ON THE GROWTH

OF THE

CRYSTALLINE LENS.

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To Norman Moore Esq. M.D. &c
with the Author's kind regards

ON THE GROWTH OF THE CRYSTALLINE LENS.

By PRIESTLEY SMITH (Birmingham).

THE present position of knowledge concerning the growth of the crystalline lens cannot, I think, be stated more concisely, or on better authority, than by quoting a passage from the chapter by Otto Becker in the Handbook of Gräefe and Saemisch.

"In the new-born child the lens is smaller than in the adult, and of a more globular form; it is clear as water, very soft, and nearly equally soft in all its layers. The comparison as to size is true, however, only of the equatorial diameter, for according to Jaeger the antero-posterior diameter is equal, or very nearly so, to that of the adult lens. The changes which take place during life are referable to two opposing processes.

"So long as the whole individual grows, that is up till about the twenty-fifth year, new lens-fibres are laid down at the equator and apply themselves, as they further develop, to the anterior and posterior surfaces, each fibre bending round the equator. Hence the lens continually increases in its transverse diameter, and gradually loses its spherical form. The addition of the new fibres at the equator has little influence on the thickness of the lens, because it is only when the fibres have attained their maximum length that they reach to the poles. Thus the surfaces of the lens assume a flatter curvature and the dioptric power diminishes.

"The slight increase in thickness which would nevertheless occur is nullified to a great extent by the peculiar process of sclerosis which affects the fibres of the lens progressively from earliest youth until old age, and which ceases, unless pathological processes intervene, only with the death of the individual.

"The sclerosis of the lens-fibres is the analogue of the hardening of the cuticle, only that while in the cuticle the older cells lie on the external surface, in the lens they are constantly driven inwards towards the centre by those more newly formed. In other respects the analogy is complete. The younger lens fibres are thicker, softer, richer in water, freer from colour; the older they grow the more they give up their water and become flat, closely compacted, and amber-coloured. And since the centrally situated fibres are for the most part the oldest, the sclerosis begins at the centre of the lens and progresses thence towards the surface."

To this description of the life history of the lens I am able, as the result of an investigation carried out during the last two years, to add another fact, namely that *the growth of the lens does not cease with that of the rest of the body, but is continuous, unless morbid processes intervene, throughout the whole period of life.*

The first intimation of this fact was given in a paper read at the Cambridge meeting of the British Medical Association.* The data then obtained were too few to justify any general conclusion, and a systematic investigation was commenced shortly afterwards.

156 lenses removed after death from the eyes of 91 persons have been examined. Each lens was accurately weighed, and immediately afterwards measured as to its volume by means of an apparatus specially devised for the purpose. I am indebted to Prof. Donders for the suggestion which led me to weigh the lenses. Weighing affords an easier and a more accurate means of estimating quantity than does linear measurement, but in the case of bodies like the lens, the specific gravity of which is not

* Published in the 'Roy. Lond. Ophth. Hosp. Reports,' vol. x, part i.

constant, it does not suffice to indicate the volume. In addition to weighing, it was necessary for my purpose either to ascertain the specific gravity of each lens, or to measure the volume by some other method. I chose to measure the volume directly rather than to calculate it from the specific gravity, because in this way each lens would be examined by two entirely independent processes.

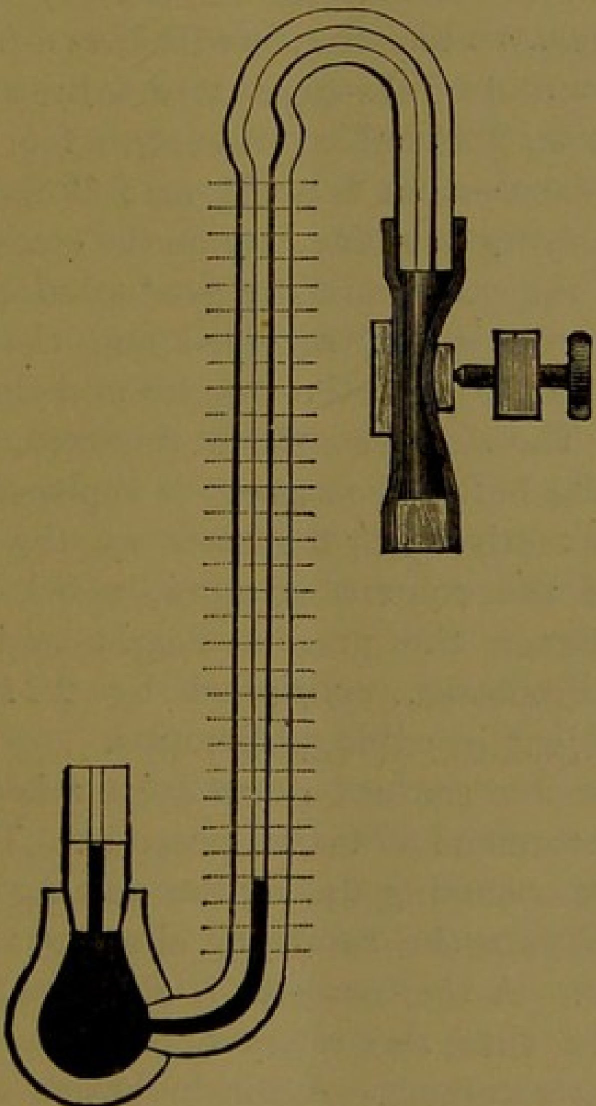

Fig. 1.—Apparatus for measuring the volume of the crystalline lens.

The measurement was effected by displacement of fluid along a graduated glass tube. This tube (see fig. 1) terminates at its lower end in a bulb closed by a perforated glass stopper very accurately ground in; its upper end is connected with a simple suction apparatus consisting of a piece of india-rubber tube plugged at its free extremity and compressed by means of a screw.

The instrument contains rectified oil of turpentine sufficient to fill the bulb and the lower part of the graduated tube. By means of the suction apparatus the fluid can be drawn from the bulb into the vertical tube or driven in the opposite direction at pleasure. A bulbous expansion in the glass tube at its upper end obviates the danger of drawing the fluid over into the descending arm, and increases the amount which can be withdrawn from the bulb. The cubical content of the graduated tube, as ascertained by experiment is, 2·24 cubic millimetres for each mm. of length. A measurement is made as follows:—The fluid is driven exactly up to a fine line on the glass stopper, and the height of the column in the graduated tube is noted down. The screw is then reversed and the fluid drawn up the tube so as to clear the stopper and the upper part of the bulb. The stopper is then removed, and the lens dropped into the bulb; the stopper is replaced, the fluid is again driven exactly up to the mark on the stopper, and the height of the column is again noted down. The difference between the present height and the former height, in millimetres, multiplied by 2·24, equals the volume of the lens in cubic millimetres.

Several possible sources of error have been taken into account and overcome as far as possible. Thus, changes of temperature occurring during the making of a measurement would vitiate the result by altering the volume of the turpentine. A thermometer is attached to the instrument in order that the absence of such changes may be definitely ascertained. Again, adhesion of the fluid to the internal surface of the graduated tube causes a considerable error if the column be lowered rapidly and irregularly. To obviate this the head of the screw is divided round its circumference by eight equi-distant notches and is turned in all cases at the rate of one notch in a second. The instrument has been crucially tested, with the help of Professor Poynting of the Mason Science College, by measuring a series of small bodies of known volumes. The average error was about ·5 cubic mm., the maximum was less than 2 cubic mm. For the purpose in hand, errors of this amount are of little importance.

Immediately after each lens had been measured in the way described, it was laid in a shallow vessel of water and at once measured as to its transverse diameter by means of finely pointed spring compasses. When, as happened several times, the diameter was unequal in different meridians, the mean was stated. In my first few observations this measurement was omitted. I knew that it could not be relied on to accurately represent the diameter of the living lens, but being advised by Mr. Bowman to make it notwithstanding, I did so in all subsequent cases, and the results have a very decided value.

The interval between the removal of the lens from the eye and its examination was as short as possible, rarely more than an hour, generally much less, and special precautions were taken to prevent loss or gain of bulk by evaporation or absorption of moisture. Shreds of the suspensory ligament were removed as cleanly as possible. When the capsule ruptured, and this happened frequently in the earlier cases, the specimen was discarded.

From the age of 20 up to that of 70 I have examined more than twenty perfectly transparent lenses in each period of ten years. Beyond 70 years of age my opportunities have been less frequent, and a large proportion of the lenses examined have been imperfectly transparent, so that the desired number of twenty clear lenses in each decade has not yet been reached beyond the age of 70. The whole of the observations are recorded in the tables appended to this paper. In every case in which any opacity was observed in the lens the fact is stated in a foot-note; the corresponding figures are given in a different type, and are not included in the averages. I now ask attention to Table I, which presents the averages only (see p. 92).

Column A shows that the *average weight* of the lens increases considerably in each decade. Between 20 and 29 years of age it is 174 mgr.; between 60 and 69 it is 240 mgr. This is a gain of 66 mgr. in forty years, and as the rate of gain is not very unequal in the different decades, we may say, speaking roughly, that the weight of the lens increases at the rate of about 1·5 mgr. each year.

The fact that the lens becomes heavier with the advance of life is, I believe, not new. Bader makes the statement that the lens of a person aged 70 is nearly as heavy again as that of a person aged 20.* But the increase appears to have been attributed to a change of density rather than of size. This, however, is incorrect, as the next column in the table proves.

Column B shows that the *average volume* increases in nearly the same proportion as the weight, viz. from 163 cub. mm. in the first decade, counting from the twentieth year, to 225 in the fifth. This is an increase of 62 cub. mm. in the forty years, so that, speaking roughly, as before, we may say that the volume of the lens increases at the rate of about 1·5 cub. mm. each year. In order to present this fact in a graphic form I have prepared a chart (see p. 85) which shows the volume of every lens examined, together with the age of the subject from which it was obtained. The dots represent lenses which were perfectly transparent; the circles represent those in which more or less opacity was observed. Omitting these latter from present consideration, it is obvious that the individual volumes vary considerably in each decade, but that the whole group moves steadily upwards even to extreme old age.

Column C shows the average *specific gravity* in each decade. It must be remembered that the figures do not represent direct measurements of the specific gravity, but are obtained by calculation from the weights and volumes shown in the preceding columns; their accuracy is there-

* 'The Human Eye,' &c., p. 268.

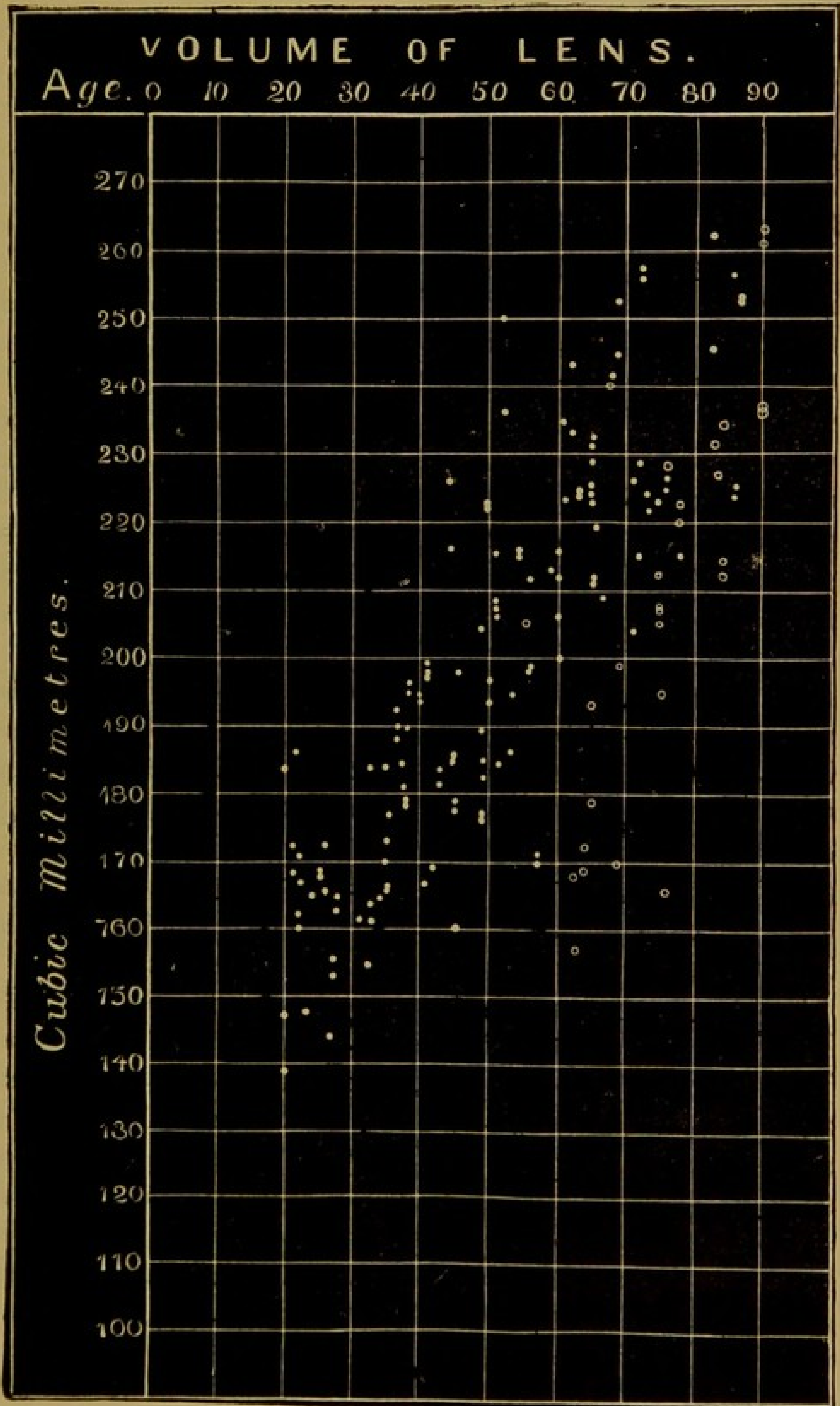

Chart showing volume in cub. mm. of each lens examined, and age of person from whom it was taken.

fore dependent upon the accuracy of these latter. The specific gravity of each lens was calculated separately, and is recorded separately in the tables. There is a considerable difference in different lenses, but in this respect age appears to exert no constant influence, for while there are lenses of high specific gravity and lenses of low specific gravity in each decade of life the average remains nearly constant throughout. The figures show a slight rise from 20 to 40, and a slight fall from 40 to 60, but the changes are too small to be accepted as positive; a very slight alteration in the corresponding weights or volumes would reverse them. The only inference which can be safely drawn from this column is that the specific gravity of the lens is, on the average, nearly the same at different periods of adult life. The continual increase in the weight of the lens is clearly not due to a change of density, but to an increase of volume.

I have not been able to find many published statements concerning the specific gravity of the human lens. Nunneley ascertained it in a few cases, and the average was 1112, but this can only be taken as a very rough estimate, for the observations were only four in number, and there were considerable differences even among these. Chevenix, as quoted by Nunneley, puts the average at 1079; this accords very closely with my own results.

Column D shows the *average diameter* in each decade. Like the weight and the volume it continually increases. With regard to this column a special source of error has to be noted. When the lens is freed from the traction of the suspensory ligament it undoubtedly alters its form to some extent, the alteration being towards the spherical, and being greater or less according to the elasticity of the lens. It is probable, therefore, that the diameters here given are slightly too small for the living eye, and that the error is greater in the earlier decades than in the later. If, therefore, something must be added to each, and rather more to the younger than to the older, the real increase in transverse diameter during the forty years will be rather less than that indicated by the figures.

The antero-posterior diameter was not systematically measured in my investigations; the measurement is more difficult to make in a trustworthy manner than that of the transverse. The impression which I derived from mere inspection was very decidedly that the older lenses were larger in all ways than the younger, and in several instances in which I was able to compare a young and an old lens side by side, there was a more obvious increase in the anteroposterior diameter than in the transverse. Fortunately it is not necessary to rely upon this impression, for the data now before us afford some evidence on the point.

The volumes of spheres vary as the cubes of their diameters. If the crystalline lens were a sphere of constant specific gravity we could calculate its diameter, at each period of life, from the ascertained volume. The same is true of bodies which, like the lens, are not spherical, provided the *form* is alike in all, *i.e.* provided the several diameters vary in equal proportions. Now, it is quite certain that the form of the lens is not alike in all cases; there are individual variations, as in all living structures, and the average form probably is different at different periods of life. But, for the sake of experiment, I have supposed for a moment that the form remains unaltered throughout life, and I have calculated, in the series before us, what the increase of transverse diameter would then be in each decade. These calculated diameters are set down in column E. On comparing columns D and E it appears that the actual increase, obtained by measurement, is on the whole not greater than it would be if the lens enlarged in equal proportion in all diameters. This is a proof that the increase is not limited to the transverse diameter.

Figure 2 shows in a diagrammatic way the relative sizes of two average lenses, aged 25 and 65 respectively. It is not to be supposed that it represents the exact form of the average lens at either age. It simply presents to the eye transverse sections of two imaginary lenses identical in form, but differing in volume, in the proportion of 163 to 225. The diameters of the figures vary as the cube-roots of these volumes, viz. as 8·67 to 9·65. For the sake of comparison the outline of the smaller lens is inscribed within the larger, the zone external to this line thus represents the addition which is made during the forty years. The volume of the added part equals rather more than one third of the smaller lens.

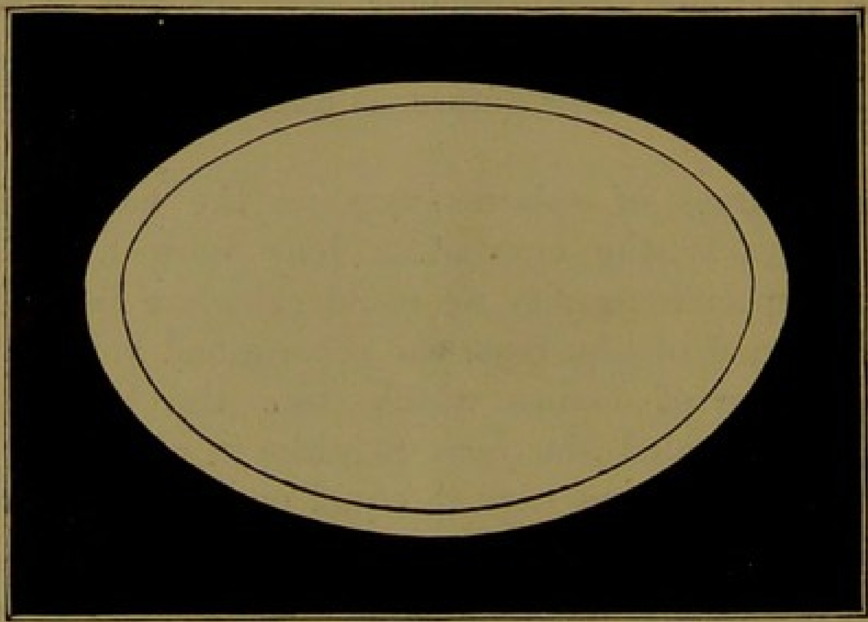

FIG. 2.—Diagram showing size of crystalline lens at the age of 25 (inner line) and 65 (outer boundary).

If we look to the statements which have been published concerning the dimensions of the adult lens, we find very considerable discrepancies. In Merkel's table in the Handbook of Graefe and Saemisch, which places side by side measurements of the several parts of the eye made by many observers, the transverse diameter of the lens is given variously from 8·1 mm. to 10·3 mm., average 9·3 ; the antero-posterior diameter from 3·6 mm. to 5·5, average 4·25. These discrepancies are now intelligible enough in view of the continual enlargement of the lens ; the averages have little value, as they are not assignable to any particular period of adult life.

I have not included the last two decades in the foregoing analysis, because the observations are too few to afford trustworthy averages; it will be seen, nevertheless, that the increase in weight and volume is continuous in these also. In the last decade but one the increment is small by comparison with that belonging to every other period; a reference to Table VII shows that the lenses in question belong almost exclusively to the earlier years of the decade.

The continuous growth of the lens being thus established as an anatomical fact, it is interesting to regard the matter from a physiological point of view. The lens is derived by development from the cuticular epiblast; its growth, as pointed out in the foregoing quotation from Otto Becker, is closely analogous to that of the cuticle. But its cells, unlike those of the cuticle, have no free surface, and are not cast off as they grow old. They multiply within a closed capsule, and are laid down layer upon layer in such a way that the older are surrounded by the younger. This unique structural arrangement seems to afford a natural explanation of the continuous enlargement. With regard to both characteristics the lens probably stands alone among all the organs of the body.

Certain of the physiological peculiarities of the senile eye may perhaps find their explanation in the continuous growth of the lens. For example, *hypermetropia acquisita.* The emmetropic eye tends when middle life is past gradually to become hypermetropic, and in old age often acquires a considerable degree of hypermetropia. Donders (p. 206) ascribes the change partly to a more uniform density throughout the layers of the lens, partly to a flattening of its refracting surfaces. Now it is obvious that a symmetrical enlargement like that indicated by the figures would involve some flattening of the surfaces, and it is not unlikely that the enlargement is not as a rule symmetrical, but that the new material is added in rather larger proportion near to the equator than at the poles, for the formation of new fibres seems to occur chiefly in the equatorial region. If the refracting surfaces are built up more rapidly in proportion at the periphery than at the centre, a still further flattening will occur. This may perhaps prove to be the cause of the hypermetropia of old age.

Again, with regard to the shallowness of the anterior chamber, which is commonly observable in advanced life. This has been attributed to an advance of the whole lens towards the cornea (Donders, p. 206). No explanation of this supposed advance has been forthcoming, however, and it is not easily reconcilable with the actual change of refraction, for an advance of the lens produces *per se* not hypermetropia but myopia. I have little doubt that the diminished depth of the anterior chamber in the healthy senile eye is simply an expression of the increased thickness of the senile lens.

Apart from the main object and result of this research, one or two points which were observed incidentally remain to be noticed.

The close relation of cataract to senility comes out in a striking manner. Between the ages of 20 and 49 no single instance of any opacity was met with among the sixty-six lenses examined. Between 50 and 59 two lenses* out of twenty-two, *i.e.* 9 per cent., presented the earliest signs of cataract in the form of slight cortical opacities at the equator. Between 60 and 69 nine out of thirty-two, *i.e.* 28 per cent., were affected similarly or to a greater extent. Between 70 and 90 thirty-four lenses were examined, and of these no less than sixteen, *i.e.* nearly 50 per cent. were affected in like manner. Thus there were altogether twenty-seven lenses which were more or less cataractous. Two of them were completely cataractous, four presented nuclear opacity, the remaining twenty-one all showed cortical opacities which appeared to be very near to the capsule, and which in nearly all cases were limited to the equatorial zone. In many of these

* These were both from the same individual; one was damaged in extraction, and does not appear in detail in the table.

the opacities would, I think, from their position, have been hardly discoverable with the ophthalmoscope.

As already stated, the cataractous lenses are shown on the chart by circles, and it is interesting to note that, as a rule, the circles stand at a decidedly lower level than the dots in the same decade ; in other words, the lenses in which cataract was beginning were as a rule smaller than transparent lenses of the same age. According to the latest researches of Becker the commencement of senile cataract is due to the separation from each other of certain of the layers of lens-fibres in consequence of advancing sclerosis and shrinkage, the separation occurring first just where the capsule and subjacent fibres are most affected by the traction of the suspensory ligament, viz. at the equator. My observations are entirely favourable to this view. The subnormal size of the cataractous lenses, which was observable even in those which presented only very slight cortical opacities, suggests that the formation of cataract is perhaps preceded by a period in which the rate of growth gradually falls below the normal.

In two instances* I was able to compare a completely cataractous lens with a fellow lens which presented only some slight cortical opacities at the equator. In both cases the opaque lens was very much smaller and lighter than its fellow. Here there was evidently a shrinking or shrivelling as the result of the degenerative process.

Finally, I may mention that, in the removal of this series of lenses from the eyes of dead subjects, I obtained constant experience of a fact which has been pointed out by Pagenstecher and others, namely, that the attachment of the lens to its suspensory ligament, and especially to the hyaloid membrane of the vitreous at its posterior surface, is very much weaker in the senile than in the youthful eye.

* Table VI, No. 67, and Table VII, No. 31.

TABLE I.—*Averages.*

Age.		A Weight. mgr.		B Volume. cub. mm.		C Spec. grav.		D Diameter. mm.		E Diameters proportionate to volumes.
20 to 29	...	174	...	163	...	1067	...	8·67	...	8·67
30 to 39	...	192	...	177	...	1085	...	8·96	...	8·91
40 to 49	...	204	...	188	...	1085	...	9·09	...	9·10
50 to 59	...	221	...	205	...	1078	...	9·44	...	9·36
60 to 69	...	240	...	225	...	1067	...	9·49	...	9·65
70 to 79	...	(245)	...	(227)	...	(1079)	...	(9·64)	...	—
80 to 90	...	(266)	...	(244)	...	(1090)	...	(9·62)	...	—

N.B.—Above the age of 69 the number of transparent lenses examined was much smaller than in the earlier decades; the averages are given in brackets, and must be taken as less certain than those belonging to the earlier periods. For details see the following tables.

Table II.—*Ages 20 to 29.*

No. in Register.	Age.	Sex.	Weight.	Volume.	Sp. gr.	Diameter.
47	20	M.	159	147	1081	8·5
			—	—	—	—
48	20	M.	—	—	—	—
			195	183	1066	9·
66	20	M.	—	—	—	—
			151	139	1086	8·75
35	21	M.	178	168	1060	9·
			180	172	1046	9·
46	21	F.	167	160	1044	8·5
			180	162	1049	8·5
60	21	M.	—	—	—	—
			195	186	1048	9·
44	22	F.	180	171	1053	8·25
			175	167	1048	8·25
29	23	F.	—	—	—	—
			152	148	1048	8·25
43	24	M.	175	165	1060	9·
			—	—	—	—
41	25	M.	176	168	1048	8·75
			178	168	1060	8·75
68	26	F.	190	172	1105	8·75
			184	166	1108	8·75
4	27	M.	—	—	—	—
			153	144	1062	—
58	27	M.	162	153	1059	8·5
			166	156	1064	8·5
70	28	M.	181	164	1104	8·75
			180	162	1111	8·75
	Average		3648÷21 =174	3419÷21 =163	1067	173·5÷20 =8·67

In this and the following tables the upper figures in each bracket represent the right eye, the lower figures the left eye. Where no figures are given, it is to be understood that the lens-capsule was broken during extraction and the specimen thereby rendered useless.

Table III.—*Ages 30 to 39.*

No. in Register.	Age.	Sex.	Weight.	Volume.	Sp. gr.	Diameter.
39	32	M.	167	155	1077	8·75
			172	161	1068	8·75
80	33	M.	177	164	1079	8·75
			173	161	1074	8·75
26	34	M.	195	184	1060	9·
			177	165	1073	9·
3	35	F.	197	173	1139	—
			—	—	—	—
7	35	F.	180	170	1059	9·
			—	—	—	—
18	35	M.	183	166	1102	—
			184	166	1108	—
51	36	M.	192	184	1043	9·
			192	177	1085	9·
34	37	M.	196	192	1021	8·75
			—	—	—	—
76	37	F.	206	188	1096	9·
			206	190	1084	9·
42	38	M.	199	184	1081	8·75
			201	190	1058	8·75
8	38	M.	199	179	1111	9·
			—	—	—	—
75	38	M.	197	181	1088	9·
			195	179	1089	9·
72	39	M.	215	196	1097	9·5
			216	195	1108	9·5
	Average		4219÷22 =192	3905÷22 =177	1085	170·25÷19 =8·96

Table IV.—*Ages 40 to 49.*

No. in Register	Age.	Sex.	Weight.	Volume.	Sp. gr.	Diameter.
71	40	M.	217 216	194 195	1118 1108	9· 9·
33	41	M.	178 —	166 —	1072 —	8·75 —
86	42	M.	220 —	198 —	1111 —	9· —
38	42	F.	217 215	199 198	1090 1086	9·5 9·5
85	42	M.	189 —	169 —	1118 —	9· —
77	43	M.	196 194	183 181	1071 1071	9·25 9·25
87	44	M.	238 230	226 217	1053 1060	9· 9·
83	45	F.	194 191	178 160	1090 1194	8·75 8·5
16	45	M.	— 194	— 185	— 1049	— 9·5
5	45	M.	204 198	185 179	1103 1106	— —
25	46	M.	211 —	198 —	1066 —	— —
20	49	M.	199 —	189 —	1053 —	9·5 —
45	49	M.	193 189	185 177	1043 1068	9· 9·
1	49	M.	203 196	183 177	1126 1107	— —
6	49	F.	214 —	204 —	1049 —	— —
Average			4696÷23 =204	4326÷23 =188	1085	154·5÷17 =9·09

Table V.—*Ages 50 to 59.*

No. in Register.	Age.	Sex.	Weight.	Volume.	Sp. gr.	Diameter.
24	50	F.	208	197	1056	9·5
			213	194	1091	9·5
32	50	M.	240	222	1081	10·
			242	222	1090	10·
13	51	M.	226	208	1086	9·
			222	206	1078	9·
22	51	M.	227	214	1060	10·
			226	207	1091	10·
19	52	M.	—	—	—	—
			191	184	1038	—
64	52	M.	251	237	1069	9·5
			257	250	1029	9·5
23	53	F.	204	186	1097	9·5
			209	196	1066	9·5
11	54	M.	227	214	1060	9·
			227	214	1060	9·
49	55	M.	**220***	**205**	**1073**	**10·**
			—*	—	—	—
10	56	M.	—	—	—	—
			234	211	1109	9·5
17	56	M.	219	198	1106	9·25
			217	199	1090	9·25
65	57	M.	186	170	1094	9·
			188	171	1099	9·
50	59	M.	225	213	1056	9·75
			—	—	—	—
	Average		4639÷21 =221	4313÷21 -205	1078	188·75÷20 =9·44

N.B.—The ***thick figures*** in this and subsequent tables represent lenses which were not perfectly transparent; they are not included in the averages.

* Slight cortical opacities at the equator.

Table VI.—*Ages 60 to 69.*

No. in Register.	Age.	Sex.	Weight.	Volume.	Sp. gr.	Diameter.
40	60	M.	215 219	200 206	1075 1063	9·5 9·5
88	60	F.	239 236	216 213	1106 1108	9· 9·
61	61	M.	248 242	235 223	1055 1085	9·5 9·5
15	62	F.	171* 179†	157 168	1090 1065	— —
30	62	M.	251 252	233 243	1077 1037	9·5 9·5
52	63	M.	239 240	224 224	1067 1071	9·75 9·75
84	63	M.	190‡ 183‡	172 169	1105 1083	9· 9·
28	65	M.	231 223	225 211	1027 1057	9· —
36	65	F.	236 228	224 211	1054 1080	9·5 9·5
53	65	M.	245 237	228 223	1075 1063	9·25 9·25
54	65	M.	247 247	231 232	1069 1065	9·5 9·5
59	65	F.	199‡ 200‡	179 193	1111 1031	8·5 8·5
63	66	M.	226 236	209 219	1081 1078	9·5 9·5
90	68	M.	263§ 263	240 242	1096 1087	9·75 9·75
56	69	F.	264 260	252 245	1044 1061	10· 10·
67	69	M.	184‖ 216‡	170 199	1082 1085	9·5 9·75
	Average		5524÷23 =240	5169÷23 =225	1067	208·75÷22 =9·49

* Nuclear opacity, with striæ radiating from it.
† Slight nuclear opacity.
‡ Slight cortical opacities at equator.
§ One flake of opacity deep in cortex.
‖ Completely cataractous.

Table VII.—*Ages 70 to 79.*

No. in Register.	Age.	Sex.	Weight.	Volume.	Sp. gr.	Diameter.
12	71	M.	237 —	226 —	1049 —	— —
91	71	M.	— 220	— 204	— 1078	— 9·25
69	72	M.	249 237	228 215	1092 1102	9·75 9·5
92	72	M.	282 284	256 258	1100 1100	9·5 9·5
2	73	M.	244 243	225 222	1084 1095	— —
55	75	M.	218* 212*	205 195	1063 1087	9·25 9·25
57	75	F.	229† 231	213 222	1075 1041	9·75 10·
81	75	F.	225† 222†	207 207	1087 1072	9·5 9·5
31	76	M.	252† 175‡	228 166	1105 1054	10· —
93	76	M.	239 242	224 226	1067 1071	10· 10·
9	78	F.	230 —	215 —	1070 —	9·25 —
74	78	F.	241† 244†	220 223	1095 1094	9·75 9·75
	Average		2938÷12 =245	2721÷12 =227	1079	86·75÷9 =9·64

* Slight nuclear opacity.

† Slight cortical opacities at equator.

‡ Completely cataractous; cortex shrivelled.

TABLE VIII.—*Ages* 80 *to* 89 (and 90).

No. in Register.	Age.	Sex.	Weight.	Volume.	Sp. gr.	Diameter.
73	82	M.	270	245	1102	10·
			283	262	1080	9·75
82	83	F.	247*	231	1069	9·5
			245*	227	1079	9·5
95	83	M.	235*	213	1103	9·
			234*	215	1088	9·
89	84	F.	254*	234	1085	9·75
			—	—	—	—
94	86	F.	249	224	1112	9·5
			249	226	1102	9·5
78	87	M.	273	253	1079	10·
			273	253	1079	10·
79	90	M.	252†	237	1063	9·75
			254†	237	1072	9·75
62	90	M.	277*	263	1053	10·
			277*	261	1061	10·
	Average		1597÷6 =266	1463÷6 =244	1090	57·75÷6 =9·62

* Slight cortical opacities at equator.

† Considerable cortical opacities at equator.

(*January* 11*th*, 1883.)

P.S.—August, 1883. Fourteen lenses, belonging chiefly to the later decades, have been examined since this paper was read. The results are incorporated in the tables as now given.

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