showed that other Indian companies had, as a result of the Quetta claims, paid out in 1936 25 % more than the normal. Presumably the "Oriental" did not transact a great deal of business in the Quetta district. Had the figures of four big offices been pooled a very different table might have been produced. One year of very heavy claims, 25 % in excess of the normal, would make a considerable difference in a ten-year experience.

The opener had had some difficulty in reconciling the author's figures. It was to be noted, however, that the author's table of new business had been extracted from the annual report, and apparently included all the rated-up cases, whereas the investigation dealt only with policies accepted at ordinary rates. That might account to some extent for the discrepancies.

Mr A. B. Chiles said that the author had reached the conclusion that the select period of mortality was only one year, and had ascribed the shortness of that period to the poor standard of medical examinations. However, his own experience in India, and in other territories where tropical or sub-tropical premiums were charged, was that the initial period of selection had been only one or two years and he believed that that was partly due to a preponderance of deaths from diseases which could not be guarded against by medical examination. Roughly 50 % of the deaths of Indian assured lives arose from diseases of rapid development, whereas the corresponding figure for assured lives in England was about 25 % : the slowly-developing diseases accounted for only 25 % of the deaths in India, as against 50 % in England.

He had been particularly interested to find the mortality at ages 20-24 higher than at ages 25-29, as that feature had been present in a number of other assured lives' experiences, and seemed to be inherent rather than spurious. Minimum values of q_x occurred at age 27 in the Japanese 1912-27 experience, at age 31 in the Canadian Men 1900-15 experience, and near to age 28 in three different sub-tropical and tropical experiences of which he had knowledge. In the Japanese experience, the ultimate rates of mortality were .00538 at age 15, .01115 at age 20, .00967 at age 25, .00802 at age 30 and .00811 at age 35. He could not believe that the increased mortality at ages 20-25 in that Japanese experience was mainly due to under-statement of age. The author had ascribed the increased mortality at ages 20-24 in his experience to under-statement of age, but the practice of under-stating the age occurred at all ages, and even if there

were a special tendency to such under-statement at younger ages at entry the effect would be projected into the higher attained-age groups.

The relatively light mortality at advanced ages was also of interest, because the same feature was to be found in the tropical experience of the company with which he was associated, where it was not due to unreported deaths under paid-up policies, because all paid-up policies had been excluded from the investigation. It had been the practice in India to issue endowment assurances maturing not later than age 65, and to apply a relatively low maximum age at entry, except in the case of especially good risks. In that way a different class of risk emerged at attained ages of 65 and over. It would be interesting to know whether the underwriting of the "Oriental" had followed similar lines.

His own knowledge of the mortality of Parsis agreed substantially with the experience which had been given in the paper. He had found that deaths amongst Parsis were about 58 % of the expected on the basis of the mortality of other Indian lives against the ratio of 61 % given in Table 12. He could also confirm the statement which had been made in the discussion that the experience under whole-life policies was very much worse than under endowment assurances. He had found that the aggregate mortality ratio was about 30 % higher under whole-life assurances than under endowment assurances, the excess mortality occurring mainly at attained ages under 40.

The comparisons he had given had been made with reference to an experience on the basis of policies: the mortality by amounts was very little different from that based on policies in the case of Indian lives.

Mr A. S. Clarke remarked that the author, having referred to the necessity of basing his standard table on a homogeneous group which would not under-state the mortality, had concluded that he ought to exclude all religious communities other than the Hindus, who experienced on the average rather heavier mortality than that of the other communities. However, later in the paper, the author had established the fact that Hindu mortality itself varied very considerably between the different provinces. Was the author satisfied that in the future, similar proportions of the experience would be received from the different provinces, because, if not, his standard table was liable to be disturbed far more on that account than on account of a variation in the proportions of the different communities.

He agreed with others in thinking that no case had been established by the paper for the introduction of non-medical business in India, even in the case of certain groups such as Government employees. He had dealt with a large number of proposals in India and had found that at least 15 % of the proposers were not accepted at ordinary rates; it seemed to him that under any non-medical scheme some part of that 15 % would be so accepted. In the up-country districts it was very difficult to exercise a close supervision and sometimes cases of fraud did occur. He felt that in any non-medical scheme such cases of fraud would be likely to increase.

The new table had been criticized as being an unsuitable instrument for use in construction of premium rates in India. He thought, however, that

no experience of a wider or more general nature could have been obtained. The "Oriental" did business in all parts of India, whereas a large number of the companies concentrated their business in certain provinces. There were companies who did business almost entirely in the North-West Province and therefore would have been seriously affected by a catastrophe such as the Quetta earthquake. He thought that there was little doubt that the "Oriental" had an average amount of business in that district. From his own experience and from certain statistics which he had been able to see, he thought that the author's table did represent on the whole the mortality in India at the present time, provided that conditions were similar to those of the author's Company, which was well-organized and had probably the best facilities available for medical examinations in India. Those who did not work under similar conditions would probably have a very much worse experience.

Mr Duncan C. Fraser recalled the great interest which had been raised 40 years ago by the publication of the results of the investigation into the mortality of the Oriental Insurance Company, made by the late James Meikle of Edinburgh. It was expected at that time that a period of gradual and steady improvement in Indian mortality would ensue, an expectation which had been unfortunately disappointed by the reappearance of plague in India, particularly in the province of Bombay. The effect was seen in Table 1 of the paper. A comparison of the aggregate years of risk and the deaths in each of the four periods dealt with in the table would indicate that, taking the broadest view of the experience, the death rates in the first three periods were 15 per 1000 per annum and in the fourth period 10 per 1000 per annum; from which it appeared, as the author had pointed out, that improvement in mortality had been delayed and had not become manifest until after 1920. He had heard the fear expressed that the risk of the return of epidemics could not be disregarded.

In Table 12 it would be seen that the mortality of Europeans and the mortality of Parsis had been little more than 60% of the mortality of the standard table based on the mortality of Hindus. That agreed with the result of other observations which had come under his notice; and it occurred to him to remark how interesting and how valuable it would be if the results of the successive investigations which had been made into the mortality of the members of the Indian Civil Service and their dependents could be recorded in the *Journal*. Those investigations were based upon precise and accurate data, and he had no doubt that they would show a steady and continuous fall in mortality rates.

Mr F. L. Bradshaw said that in reading the paper he had felt that the author had a poor opinion of the doctors in India. The author was probably right, but he did not think that he had proved his case.

It was stated on p. 24 that as regards the policies effected during the period 1925-35, "the policies effected during the later years would have provided in the aggregate very nearly the same weight as those effected during the earlier years". But if, in Table 5, the policies of 1935 were given

half-a-year's exposure, those of 1934 $1\frac{1}{2}$ year's and so on throughout the period, it would be found that the policies effected in the first five years gave double the weight of those effected during the last five years.

In Table 8 the author had purported to show that there was very little selection after the first year. If, however, the age groups in that table were grouped, the first four and the last four, it would be found that in the last four there was a great deal of selection in the second year, judging by Grouping I or by Grouping II. The total of the figures of the last four age groups was 79 for the first column and 47 for the second for Grouping I, and 106 and 55 in the other case. Those totals showed that there was a certain amount of selection and that at the higher ages there was more scope for exercising selection on the part of the doctor than at younger ages.

The author had compiled Table 9 by the use of the formula

$$\frac{q^3 \text{ and over} - q}{q^3 \text{ and over}},$$

but if the denominators were different, i.e. if the A 1924-29 denominator were the q^3 and over according to the A 1924-29 Table, and a similar q had been taken from the "Oriental" Table, then if one of those q 's were double the other, which was the case, the author was halving his selection by the use of a different denominator.

He thought that if medical examination was not much good in India it could not improve matters to do away with it, and he agreed with the opener on that point.

Mr R. E. Beard said that he had made some experiments in graduation on the figures given in Table 3 and had used the curves suggested by Mr Perks in *J.I.A.* Vol. LXIII, the quinquennial groups from ages 20 to 79, adjusted by deduction of $1/25$ th of the second central differences, having been operated upon. It was soon apparent that some modification was necessary and a term involving e^{-x} was introduced into the numerator of the generalized curve. That curve gave a minimum value for q_x at age 29, but he thought that a minimum value was a feature of the data at about that point. At the older ages the curve gave values in good agreement with the crude data, but the rates of mortality were, on that account, lower than those given by the graduation in the paper. In view of the remarks regarding unreported deaths he had increased the actual deaths in the three groups from ages 65 to 79 by 50, 20 and 35 deaths respectively. On recalculating the constants it was found that the resulting rates of mortality were satisfactory up to age 80 as compared with the graduation given in the paper. At ages over 80 the values of q_x given by the formula were below those suggested but at those advanced ages the level of values seemed to him to be largely a matter of opinion, and if higher values were desired a slight modification in the constants would produce a higher level at those ages without materially altering the rest of the graduation.

Mortality of Indian Assured Lives

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The figures were:

Graduation of the Standard Table by means of the formula

$$q_x = \frac{Fc^{-x} + A + Bc^x}{Ec^{-x} + 1 + Dc^x}$$

	(a)	(b)
F	·00596	·00486
A	— ·02418	— ·01979
B	·05653	·04792
E	·48688	·37760
D	·22197	·10075

$c = 1.06$; origin = 52.

Age group	Expected deaths minus actual deaths				√ (Expected deaths)	Age	Graduated $q_x \times 10^5$		
	(a)		(b)				(a)	(b)	Paper
	+	-	+	-					
20-24		2		3	12	22	519	517	420
25-29	2		1		23	27	464	463	440
30-34	27		29		29	32	477	479	490
35-39		38		33	33	37	606	609	620
40-44		52		53	37	42	905	904	904
45-49	86		78		38	47	1,433	1,425	1,413
50-54	18		12		37	52	2,242	2,232	2,234
55-59		40		36	28	57	3,367	3,385	3,420
60-64		23		7	25	62	4,816	4,941	4,928
65-69	31		9		22	67	6,559	6,940	6,874
70-74		14	3		19	72	8,531	9,399	9,346
75-79	4			2	15	77	10,641	12,301	12,465
						82	12,780	15,587	16,572
						87	14,845	19,149	22,310
Total	168	169	132	134	318				
	± 337		± 266						

Graduation (a) refers to the crude data and (b) to the data adjusted as described above. The deviations in the last three age groups of graduation (b) have been calculated with reference to the deaths after the adjustments.

Mr H. L. Trachtenberg remarked that the formula which the author had given on p. 29 was purely empirical. It might be thought, on seeing the periodic functions shown, that some periodic law of life had been found, but that was clearly not the case. It might be a good smoothing formula, but parabolic terms would be equally effective over the short distances taken.

Mr James Bacon, in closing the discussion, said he thought that it would be agreed that the author had performed a public service in bringing up to

date the only reasonably satisfactory experience of Indian assured lives which was available. There were approximately 139 native Indian companies with nearly 1,000,000 policies assuring over £100,000,000 and they were being valued by various old tables, e.g. the H^M , the O^M and the $O^M(s)$, and it was clear that none of those tables was really satisfactory.

When results of consecutive experiences were available at least three questions naturally arose. Had there been any significant change in those experiences? Were the past trends still continuing or were they being modified? And, in particular in India, was the period under review in any respect abnormal? He also asked, as India was a sub-continent with many different religious communities, how far the experience given was likely to be typical.

It was very difficult to give a complete answer to those questions. He regretted that the author had not been able to investigate his experience on precisely the same lines as the previous experience, which for the period 1905-25 was on the basis of lives, duplicates being omitted. In the present experience duplicates had not been omitted. In an experience of which he had some knowledge, the mortality according to sums assured, was (contrary to the experience of a previous speaker) worse than according to policies. On the other hand, it was only the lives still able to pass a medical examination who could effect duplicate policies; but he did not like to draw a definite inference that the inclusion of duplicates would have had the effect of lowering the rates of mortality because in some cases he had known the mortality to improve as the duration increased. He was not sure, having that in mind, how far the inclusion of so large a body of new lives would affect the experience. Much depended upon the efficiency of the medical examination which might vary very considerably from place to place.

The paper had confirmed the impression which had been gained from other experiences that selection was operative for one year but probably not much longer, and in some cases there might be the same features that were at one time present in industrial assurance in England, where the selection against the company was more powerful than the selection on behalf of the company.

He would like to emphasize the suggestion that, if possible, experiences of the kind in question should be analysed according to the principal classes of policy. He thought that endowment assurances unquestionably showed a lighter rate of mortality than whole-life policies, and although it was not necessarily true at the present time, it probably would be true in the future that with-profit policies would show a lighter rate of mortality than non-profit policies. Unless the proportion of policies of different types and the geographical distribution remained constant in succeeding investigations, the differences would undoubtedly affect the resulting composite mortality table, and that might have some bearing on the question of select mortality.

The author had provided a very interesting map showing the mortality in the different provinces as compared with his Standard Table. It would be asking a good deal of the author to suggest that he should give his various tables according to age, but he did think that it was rather un-

satisfactory merely to have totals. It might be interesting to note the experience of two companies of which he had particulars. One operated in the Madras area—a healthy district, according to the author's map—did not seek to make profits for the proprietors, which was important, and transacted endowment assurance business very largely. The experience was almost limited to ages 20-65, and taking durations 5 and over and limiting himself to endowment assurances, he had found that whereas for the period ended 30 June 1933 the actual deaths were 101 % of the expectation according to the 1935 "Oriental" Table, those for the five years ended 30 June 1938 were only 87 %. That confirmed the author's conclusions that mortality had been improving, and was continuing to improve, and that the area which he had labelled "Madras" was more favourable than India as a whole. It was, however, perhaps necessary to bear in mind that the experience to which he had just referred was confined to endowment assurances. The second experience related to business mainly in Bengal, and showed that the period 1932-36 experienced lighter mortality than the period 1928-32, which had itself shown improved mortality over earlier periods. That experience was extracted according to sums assured and according to policies and was analysed in respect of class of assurance; it showed on the whole that the experience according to sums assured was heavier than according to policies, being lighter under age 40 and heavier thereafter. That emphasized the necessity of dealing with mortality from age to age and not merely in total. The whole-life assurances experienced mortality heavier than the endowment assurances in respect both of policies and of sums assured. From 1932 to 1936 the ratio of actual to expected deaths was 99 % of the "Oriental" experience in respect of policies and 100 % in respect of sums assured, while for the whole-life limited-payment class it was 118 % for both policies and sums assured. In the whole-life class it was 124 % for policies and 148 % for sums assured. In each case, although the number of claims was not sufficient to form an experience by itself, it was quite sufficient to give a reasonable comparison with the standard. It should perhaps be said that those results in total were not due to any special distribution of the business.

On more than one occasion he had been asked to advise on industrial assurance in India and on group life assurance. Like other speakers, he did not agree with the author's suggestion regarding the introduction of non-medical business. He had had some experience of non-medical business in connexion with policies of small amount, and that experience had been dreadful. Taken in conjunction with other aspects of the business it seemed to him rather to emphasize the importance of tightening up medical selection. His own impression was that until insurance companies in India were smaller in number and larger in size, any weakening of selection would be regretted, and both group life and industrial assurance might prove very costly until considerable experience had been gained. Unless the offices transacting the business were prepared, without undue regard to competition, to introduce any safeguards shown to be necessary by experience, difficulties would be experienced. It was interesting to notice

that in the new Indian Insurance Bill the minimum sum assured for companies was Rs. 500. That would seem to cut out industrial assurance, at any rate by companies, and perhaps also group life assurance for the ordinary Indian workman, although there might possibly be a case, as had been suggested by the author, for taking lives of a somewhat different social standing where the employer was able to give the benefit of past records.

The President (Colonel H. J. P. Oakley) said he was sure that it would be the wish of the members to accord a very hearty vote of thanks to the author for his interesting and valuable contribution to the transactions of the Institute. The author had shown an excellent professional spirit in bringing before the Institute the experience of his own company, and the members of the profession in Great Britain would be very grateful to him for the information which he had placed at their disposal. It was interesting to note that the mortality of lives in India had so greatly improved. It was of course improving in Great Britain also, and the mortality shown by the author's table was approximately double that of the A 1924-29 experience. That had led no doubt to the interesting suggestion made by the opener to use for Indian assured lives the A 1924-29 Table for joint lives. That was an excellent suggestion, but in practice it was difficult to get the functions required.

He was interested in the remarks of the speaker who, referring to the geographical distribution of the experience and to the fact that mortality in some parts of India was lighter than in others, wondered whether those features would be maintained. His own feeling was that, as a result of the present paper, there might be greater competition in those areas where the mortality was favourable, and it might be, with the greater competition in those areas and the greater caution shown in the others, that when the author came to give his next experience he would find that conditions had somewhat levelled up. The members would be very interested to hear what the author would have to tell them in ten years' time when he gave them the results of another ten years' experience. In the meantime they would wish to thank him for his present contribution. His paper had produced an excellent discussion, and almost every phase of the paper had been dealt with. He trusted that when the author came to review the discussion he would find considerable cause for satisfaction and would then be able to make that reply which, unfortunately, owing to his absence, he could not make that evening.

Mr P. V. Krishna Murthy, in a written contribution to the discussion, reported that the author's conclusion that selection did not last much longer than a year confirmed what the writer had found in some smaller experiences, though his results were complicated by some selection against the company. The author's suggestion that the small magnitude of selection was probably due to the standard of medical examination contained a great measure of truth, particularly in rural areas, but moral hazard had also to be considered. Medical selection was only a part of the total selection made by the organization of a company, and even if

medical selection were satisfactory, it would not be impossible for the aggregate selection by the company to be rather poor in magnitude or even adverse.

The author had further suggested that the two features of selection revealed by the paper made a strong case for the introduction of non-medical business in India, but that conclusion was not perhaps so obvious. The members of selected services to whom the scheme would be limited, at least at the outset, were mainly resident in urban areas, where it was not so difficult as it was in rural areas to secure reliable medical examinations, and for such "service" lives, whose leave history would be available, moral hazard would be practically absent. If the features of selection disclosed by the paper were due not only to poor medical examinations but also to moral hazard, it was possible that an experience, on an all-India basis, of such a special group of lives, where moral hazard was practically absent and medical examinations were much more reliable, would disclose selection of longer duration and larger magnitude. He therefore felt that it could not be definitely said that the results of the paper made a case for non-medical business in India but that, on theoretical considerations, "persons in selected services", in adequate numbers, might be so accepted.

The heavy mortality in Burma was rather surprising. The large size of the average sum assured suggested the explanation that most of the policies had been taken for financial reasons. Many of the settlers were of the money-lending Chettyar community. The rather high mortality shown by Madras had, in his view, been rightly ascribed to the large proportion of policies for less than Rs. 1000. Nevertheless, many of those policies had been taken by poorly paid teachers, employed by the Local Boards distributed throughout the presidency and their premiums were paid out of the provident funds maintained by the joint contributions of the employer and the employee; and if the policies below Rs. 1000 had been taken out mainly by illiterate persons, the mortality of Madras would perhaps have been even higher. It would be interesting to know to what extent the low mortality of Bengal, and the relative mortality of other provinces, had been influenced by a varying stringency of selection in the different provinces. In Bengal there was not only high malarial mortality, but also some degree of moral hazard, and it might be that the "Oriental" had been more cautious than usual in selecting lives from that area.

Mr Vaidyanathan, in a written reply to the discussion, considered that the President's remarks formed an effective reply to the suggestion made by Mr Clarke concerning varying mortality rates in the various provinces; and he confirmed that Mr Kingham had correctly attributed to the exclusion of rated-up cases the difficulty which the opener had found in reconciling the statistics.

He could not agree with most of the points raised by the opener. The term "secular trend" had been used throughout the paper in the sense in which it was used in books on statistics, namely, trend over a long period of years. The opener's statement "it appeared to him that progressive improvement in mortality would not produce an appearance of

selection unless combined with a changing rate of increase of new entrants" appeared to be not quite accurate. Sir William Elderton and the President had conclusively shown in Table 2 of their paper on "Notes on the interpretation of 'Select' Rates of Mortality" (*J.I.A.* Vol. LV) that "appearance of selection" persisted even when the number of new entrants was constant. In the case of the "Oriental", because of the progressive increase in the volume of new business from year to year, the "appearance of selection" for which force (2) was responsible was further augmented by force (3). The opener had also given a narrower meaning to "class selection" than the author had done and the author's meaning conformed to the paper referred to.

The opener had not entirely approved of the manner in which Table 8 had been computed. Although the table would normally be open to criticism, in view of Table 7 it was not thought necessary to take the trouble of comparing expected and actual deaths in order to prove something very obvious. The calculations had, however, since been made in the orthodox manner by comparing the deaths expected by the ultimate rates of mortality after four years with the actual deaths during the 1st, 2nd, 3rd and 4th years. The actual deaths were found to be only 75 % of the expected in the 1st year, increasing to as much as 92 % during the 2nd year and to practically 100 % (99.7 % actually) in the 3rd year; in the 4th year there was a slight drop to 95 %. Those figures confirmed the analysis given in Table 8 but he agreed that they gave a better idea of the degree of selection than was given by Table 8.

Further, he did not agree with the suggestion that all paid-up policies irrespective of amount should be treated as having withdrawn on the date of conversion. That would deprive the investigation of a large mass of useful information, particularly at the older ages; he thought, nevertheless, that it would be desirable to raise the minimum limit from Rs. 150 to about Rs. 250 or Rs. 300.

As regards the premiums which had been calculated by the opener he would not recommend the adoption of the new tables generally, for, apart from the fact that, as Mr Clarke had pointed out, the conditions of offices might vary, the adoption of premiums based on the very light mortality which had been revealed by the investigation would reduce the safety margin which, in view of the falling rate of interest and the further restrictions as to investment imposed by the new Act, the business needed.

It had been observed that the new table had not included the full effect of the Quetta earthquake which occurred on 31 May 1935. It had, however, included the full effect of the earthquake, more catastrophic and affecting a wider area in the Indo-Gangetic plain, which had occurred about the middle of January in the previous year. Even as regards the Quetta earthquake claims a substantial part had been included in the investigation, as, in common with most of the other Indian companies, the bulk of the "Oriental's" new business came in during the closing months of each year and therefore the centre of gravity of the business in a year could be placed somewhere near the middle of October.

Messrs Bacon and Krishna Murthy had made reference to the selection

against the company being more powerful than selection on behalf of the company; and Mr Chiles's observation that the short duration of selection was probably due to the preponderance of deaths from diseases of rapid development was particularly interesting. The statistics in the possession of the company did not permit an investigation of that point, but the cards would be maintained in such a manner that the next investigation would throw light on that interesting question.

As regards non-medical business, only Messrs Jamieson, Bacon and Clarke had made reference to the restrictions under which the author had suggested that the experiment might be tried. He could give the actual results of non-medical business transacted amongst the clients of a large bank in India. No records about past service or leave were available and the only condition of eligibility for insurance was that any insured client of the bank should at all times maintain a minimum deposit of Rs. 10. That insurance fund had been working for the past six years and the results of the mortality investigation for the period ended 31 March 1938 indicated that the actual deaths were only 92 % of those expected by the new "Oriental" ultimate rates. Had the clients of the bank been drawn from some selected services and had their past leave records also been scrutinized before acceptance, needless to say the results would have been much better.

As regards Table 9 his endeavour had been to produce an absolute measure, not affected by the unit of the table, which would convey an idea of the extent of selection secured by medical examination; just as, in statistics, the standard deviation measured dispersion. That would not have been the case had Mr Bradshaw's suggestion been followed.

The ratios of actual to expected deaths for various communities given in Table 12 should be compared with .985 (that being the ratio of actual to expected deaths for Hindus) and not unity. The standard table had been constructed with an addition of 1.52 % to the aggregate actual deaths as an allowance for unreported deaths.

The author had perused with interest the observations which Mr Beard had made regarding graduation, as he himself had performed some experiments with Perks's curves. The graduation was originally performed with Spencer's 21-term formula which gave a good enough fit in the main section of the table. In evolving other formulae with a view to securing greater smoothness and to deriving the rates at the ends of the table, the fit in that section had been taken as the criterion.