Remarks

ON

THE INFLUENCE OF RAINY WINDS
ON PHTHISIS IN TWENTY-THREE PARISHES
OF NORTH DEVON

DURING THE 45 YEARS, 1860 TO 1904.

BY

W. GORDON, and J. R. HARPER,

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

M.R.C.S., L.R.C.P.,

PHYSICIAN TO THE ROYAL DEVON
AND EXETER HOSPITAL.M.O.H. BARNSTAPLE BOROUGH
AND RURAL DISTRICT, SURGEON
TO THE NORTH DEVON INFIRMARY.

THE influence of rainy winds on phthisis has been investigated by one of us (W. G.) in several districts of Devon¹ and in Exeter² over periods of ten years, and over periods of various length in different parts of the world.³ In each of these investigations the same result has been reached, namely, that populations exposed to strong prevalent rainy winds have a higher death-rate from phthisis than populations sheltered from them. The object of the present inquiry is to discover if the same relation of rainy winds to phthisis can be traced over a longer period in a considerable area, where reliable information can be obtained and where disturbing influences may be shown to be unimportant.

The Exmoor part of Barnstaple Rural District is known to both of us, and intimately known to one of us (J. R. H.). It presents exceptionally marked contrasts of shelter from, and exposure to, the prevalent strong rainy winds—SW., W., and NW.—its weather has been carefully observed, the characters of its soils can be satisfactorily stated, its inhabitants are of uniform race, the district is agricultural, and parish sanitation may be taken as uniform.

The parishes selected have been chosen because of the definiteness of their shelter and exposure. It is not pretended that either shelter or exposure is absolute in any of them, probably none are *absolutely* sheltered in all conditions of weather, but the contrasts between the "sheltered" parishes and the "exposed" is at least exceedingly marked, much more marked than can be found in most parts of England. Only female deaths over 5 years of age have been considered. Cases dying in hospitals or in the workhouse have, so far as possible, been referred to the parishes they came from; error from this source, if it exists, must be small.

As diagnosis may be reasonably expected to have been more accurate since Koch's discovery of the tubercle bacillus in 1881 simplified the conception of phthisis, the twenty years, 1885 (by which time knowledge of the fact must have been general) to 1904, have also been separately considered.

As the weather conditions during the ten years 1890 to 1899 were exceptional, the rainfall being small and the frequency of the north-west wind relatively much reduced, those years have also been considered by themselves.

It will be found that the results arrived at furnish striking confirmation of those previously obtained.

DESCRIPTION OF THE PARISHES.

The district under discussion forms roughly the western half of Exmoor, and is an irregular oblong, bounded on the north and west by the Bristol Channel, on the south by the estuary of the Taw as far as Barnstaple, and, east of Barnstaple, by an irregular line running eastwards over the foothills of the moor, to meet another, equally irregular, part of the eastern boundary of the county, which strikes northwards over the heights of Exmoor Forest to the coast. It is a country of steep hills and rapid streams, so that surface drainage is naturally good. The northern coast line is for the most part precipitous, broken here and there by deep and often wooded combs, but westward the hills fall gradually to a low sandy shore, as they also do southwards to the level banks of the Taw and the meadows round Barnstaple. East of Barnstaple the ground rises steeply, and becomes part of the convoluted table-land of the moor, which slopes gradually upward from west

to east.* The position of the parishes is shown in the map subjoined (p. 1170).†

This district is composed of the following materials:

1. Igneous rock, in patches, impervious.
2. Argillaceous slates } impervious, apt to become clayey.
3. Morte slates }
4. Ilfracombe beds } less impervious than 2 and 3.
5. Lynton beds }
6. Pilton slates }
7. Hangman grits } all very pervious.
8. Baggy beds }
9. Foreland grits }
10. Pickwell Down sandstone }

The extent to which these enter into the structure of each parish will be presently considered.

The annual prevalence of the different winds at Barnstaple since 1870 is given in Table I, the annual rainfall at Barnstaple since 1860 in Table II, and the rainfall at

TABLE I.—Direction of the Wind at Barnstaple at 9 a.m.
(Kindly prepared for us by Mr. Wainwright.)

Year.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
1870	17	48	41	49	31	74	54	51
1871	—	—	—	—	—	—	—	—
1872	14	22	6	50	67	104	62	41
1873	12	23	37	43	58	89	55	48
1874	24	20	26	37	53	81	66	53
1875	23	34	51	40	61	71	55	30
1876	19	36	30	60	62	72	59	38
1877	15	18	28	40	56	94	57	57
1878	32	23	28	45	38	90	55	54
1879	22	39	31	63	49	76	46	49
1880	23	51	29	49	52	69	60	23
1881	16	46	33	37	49	77	69	38
1882	19	27	21	44	57	86	56	55
1883	26	31	26	36	67	63	61	55
1884	17	24	34	45	57	68	70	51
1885	33	44	34	39	52	67	52	44
1886	13	50	34	34	56	56	65	57
1887	33	58	43	20	42	68	44	57
1888	15	34	57	47	36	69	73	35
1889	8	23	42	35	26	83	86	62
1890	12	37	75	92	30	42	50	27
1891	12	18	93	79	38	53	61	11
1892	18	30	84	60	40	60	48	26
1893	16	30	101	55	37	50	57	19
1894	13	36	51	83	31	51	57	33
1895	6	45	75	52	41	72	40	34
1896	16	71	74	29	48	72	30	26
1897	8	52	77	48	49	86	21	24
1898	7	72	70	49	67	63	17	20
1899	6	46	70	51	61	96	23	12
1900	9	28	35	76	38	62	62	55
1901	7	32	66	107	27	24	41	61
1902	14	19	46	93	25	32	87	49
1903	6	20	23	99	32	49	76	60
1904	7	9	41	121	25	37	77	49
Total...	538	1200	1625	1886	1562	2306	1892	1409

Total number of days 12,418

* A good idea of the district can be gained from Bartholomew's reduced ordnance survey coloured contour map of North Devon, scale two miles to an inch.

† West Down (included as "sheltered" from south-west and west in a former paper) has been omitted because its position seems doubtful. Pilton, exposed to south-west and west (included in a former paper), has been omitted because in the forty-five years its boundaries have considerably altered.

various points in or close to the district during 1901 to 1904 in Table III. The inclusion of a few outside stations helps to make clear the distribution of the fall.

TABLE II.—Rainfall at Barnstaple.*

Year.	Inches.	Year.	Inches.	Year.	Inches.	Year.	Inches.	Year.	Inches.
1860	50.14	1870	28.79	1880	42.99	1890	29.67	1900	40.26
1861	37.15	1871	38.00	1881	38.09	1891	32.30	1901	33.40
1862	43.78	1872	57.96	1882	53.71	1892	25.99	1902	32.40
1863	40.17	1873	39.30	1883	44.24	1893	32.02	1903	45.76
1864	26.43	1874	41.96	1884	37.97	1894	38.26	1904	35.21
1865	39.36	1875	45.34	1885	37.71	1895	33.78		
1866	43.02	1876	39.95	1886	45.03	1896	32.01		
1867	39.34	1877	49.53	1887	29.43	1897	42.26		
1868	39.94	1878	44.08	1888	34.29	1898	31.62		
1869	39.72	1879	39.35	1889	30.86	1899	33.13		

* Kindly prepared for us by Mr. Wainwright.

TABLE III.—Rainfall at Several Places in and near the District.

Station.	Height in Feet.	Rainfall in Inches.			
		1901	1902	1903	1904
Lynmouth (Rock Ho.) ...	20	33.6	34.0	58.3	39.0
Barnstaple ...	25	33.4	32.4	45.7	35.2
Ilfracombe ...	35	36.1	33.3	53.2	37.0
Woolacombe ...	60	26.6	25.3	38.3	28.2
Pilton... ..	83	—	33.3	47.6	35.6
Lynmouth (Gwynallt) ...	300	38.0	35.9	61.9	41.4
Ilfracombe (Reservoir) ...	377	—	—	60.4	45.0
Marwood	400	—	—	59.7	—
East Down	399	—	44.3	—	—
Arlington	612	47.9	46.0	67.4	51.2
Stoke Rivers	767	—	—	—	50.4
Parracombe... ..	795	41.9	39.5	68.7	50.0
Martinhoe	808	38.5	36.2	61.4	44.5
Challacombe	925	52.3	55.5	79.7	64.5
Westward Ho	60	29.0	29.3	42.7	29.8
Northam	67	32.3	—	40.6	31.4
Instow	100	27.8	27.5	41.6	30.7
Simonsbath... ..	1,098	63.7	—	86.6	—

SOIL AND EXPOSURE OR SHELTER OF PARISHES.

In the following brief statement the parishes have been arranged (as they will be in the subsequent tables) approximately in order of shelter and exposure, beginning with the most sheltered and ending with the most exposed. In assessing shelters and exposures local knowledge has been laboriously supplemented by study of the ordnance survey maps, 1 and 6 in. to the mile.

Bittadon.—A very small parish, very well sheltered from SW., W., and NW. winds. Except for a small patch of igneous rock, its soil is composed of argillaceous slate.

Brendon.—A large parish, mostly moorland, with its dwellings very well sheltered from SW., W., and NW. winds. The village stands on Lynton beds; the parish generally is on Lynton grits and slates.

Highbray.—The whole parish may be regarded as well sheltered from SW., W., and NW. winds. The village is on Baggy beds, the extreme north of the parish on Morte slates, the central and greater part of it on Pickwell Down sandstone with bands of argillaceous slate, and the southern part on slates, passing into grits and sandstones.

Challacombe.—Excepting one farm exposed to the NW., this parish is sheltered from SW., W., and NW. The village is on the boundary between Ilfracombe beds and

Morte slates. The north of the parish is on slate, with bands of limestone (Ilfracombe beds), and the southern part on argillaceous slate.

Trentishoe.—The houses are all sheltered from SW., W., and NW., but in some places a short walk from a house leads into a very exposed situation. The village is on Hangman grits, and these and Ilfracombe beds form the soil of the parish.

Berrynarbor.—A long, straggling village in a combe running up southwards from the Bristol Channel. It is well sheltered from SW. and W., and most of it from NW.; but some houses are exposed to NW. The parish is on Ilfracombe beds.

Arlington.—The village is well sheltered from SW. and W.; not quite so well from NW. The east of the parish is well sheltered from all three, but some houses in its western part are open to W. and NW. The village is on Morte slates, as is also the parish generally, except its southern part, which is partly composed of Pickwell Down sandstone.

East Down.—Except at its SW. corner, this whole parish is well sheltered from SW., W., and NW. winds. At this corner three farms are exposed to SW. The village is on Morte slates, which constitute most of the soil of the parish. There is a little sandstone.

Kentisbury is probably sheltered from SW. and W., but partly at least exposed to NW. It is on Ilfracombe beds.

Parracombe seems well sheltered from SW. and W., but is fully open to the NW. It is on Hangman grits and Ilfracombe beds—the village on the latter.

Martinhoe is sheltered from SW. and W., but open to NW.; the village high and exposed. The northern part, with the village, is on Hangman grits, the southern on Ilfracombe beds.

Combemartin.—A large village in a combe, running up from the Bristol Channel towards the south-east, and so well sheltered from SW. and W., but peculiarly open to the NW. The village is on Ilfracombe beds, the soil of the parish being partly Ilfracombe beds, partly Hangman grits.

Countisbury.—There is some difficulty in assessing the shelter and exposure of this parish. The village at least is exposed to SW., W., and NW. Foreland grits and sandstones form the soil.

Bratton Fleming.—The east of the parish is well sheltered from SW., W., and NW., but the village itself is well exposed to SW. and W. Some farms are exposed, some sheltered. The village stands on Pickwell Down sandstone, which forms the southern part of the parish, the northern being composed of Morte slates. Some igneous rock occurs in patches.

Georgeham.—The village and most of the houses lie low, exposed to W., partly to SW., but sheltered from NW. The parish is on Baggy beds, Pickwell Down sandstone, and Pilton beds, the village on Baggy beds.

Shirwell.—The village itself is sheltered from SW., W., and NW., but the parish is a large one, and, except the village, is generally exposed to SW. and W., especially Shirwell Cross, which is also exposed to NW. The village is on Baggy beds, the parish on these, Pilton beds, and Pickwell Down sandstone.

Morthoe.—Exposed to SW., W., and NW. The village is on Morte slates, the rest of the parish on Morte slates (the main part) and Pickwell Down sandstone.

Braunton.—A large village lying fairly low. Exposed to SW. and W., but sheltered from NW. The soil consists of Pilton Beds.

Heanton Punchardon.—Low lying, swept by SW. and W. Sheltered from NW. On Pilton slates.

Ashford.—Exposed to SW. and W. Sheltered from NW. Lies rather low. On Pilton slates.

Goodleigh.—Exposed SW. and W. On Pilton slates.

Stoke Rivers.—Exposed to SW., W., and NW. The village is on the boundary between Baggy beds and Pilton slates. The parish is on Baggy beds, Pickwell Down sandstone, and Pilton slates.

Loxhore.—The village lies very high and is very exposed to SW., W., and NW. Some other houses are very exposed, but some are sheltered. The village is on Pickwell Down sandstone. The north of the parish is on Morte slates, the south on the sandstone. A few patches of igneous rock exist.

Reviewing, as far as is possible with these data, the soil

of the parishes and taking into account their population, it may be fairly said that the villages classed in the

TABLE V.—*Female Phthisis Death-rates from 1860 to 1904, as in Table IV. arranged in Quinquennial Periods.*

Period.	Barnstable. Total Rainfall 5 Years.	I.—Sheltered from SW., W., and NW.	II.—Exposed only to NW.	III.—Exposed to SW. and W. Some to NW.	Population accord- ing to Census of—	Sheltered.	Exposed.
1830-1834	197.67	2.1	2.5	1.5	Mean of 1851 and 1871	1,194	3,288
1865-1869	201.38	0.8	1.6	1.7	1871	1,127	3,033
1870-1874	206.01	1.0	1.6	2.1	1871	1,039	2,883
1875-1879	212.25	1.5	2.8	1.8	1881	1,071	3,038
1880-1884	217.00	1.5	2.2	1.8	1881	974	3,139
1885-1889	177.32	1.1	0.8	1.6	1891		
1890-1894	158.21	0.0	0.5	0.8	1891		
1895-1899	172.10	0.0	0.1	1.2	1901		
1900-1904	187.03	0.7	0.4	1.0	1901		

TABLE VI.—*Female Deaths from Phthisis over 5 Years of Age in the Same Area during the Twenty Years 1885-1904.*

Name of Parish.	Total Deaths. Twenty Years, 1885-1904.	Female Population.			Death-rate per 1,000 per Annum.
		1891.	1901.	Mean.	
I. Sheltered from SW., W., and NW. :					
Bittadon	0	23	30	27	—
Brendon	0	139	129	134	—
Highbray	1	109	99	104	—
Challacombe	0	113	105	109	—
Trentishoe	2	45	32	38	—
Berrynarbor	3	340	316	328	—
Arlington	2	127	109	118	—
East Down	2	175	154	164	—
Tota's	10	—	—	1,022	0.91
II. Exposed to NW. only :					
Kentisbury	1	195	161	178	—
Parracombe	3	151	153	152	—
Martinhoe	0	84	95	90	—
Combemartin	8	731	815	773	—
Totals	12	—	—	1,193	1.03
III. Exposed to W. and SW., some also to NW. :					
Countisbury	1	125	155	140	—
Bratton Fleming	8	247	263	255	—
Georgeham	6	390	358	374	—
Shirwell	8	179	165	172	—
Morthoe	4	346	440	293	—
Brauntou	30	1,125	1,132	1,128	—
Heanton Punchardon	4	224	205	215	—
Ashford... ..	1	87	88	87	—
Goodleigh	5	119	129	124	—
Stoke Rivers	0	96	94	95	—
Loxhore	4	100	110	105	—
Totals	71	—	—	3,088	2.29

accompanying tables as "II. Exposed to NW. only" are on the most generally impervious soil, whilst those classed as "III. Exposed to SW. and W., some also to NW." are on the most generally pervious soil.

Again, on examining the rainfall of the north of Devon, it is seen that on the whole the heaviest rainfall is on the parishes in Class I, that is, "Sheltered from SW., W., and NW.," these being mostly very high-lying parishes, and the lowest rainfall is on the parishes in Class III, which include many large low-lying villages near the western coast or the banks of the estuary. It therefore cannot be alleged that dampness of subsoil accounts for the figures in the following tables. The relation of high rainfall on relatively impervious soil may, however, account for the relatively great mortality in Class II, Table V, during the wetter years.

From a review of the occupations of those dying of phthisis during the 45 years, so far as these are stated, it cannot be said that specially-occupational phthisis has to be taken into account. Thus 177 were "married," 24 were domestic servants, 11 "of no occupation," 8 dress-makers, 5 farm servants, 2 draper's assistants, 2 carriers, 1 governess, 1 milliner, the rest being given as "single" or "widows."

Table IV shows that over a period of 45 years, in an average population of 5,710 females, with a total of 334 deaths from phthisis, the phthisis mortality in the exposed parishes was greater than that in the sheltered parishes;

TABLE VII.—*Female Deaths from Phthisis over 5 Years of Age in the Same Area during the Ten Years, 1890-1899.*

Name of Parish.	Total Deaths, Ten Years, 1890-99.	Female Population.			Death-rate per 1,000 per Annum.
		1891.	1901.	Mean.	
I. Sheltered from SW., W., and NW. :					
Bittadon	0	23	30	27	—
Brendon	0	139	126	134	—
Highbray	0	109	99	104	—
Challacombe	0	113	105	109	—
Trentishoe	0	45	32	38	—
Berrynarbor	0	340	316	328	—
Arlington	0	127	109	118	—
East Down	0	175	154	164	—
Totals	0	—	—	1,022	0
II. Exposed to NW. only :					
Kentisbury	1	195	161	178	—
Parracombe	2	151	153	152	—
Martinhoe	0	84	95	90	—
Combemartin	2	731	815	773	—
Totals	4	—	—	1,193	0.33
III. Exposed to W. and SW., some also to NW. :					
Countisbury	1	125	155	140	—
Bratton Fleming	4	247	263	255	—
Georgeham	4	390	358	374	—
Shirwell... ..	1	179	165	172	—
Morthoe	2	346	440	393	—
Brauntou	13	1,125	1,132	1,128	—
Heanton Punchardon ..	3	224	205	215	—
Ashford... ..	0	87	88	87	—
Goodleigh	2	119	129	124	—
Stoke Rivers	0	93	94	95	—
Loxhore... ..	1	100	110	105	—
Totals	31	—	—	3,088	1.00

CHART I.

CHART II.

and Table V shows that this greater mortality can be traced in every quinquennial period of these 45 years except the first. This table also shows that in the wetter years the difference grew less, possibly because of the conflicting influence of soil. Soil influence, too, possibly caused the remarkable increase in death-rate in Class II during the wetter years.

Table VI shows that, in the twenty years during which diagnosis was probably more exact, the contrast between the mortalities of the exposed and sheltered populations became much more marked. This may possibly also be due in part to the removal of some disturbing influence, such as different conditions of sanitation in different parishes, since it is coincident with the general lowering of phthisis mortality, which is generally attributed in England partly to the introduction of better sanitary conditions.

Table VII shows that during the ten years in which the problem was simplified by the especially diminished frequency of the north-west wind, and by a lower rainfall not likely to produce a very damp soil, the contrast became exceedingly remarkable.

To further examine these relations of rain, wind, and phthisis, the accompanying charts have been prepared.

Chart 1 shows how remarkably the curves of rainfall (at Barnstaple) and phthisis mortality (all parishes included) resemble each other. The straight transverse lines indicate, in the rain chart, periods of greater or less fall, and the corresponding lines in the phthisis chart show the corresponding effects on mortality. The general trend of the phthisis mortality is downwards, but the very wet period (*a*, *b*) checked it, the very dry period (*c*, *d*) accelerated it, and the renewal of wet (*c*, *d*) slightly reversed it.

This chart also shows a correspondence between the curve of rainfall and the curve of mortality in the sheltered parishes, which is perhaps an indirect effect through soil.

Table VIII, however, indicates (what has been abundantly proved elsewhere) that rainfall does not *by itself* increase phthisis mortality, and, from what has already been said about soil, its influence on the whole distribution of phthisis mortality in these parishes cannot be explained as an indirect effect through soil. It can only be, we submit, from the evidence here given, at least in large part, the result of the combined effect of wind and rain.

In confirmation of this conclusion, Chart 2 indicates a

rough resemblance between the sharply-interrupted curve of NW. wind frequency, and the also rather sharply-interrupted curve of mortality in the population exposed

TABLE VIII.—Rainfall and Phthisis.

Name of Parish.	Female Phthisis death-rate, 1885-1904.	Annual Rainfall (average 1901-4).
Morthoe (Woolacombe) ...	0.5	29.6 in.
Arlington (Court) ...	0.8	53.1 in.
Parracombe ...	0.9	50.0 in.
Martinhoe ...	0.0	45. in.
Challacombe ...	0.0	63.0 in.

to NW., and between the relatively steady sweep of the curve of SW. and W. wind frequency and the similarly steady sweep of the mortality curve of the population exposed to these winds.

Without insisting, however, on the points illustrated in Chart 2, we would submit that the figures now given bear out the experience of former investigations (already referred to) that *the death-rate from phthisis of populations exposed to strong prevalent rainy winds is greater than that of populations sheltered from them.*

Our best thanks are due to Mr. T. Wainwright of the North Devon Athenaeum for the immense trouble he has taken in preparing figures for us, and for the invaluable information placed at our disposal; also to Mr. J. G. Hamling of The Close, Barnstaple, for his invaluable and laborious help as a geologist, specially acquainted with the district, in dealing with the question of soils.

We would also gratefully acknowledge the courtesy of the Registrar-General in permitting us to obtain information as to deaths in the workhouse and in Ilfracombe Hospital, and of Dr. Morris at the North Devon Infirmary, who was so good as to look up for us the deaths which had occurred there.

REFERENCES.

- 1 Wind Exposure and Phthisis, *Medico-Chirurgical Transactions*, vol. lxxxiv, and Remarks on the Influence of Wind on Phthisis, *BRITISH MEDICAL JOURNAL*, May 23rd, 1903.
- 2 The Influence of Rainy Winds, Soil, Poverty, and General Death-rate on the Phthisis Death-rate in Exeter, 1892-1901, *BRITISH MEDICAL JOURNAL*, January 14th, 1905.
- 3 The Influence of Rainy Winds on Phthisis, *Lancet*, January 7th and 14th, 1905.
- 4 Cf. Papers 1 and 3.