ALTERATIONS IN THE BLOOD OCCURRING IN
HAY FEVER.

By E. EMRYS-ROBERTS, M.D.,

PROFESSOR OF PATHOLOGY AND BACTERIOLOGY, UNIVERSITY COLLEGE,
CARDIFF.

For many years I have been the victim of hay fever; gradual in onset, the symptoms have increased in severity year by year, the only remission occurring when much rain has fallen during the summer months—for example, in 1912, a distinctly wet summer. The symptoms usually start towards the end of May and continue throughout the whole of June and generally through the greater part of July, gradually clearing up.

Last summer, soon after the symptoms set in on May 28th, I determined to try the effect of a vaccine, but, before doing so, I thought I would examine my blood. As the findings were so peculiar and had not been recorded in the accounts of this condition, I considered it more important to study the blood picture day by day (which I did at 10 a.m., with one exception, noted in Table I) than to attempt in any way to alter it by any method of treatment. I therefore endured the full effects of an aggravated attack—aggravated, since the summer of 1913 was particularly bright and dry. The greater part of the results obtained have been charted in the following tables.

It will be seen that throughout the attack the haemoglobin content varied from 65 to 80 per cent., the colour index from 0.4 to 0.8, and the red blood count showed an almost consistent polycythaemia, while the leucocyte count showed an equally marked leucopenia. The polycythaemia is unassociated with either an enlarged spleen or cyanosis.

The differential leucocyte count showed a diminution of polymorphs, a marked increase of large mononuclears and transitionals, a definite increase of eosinophiles, and the presence of occasional mast cells. The variation in rouleaux formation was not great. No correlation to the symptoms could be adduced in the case of the blood platelets, the presence of phantom cells was noted throughout, and particularly noticeable were the large numbers, sometimes amounting to 5 per cent. of the total count, of "dead" leucocytes—that is, leucocytes whose nuclei had undergone complete degeneration and whose protoplasm had become unrecognizable. By the study of forms intermediate between healthy leucocytes and "dead" leucocytes it was possible to determine that by far the largest proportion were derived from large mononuclears and transitionals. In addition it was also noted that, throughout the attack, many of the leucocytes, more especially the large mononuclears and transitionals, exhibited well-marked vacuoles both in protoplasm and nucleus. It was also noticed that the red blood corpuscles showed decided variations in relative size, macrocytes and microcytes being always commonly found while distortions in shape were by no means uncommon, almost amounting to a definite poikilocytosis. The fusion of several red blood corpuscles into the form of a rosette was noted from time to time. Polychromatosis was noted on June 16th and 24th. No nucleated reds were seen at any time. The size and staining properties of the blood platelets varied considerably, sometimes they were uniformly small, at other times there would be many large forms scattered about, while sometimes they would be stained deeply, at other times quite lightly.

In making the differential counts it was found essential to count both at the periphery of the smear and also at

TABLE I.

Date.	Weather.	Symptoms.	Haemoglobin.	Colour Index.	Red Blood Corpuscles (Thousands).	Leucocytes (Hundreds).	Polymorphs.	Large Mononuclears.	Lymphocytes.	Eosinophiles.	Mast Cells.	Rouleaux Formation.	Blood Platelets.	Phantom Cells.	Dead Leucocytes.
1913.			%				%								
June 5 ...	H D R	H	70	0.5	6984	72	61.3	13	17.3	7.3	1.0	Fair	In great excess	Few	++
" 6 ...	C D R	H C A	70	0.4	8184	42*	64.25	6	20.0	9.5	0.25	Fair	In excess	Few	++
" 7 ...	C D R	H S	60	0.5	5112	56	62.0	12	19.2	5.6	1.0	Good	In slight excess	Few	+
" 9 ...	C D	Nil	70	0.5	6296	48	62.25	8.5	24.0	4.75	0.5	Good	In excess	Many	++
" 10 ...	C R	H	70	0.5	6288	36	63.0	7.75	21.5	6.0	1.0	Good	In great excess	Many	++
" 11 ...	C B	H	70	0.5	6016	46	63.35	8.6	22.0	4.8	0.8	V.g.	In excess	Few	++
" 13 ...	C D-B S	H S	60	0.5	5768	54	57.2	9.8	24.2	7.4	0.8	Good	In excess	Few	++
" 14 ...	C S	H S C	65	0.4	6840	62	54.4	12.0	27.8	5.6	0.2	V.g.	In excess	Few	++
" 16 ...	H B	H S C	70	0.5	6712	70	57.6	13.2	22.4	5.8	1.0	V.g.	In great excess	Many	++
" 17 ...	H B	H S C	70	0.6	5856	50	54.1	15.0	18.5	11.0	1.3	V.g.	In great excess	Many	++
" 18 ...	C D	†	75	0.8	4568	40	68.3	10.0	16.0	5.3	0.3	V.g.	In excess	Few	++
" 19 ...	C B	H S C	70	0.6	5912	30‡	64.4	12.6	14.8	7.2	1.0	V.g.	In excess	Few	++
" 20 ...	C D	H S C	65	0.5	6344	38	63.1	13.3	15.3	7.5	0.6	V.g.	In excess	Few	++
" 21 ...	C D	S C	65	0.6	5632	50	63.5	15.3	13.3	7.3	0.3	V.g.	In slight excess	Few	++
" 22 a.m.	H B	H S C	—	—	—	—	61.8	7.5	20.3	9.6	0.5	V.g.	In slight excess	Many	++
" 22 p.m.	H B	H S C A	—	—	—	—	60.8	9.3	23.3	5.6	0.8	V.g.	In slight excess	Many	++
" 23 ...	C D S	H S C	75	0.7	5112	42	54.2	12.4	23.5	9.1	0.4	V.g.	In slight excess	Many	++
" 24 ...	C D S	H S C	65	0.4	7306	82	59.4	11.4	23.6	5.2	0.4	V.g.	In excess	Many	5.5%
" 25 ...	C D	H S C	75	0.7	5424	62	51.3	13.5	26.3	8.0	0.8	V.g.	In excess	Many	++
" 26 ...	C B	H S C	75	0.5	6760	64	60.0	12.0	21.5	5.8	0.6	V.g.	In excess	Very many	++
" 27 ...	H B	H S C	75	0.4	7960	64	55.2	11.4	24.5	8.1	0.5	V.g.	In slight excess	Very many	++
" 28 ...	H B	H S C A°	80	0.7	5688	52	61.6	10.5	22.6	4.8	0.3	V.g.	Very few	Many	++
" 29 ...	H B	H S C A°	—	—	—	—	52.0	8.8	30.4	8.2	0.6	V.g.	Few	Many	++
" 30 ...	H B	H S C A°	75	—	6256	40	64.0	11.0	18.5	6.5	0	V.g.	Few	Many	+++

In "Weather" H = hot, D = dull, R = rain, C = cold, B = bright, S = showery.

In "Symptoms" H = headache, C = coryza, A = asthma, S = sneezing.

* Three estimations.

† From 5.40 a.m. to 6.10 a.m. typical attack of asthma; during rest of day no symptoms.

‡ Two estimations.

° From 3 a.m. to 5 a.m. typical attack of asthma.

TABLE II.

Date.	Weather.	Symptoms.	Haemo- globin.	Colour Index.	Red Blood Corpuscles (Thousands).	Leucocytes (Hundreds).	Polymorphs.	Large Mono- nuclears.	Lympho- cytes.	Eosino- philes.	Mast Cells.	Rouleaux Formation.	Blood Platelets.	Phantom Cells.	Dead Leucocytes.
1913. July 1	H B	H C S	75	0.6	5,600	76	67.4	9.8	17.2	5.4	0.2	Poor	In excess	Many	++
" 2	H B	H C S A	80	0.6	6,528	56	56.4	15.2	19.4	9.0	0	V.g.	In slight excess	Few	+
" 3	H B	H C S A	—	—	—	—	41.8	13.3	37.0	7.1	0.6	V.g.	In excess	Many	+
" 4	H D	H C S A	75	0.6	6,008	66	66.0	10.6	16.0	6.0	1.4	V.g.	In slight excess	Many	++
" 5	C D	H C A	85	0.7	5,656	94	64.2	15.2	12.2	7.8	0.6	V.g.	In excess	Very few	+
" 7	C D	H A	80	0.7	5,760	64	64.2	11.8	15.8	8.0	0.2	V.g.	Not in excess	Many	+
" 8	C D	A	80	0.7	5,824	64	64.8	10.0	13.6	11.0	0.6	V.g.	Not in excess	Many	+
" 9	C R	C A	80	0.7	5,608	76	55.0	13.5	17.8	13.3	0.3	V.g.	In excess	Many	+
" 10	C D	A	80	0.6	5,808	66	55.1	11.0	19.1	13.8	0.8	V.g.	In excess	Many	+
" 11	C D	C A	80	0.6	5,920	63	55.4	9.4	22.6	13.2	1.4	V.g.	In great excess	Many	++
" 12	H D	H C A	80	0.7	5,664	58	54.2	17.2	14.6	13.8	0.2	V.g.	In great excess	Many	++
" 13	H D	H C S A	—	—	—	—	48.2	17.0	19.7	13.7	1.2	V.g.	In slight excess	Many	+
" 14	C D-B	H C S A	80	0.6	6,528	56	58.6	13.6	17.8	9.2	0.8	V.g.	In great excess	Many	++
" 15	H B	H C S A	80	0.7	5,192	58	65.8	7.6	17.3	8.5	0.6	V.g.	In excess	Many	+
" 16	H B	H C S A	80	0.6	6,328	66	56.8	13.6	25.6	3.8	0.1	V.g.	Very few	Very many	++
" 17	C D	Nil	—	—	—	—	59.6	8.2	22.6	9.0	0.6	V.g.	In excess	Few	++
" 18	C D	Nil	—	—	—	—	68.0	6.6	14.3	11.0	0	V.g.	In excess	Few	++
" 19	C D	Nil	—	—	—	—	65.0	16.7	12.0	6.2	0	V.g.	Few	Few	++
" 20	H B	Nil	—	—	—	—	65.4	10.8	17.0	6.6	0.2	V.g.	Few	Few	+
" 21	H B	C	—	—	—	—	62.0	13.7	18.4	5.3	0.4	V.g.	Few	Few	+
" 23	H B	C	—	—	—	—	61.6	21.2	12.0	5.2	0	V.g.	Almost absent	Few	+
" 24	H B	Nil	—	—	—	—	45.6	29.2	12.6	12.6	0	V.g.	Few	Very few	++
" 25	H B	Nil	—	—	—	—	65.2	9.8	18.0	7.0	0	V.g.	In excess	Few	++
" 26	H B	A	—	—	—	—	54.8	14.6	21.6	8.8	0.2	V.g.	In excess	Few	++

TABLE III.

	Date.	Poly- morphs.	Large Mono- nuclears.	Lympho- cytes.	Eosino- philes.	Mast Cells.	Rouleaux Forma- tion.	Blood Platelets.	Phantom Cells.	Dead Leuco- cytes.	Notes.
A.	1913. June 29	% 53.2	13.4	24.2	8.0	1.2	V.g.	In excess	Many	++	Female, aged 65; first attack, 1885; yearly since; headache; coryza; sneezing; asthma; taken on bright hot day.
B.	July 1	62.0	13.2	18.8	6.0	0	V.g.	Very few	Many	+	Female, aged 30; first attack, 1902; as above; asthma rarely.
C.	" 2	56.8	16.8	18.0	8.0	0.4	V.g.	In slight excess	Few	+	Male, aged 27; first attack, 1900; as above; asthma rarely.
D.	" 2	49.2	14.2	21.6	14.6	0.4	V.g.	Not in excess	Few	+++	Female, aged 42; first attack, 1911; as above; asthma especially bad.
E.	" 2	67.0	12.0	16.6	4.0	0.4	V.g.	In slight excess	None	++	Female, aged 26; first attack, 1907; as above; but no asthma.
F.	" 3	61.0	13.2	20.2	4.6	1.0	V.g.	Not in excess	None	++	Male, aged 37; first attack many years ago; as above; asthma very rarely.
G.	" 5	63.8	16.4	13.8	5.8	0.2	V.g.	Not in excess	Many	+	Male, aged 22; a sufferer from chronic asthma of six years' duration, with no seasonal variation.

some little distance therefrom, as the lymphocytes were frequently present away from the periphery.

It is hardly necessary to remark that the symptoms were increased whenever the day was hot, bright and dry, and diminished whenever there was rain, while exposure to pollen was always followed by increased severity. It was also found that sleeping in a draught induced attacks of asthma.

A reference to Tables I and II will demonstrate the marked increase of eosinophilia associated with symptoms of asthma, further reference to the occurrence of eosinophilia in hay fever and its relation to asthma will form the basis of a future paper. As the changes in my blood were considered to result from hay fever I obtained smears, during the most distressing period, from six persons suffering from this condition; the results are charted in Table III. It will be seen that each case supports the conclusion that in hay fever a definite blood picture is produced. At the same time a further reference

to a case of asthma with no seasonal variation, in the same table, will demonstrate the close relationship existing.

The cessation of symptoms in my case not being followed, as I had expected, by a return to what might be considered a normal blood picture (see Table IV), I decided to make periodic examinations up to the next hay fever season. The results are charted in Table IV. It will be at once seen that the haemoglobin rises to 100 per cent.; that the colour index rises to between 0.8 and 1; that the polycythaemia has tended to diminish, though only slightly; that a slight leucopenia persists; and that, so far as the differential leucocyte count is concerned, little alteration is noted, with the exception of a sensibly diminished eosinophile count. The number of "dead" leucocytes has also appreciably decreased, and the variations in size of the red blood corpuscles is not nearly so marked. On the whole it may be said that the blood during the interval between the attacks has become distinctly healthier.

though it does not conform with the recognized standard of a normal blood. Similar and confirmatory results will be seen in Table IIIA.

On the vexed question of what does or does not constitute an eosinophilia it is difficult to speak with certainty, but my own experience leads me to say that 4 per cent. is abnormal, and should strictly be considered to mark the beginning of an eosinophilia.

The complement content of the blood serum has not appreciably altered during the whole period of examination, except on those occasions when it was deliberately increased by experimental inoculation.

CONCLUSIONS.

1. That hay fever is definitely associated with an alteration in the blood picture.

2. That the alteration in the blood picture chiefly consists in a decrease of the haemoglobin content, a polycythaemia, an increase in large mononuclears and eosinophiles, together with the presence of vacuolated and degenerated leucocytes, and a degree of leucopenia.

3. That increased eosinophilia coincides with symptoms of asthma.

4. That an altered, but modified, blood picture persists during the interval between the seasonal attacks.

TABLE IIIA.—Cases A, B, and D, taken prior to Seasonal Attack.

	Date.	Poly-morphs.	Large Mono-nuclears.	Lympho-cytes.	Eosino-phil.	Mast Cells.	Rouleaux Formation.	Blood Platelets.	Phantom Cells.	Dead Leuco-cytes.	Notes.
A.	1914. May 13	% 61.2	17.8	17.6	2.6	0.8	Good	Not in excess	None	Very few	Free from symptoms, including asthma.
B.	" 13	62.0	20.8	14.4	2.4	0.4	Poor	Not in excess	None	Almost none	Free from symptoms, including asthma.
D.	" 13	45.2	14.2	25.8	14.6	0.2	Fair	Not in excess	None	+	Free from symptoms, including asthma.

TABLE IV.

Date.	Haemo-globin.	Colour Index.	Red Blood Corpuscles (Thousands).	Leucocytes (Hundreds).	Poly-morphs.	Large Mono-nuclears.	Lympho-cytes.	Eosino-phil.	Mast Cells.	Rouleaux Formation.	Blood Platelets.	Phantom Cells.	Dead Leuco-cytes.
1913.	%				%								
Sept. 3 ...	90	0.6	6,504	60	54.3	15.0	22.4	8.0	0.3	Fair	Not in excess	Few	+
" 11 ...	90	0.8	5,560	56	68.1	8.8	15.5	7.1	0.3	Fair	Not in excess	Many	Few.
" 18 ...	95	0.9	6,080	90	64.4	10.4	15.8	9.0	0.4	V.g.	In excess	Many	++
" 23 ...	95	0.7	6,696	60	57.0	18.0	16.4	8.4	0.2	V.g.	Not in excess	Many	+
Oct. 1 ...	100	0.7	6,448	52	63.8	12.6	14.2	9.2	0.2	V.g.	In excess	Many	Few.
" 9 ...	100	0.8	5,888	52	58.8	16.0	21.4	3.6	0.2	V.g.	Not in excess	Many	Very few.
" 16 ...	100	0.8	6,096	44	69.6	13.4	13.0	4.0	0	V.g.	In great excess	Many	Almost none.
" 24 ...	100	0.8	5,992	42	66.0	16.6	15.2	1.8	0.4	V.g.	In slight excess	None	None.
" 30 ...	100	0.8	6,240	62	61.0	14.0	20.9	3.8	0.3	Good	Not in excess	Few	Very few.
Nov. 6 ...	100	0.8	6,248	50	70.2	8.4	15.8	5.0	0.6	V.g.	Not in excess	Few	Few.
" 13 ...	100	1.0	4,784	60	52.6	20.2	21.0	5.8	0.4	V.g.	Not in excess	Many	Very few.
" 20 ...	100	0.9	5,192	58	63.0	15.2	15.2	6.0	0.6	V.g.	In excess	Many	+
" 27 ...	100	0.7	6,560	64	62.4	15.4	16.8	4.8	0.6	V.g.	Not in excess	Many	+
Dec. 4 ...	100	0.9	5,296	62	64.0	11.6	18.6	5.4	0.4	Fair	Not in excess	Many	Few.
" 12 ...	100	0.9	5,576	50	66.4	12.0	17.8	2.8	1.0	Fair	Not in excess	Very few	Few.
" 19 ...	100	0.9	5,344	62	55.6	12.4	23.2	7.8	1.0	Fair	In excess	Very few	Very few.
1914.													
Jan. 15 ...	100	1.0	4,984	52	67.4	15.0	14.6	2.8	0.2	V.g.	In great excess	Few	Very few.
" 22 ...	100	0.9	5,376	70	57.6	17.8	19.3	4.8	0.3	V.g.	Not in excess	Very few	Few.
" 29 ...	100	1.0	4,848	86	68.6	13.2	13.0	5.0	0.2	V.g.	In slight excess	Few	None.
Feb. 5 ...	100	0.8	5,864	48	65.6	13.8	13.8	5.6	1.2	V.g.	Not in excess	Few	None.
" 19 ...	100	0.8	5,824	64	53.8	16.0	25.2	4.8	0.2	V.g.	In slight excess	Few	None.
" 26 ...	100	0.8	5,792	50	62.2	13.8	18.0	5.4	0.6	V.g.	In slight excess	Many	None.
Mar. 5 ...	100	0.9	5,520	50	63.4	12.2	20.8	3.0	0.6	V.g.	In slight excess	Few	Very few.
" 20 ...	100	0.8	6,016	56	61.4	13.8	22.0	2.0	0.8	V.g.	Not in excess	Many	Very few.
" 31 ...	100	1.0	4,976	38	60.8	19.8	16.4	2.0	1.0	V.g.	In excess	Many	+
Apr. 7 ...	100	0.9	5,200	42	64.6	15.2	17.2	2.8	0.2	V.g.	Not in excess	Many	None.
" 16 ...	100	0.9	5,536	56	53.8	19.4	22.6	3.2	1.0	V.g.	Not in excess	Many	Very few.
" 23 ...	100	0.7	6,712	56	69.2	12.0	15.0	3.2	0.6	V.g.	In very great excess	Many	Almost none.
" 30 ...	100	0.9	5,344	58	63.0	13.8	19.6	2.5	0.9	V.g.	In excess	Few	None.
May 7 ...	100	0.9	5,344	68	64.0	13.2	18.6	3.6	0.6	V.g.	In slight excess	Few	+
Normal standard	95-110	1.0	About 5,000	50-80*	70.0	8.0	20.0	1 or more	1 or less	V.g.	Vary.	None.	None.

* Not more than 100.