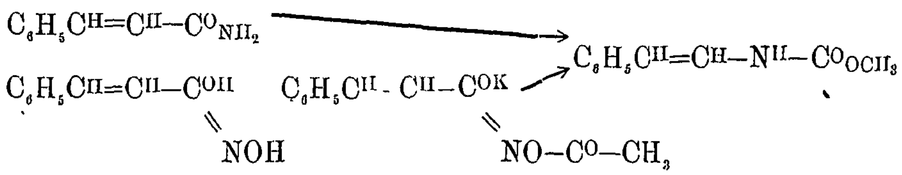
Citation:

J.P. van der Stok, The analysis of frequency-curves of the air-temperature, in:
KNAW, Proceedings, 10 I, 1907, Amsterdam, 1907, pp. 309-321

A substance of the same structure has been described by THIELE and PICKARD [1]), who prepared it from the potassium salt of the acetylated cinnamo-hydroxamic acid. As they give the melting point as 115°, and as, in another respect, their observations do not quite agree with mine, the urethane was prepared by Mr. W. OCHTMAN, in the manner indicated by THIELE and PICKARD for the purpose of comparison.

The two substances appeared to be quite identical; the melting point was found to be 122°—123° and a mixture of the two melted at the same temperature.



This ready formation of urethane in an aqueous-alcoholic alkaline medium is remarkable.

I ascertained that this reaction also takes place with a derivative of cinnamic acid. From o-nitro-cinnamide is formed the o-nitrostyryl-aminoformicmethyl ester:

$$C_6H_4NO_2 — CH = CH — NH — CO\ OCH_3$$

This crystallises in bright yellow needles mp. 149°—150°.

0,2009 gr. yielded 0,3956 gr. CO_2 and 0,0781 gr. H_2O.
0,1457 „ „ 15,8 cc. N_2 at 15° and 758 mM.

Found:	53,70 % C; 4,36 % H and 12,60 % N.
Calculated for $C_{10}H_{10}O_4N_2$:	54,03 % C; 4,55 % H and 12,61 % N.

A fuller communication will follow in the Receuil.

Delft, July 1907. *Chemical Laboratory of the Technical High School.*

Meteorology. — *"The analysis of frequency-curves of the air-temperature."* By Dr. J. P. VAN DER STOK.

1. The question in what way the characteristic details of frequency-curves of different kinds may be pointed out in a striking way in a pliant, analytical form has again been treated extensively in a recent work [2]).

The aim of this communication is to fix the attention on the

1) Ann. 309, 197.

2) H. BRUNS, Wahrscheinlichkeitsrechnung und Kollektivmasslehre, Leipzig und Berlin, TEUBNER, 1906.

method of treatment suggested in it and to give some applications of it to frequency-numbers concerning air-temperature, deduced from observations made on board the lightship "Schouwenbank".

2. The method suggested by BRUNS deserves the more the consideration of all who are occupied with the treatment of frequencies as it is based on the classical works of BESSEL and FECHNER and can be regarded as a logical outcome of the principles indicated by these investigators.

As a basis is taken the well-known function

$$\Phi_0(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

for which in various works tables are given; the first derivative of this function:

$$\Phi_1(x) = \frac{2}{\sqrt{\pi}} e^{-x^2} \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

assumes after substitution of hx for x and multiplication by h the form of the specific probability of a deviation x according to the law of errors of GAUSS in its simplest form. The derivatives of higher order can be written thus:

$$\left.\begin{aligned}
\Phi_2(x) &= \frac{2^2}{\sqrt{\pi}} e^{-x^2} \,.\, 1!\left[-\frac{x}{0!\,1!}\right] \\
\Phi_3(x) &= \frac{2^3}{\sqrt{\pi}} e^{-x^2} \,.\, 2!\left[\frac{x^2}{0!\,2!} - \frac{1}{1!\,0!\,2^2}\right] \\
\Phi_4(x) &= \frac{2^4}{\sqrt{\pi}} e^{-x^2} \,.\, 3!\left[-\frac{x^3}{0!\,3!} + \frac{x}{1!\,1!\,2^2}\right] \\
\Phi_5(x) &= \frac{2^5}{\sqrt{\pi}} e^{-x^2} \,.\, 4!\left[\frac{x^4}{0!\,4!} - \frac{x^2}{1!\,2!\,2^2} + \frac{1}{2!\,0!\,2^4}\right] \\
\Phi_6(x) &= \frac{2^6}{\sqrt{\pi}} e^{-x^2} \,.\, 5!\left[-\frac{x^5}{0!\,5!} + \frac{x^3}{1!\,3!\,2^2} - \frac{x}{2!\,1!\,2^4}\right]
\end{aligned}\right\} \; . \quad (3)$$

etc.

Now BRUNS' suggestion is as follows: the specific probability (sum of the numbers $= 1$) of a deviation from a groundvalue assumed arbitrarily be represented by the series:

$$y = h\,[D_0\Phi_1(hx) + D_1\Phi_2(hx) + D_2\Phi_3(hx) + \ldots\ldots] \; . \; . \; . \quad (4)$$

from which ensues, that the integral of this equation, called the curve of the sums, is expressed by the form

$$D_0\Phi_0 + D_1\Phi_1 + D_2\Phi_2 + \text{etc.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where Φ means $\Phi(hx)$. as is the case in what follows.

From (4) it is immediately evident when regarded in connection with (3) that the suggested analysis of the curve (called by BRUNS not frequency-curve but curve of distribution) shows a resemblance to the development of a function in terms of a FOURIER series.

In the different Φ_p terms appear polynomial functions of order $p-1$; the Φ_p curve shows p maxima and minima and intersects the x axis in $p-1$ points and alternately will be found for $x = 0$ either an extreme value (order uneven) or a point of intersection (order even).

The constants D are determined in the well-known way by evaluating the moments of various orders with respect to the y-axis through the origin of coordinates; if we take for this origin the value of x corresponding to the arithmetical mean and if we put:

$$\int_{-\infty}^{\infty} x^n y \, dx = \mu_n ,$$

we find evidently $D_0 = \frac{1}{2}$ on account of μ_0 being equal to 1; furthermore μ_1 must be $= 0$ on account of the choice of the origin, so D_1 must be put equal to 0, whilst, if one defines the value of the constant h in such a way that

$$2\,h^2\mu_2 = 1 ,$$

it is then easy to deduce that also D_2 must be 0.

The expressions (4) and (5) can thus be simplified and they become

$$y = h\,[\tfrac{1}{2}\,\Phi_1 + D_3\Phi_4 + D_4\Phi_5 \ldots] \quad . \quad . \quad . \quad . \quad (4^a)$$

and

$$\tfrac{1}{2}\,\Phi_0 + D_3\Phi_3 + D_4\Phi_4 \ldots \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5^a)$$

The constants D_3, D_4, etc. can easily be calculated by means of the formula (3) where, with a view to this, the above mentioned form is given.

To calculate $2D_n$ we have namely, to consider the form appearing between square brackets in the expression for Φ_{n+1} and to substitute in it $h^n\mu_n$ for x^n.

Our finding in this way $2D_n$ instead of D_n is due to the same reason why D_0 must be put equal to $\frac{1}{2}$; namely to the form of (1) in which the number 2 stands as coefficient.

TABLE I.

Air temperature. Schouwenbank. Frequencies of Daily-means

Celsius		January	February	March	April	May	June	July	August	September	October	November	December
−8°.9 to	−8°.0	1	—	—	—	—	—	—	—	—	—	—	1
−7.9	−7.0	—	—	—	—	—	—	—	—	—	—	—	—
−6.9	−6.0	—	1	—	—	—	—	—	—	—	—	—	1
−5.9	−5.0	2	2	—	—	—	—	—	—	—	—	1	—
−4.9	−4.0	2	3	—	—	—	—	—	—	—	—	—	3
−3.9	−3.0	5	5	—	—	—	—	—	—	—	—	1	7
−2.9	−2.0	18	14	3	—	—	—	—	—	—	—	—	10
−1.9	−1.0	32	23	6	—	—	—	—	—	—	—	3	27
−0.9	0.0	53	37	15	—	—	—	—	—	—	—	2	21
0.1	1.0	56	48	25	—	—	—	—	—	—	—	—	27
1.1	2.0	77	89	50	—	—	—	—	—	—	—	13	39
2.1	3.0	112	123	69	8	—	—	—	—	—	—	23	85
3.1	4.0	134	134	111	13	—	—	—	—	—	—	30	77
4.1	5.0	150	176	150	36	—	—	—	—	—	—	45	101
5.1	6.0	147	142	202	96	—	—	—	—	—	1	55	163
6.1	7.0	113	111	157	167	11	—	—	—	—	6	81	163
7.1	8.0	70	82	95	206	36	4	—	—	—	28	131	122
8.1	9.0	24	10	69	186	112	3	—	—	—	57	158	91
9.1	10.0	4	—	25	142	161	3	—	—	—	73	158	48
10.1	11.0	—	—	15	97	215	19	—	—	4	105	167	14
11.1	12.0	—	—	2	45	166	71	—	—	6	194	86	—
12.1	13.0	—	—	6	3	130	165	8	—	51	189	41	—
13.1	14.0	—	—	—	1	87	180	27	4	67	182	4	—
14.1	15.0	—	—	—	—	46	218	85	49	149	87	1	—
15.1	16.0	—	—	—	—	32	160	170	152	222	53	—	—
16.1	17.0	—	—	—	—	4	94	275	254	230	18	—	—
17.1	18.0	—	—	—	—	—	57	215	245	152	3	—	—
18.1	19.0	—	—	—	—	—	19	130	137	71	4	—	—
19.1	20.0	—	—	—	—	—	7	64	106	29	—	—	—
20.1	21.0	—	—	—	—	—	—	24	32	15	—	—	—
21.1	22.0	—	—	—	—	—	—	1	15	4	—	—	—
22.1	23.0	—	—	—	—	—	—	1	3	—	—	—	—
23.1	24.0	—	—	—	—	—	—	—	3	—	—	—	—

For the values of Φ_1, Φ_2 .. Φ_6 BRUNS has given tables, so there are no further difficulties about the calculations which can easily be done after some practice

We must suffice with this short and for that reason incomplete survey of the method, for further details we must refer to the abovementioned work, where all questions which may arise are discussed extensively.

3. When applying this method to observations of air-temperature it has been assumed that the series need not be continued farther than to the third term, so that only asymmetrical (D_3) deviations and symmetrical ones (D_4) of order one of the simple law are regarded, which, with these kinds of curves not differing much from the bell-shape, proves to be sufficient. When introducing terms of higher order the disadvantage moreover appears that with the evaluation of the higher moments the single extreme deviations, therefore inaccurately determined, play an unduly important part. As first example have been selected the daily-means of the air-temperature, because with these frequency-curves their obliquity changes sign along with the season and can therefore be regarded as a climatological factor. The daily-means are calculated from observations on temperature taken six times a day during the years 1882—1904.

In Table I the frequencies are given from degree to degree, calculated at a total of 1000, the number of data amounts of course for every month to about

$$23 \times 30 = 690 \text{ or } 23 \times 31 = 713.$$

The obliquity is immediately evident; in winter we find extreme temperatures or negative deviations which are not compensated by equally large positive deviations, in summer we find on the contrary important positive deviations not contrasted by negative ones. The constants of the curve, namely, the mean temperature M indicating the origin of coordinates, the factor of consistency h and the coefficients D_3 and D_4 by which the deviations of the curve from the regular bell-shape are determined are found in survey in Table II, the last two quantities having reference to $\mu_0 = 1$, so that they must still be multiplied by 1000 for the calculation of the numbers comparable to the frequencies of Table I.

TABLE II

Constants of the frequency-curves.
Daily-means of air-temperature.

	M	h	D_3	D_4
January	3 762 C.°	0 2587	+ 0 01657	— 0 00043
February	3 842	0 2773	+ 0 01959	+ 0 00048
March	5 321	0 2908	+ 0 00214	+ 0 00213
April	7 953	0 3738	+ 0 00313	— 0.00115
May	11 068	0 3540	— 0 00847	— 0 00166
June	14.320	0 3708	— 0 00015	+ 0 00114
July	16 871	0 4442	— 0 00216	+ 0 00007
August	17 367	0 4380	— 0 01170	— 0 00026
September	16 032	0 3893	— 0 00634	+ 0 00106
October	12.142	0 3335	+ 0 00470	— 0 00002
November	8 399	0 2662	+ 0.02657	+ 0.00659
December	5.174	0.2377	+ 0 02463	+ 0 00390

From these results of the calculation it is evident that in contrast to most frequency-curves, the D_4 deviations from the simple exponential law for the frequency-curve of the daily-means of the air-temperature are slight and may be regarded as being within the limits of the errors of observation.

In order to investigate how far the calculation agrees with the observation, the numbers of Table I for the months of January and December are taken together as being the most asymmetrical. The numbers obtained in this way are indicated in Table III by O (observed).

The constants of these curve are:

$$M = 4.469 \text{ C}^\circ$$
$$h = 0.2403$$
$$D_3 = +0.01764$$
$$D_4 = +0.00130$$

TABLE III.

Analysis of the frequencies Jan. + Dec of Table I.

O	C_0	$O-C_0$	C_1	$O-C_0-C_1$	C_4	$O-\Sigma C$
1	0	1 0	0 1	0 9	—	1
0	0 1	— 0 1	0.2	— 0 3	0 1	0
0^5	0 2	0 3	0.3	0 0	0.2	0
1	0.4	0 6	1.3	— 0 7	0.3	— 1
2^5	1.4	1 1	2.5	— 1.4	0 4	— 2
6	3.4	2.6	4.0	— 1 4	0.4	— 2
14	8.4	5.6	5.0	0.6	0.1	1
29^5	17.5	12.0	3 7	8 3	— 0.9	9
37	32 9	4.1	— 0 3	4 4	— 2 0	6
41^5	54 9	— 13 4	— 8 7	— 4 7	— 2 5	— 2
58	81.5	— 23.5	— 16 0	— 7 5	— 1 7	— 6
98^5	108 0	— 9.5	— 25 2	15 7	0.6	15
105^5	127 9	— 22 4	— 11 9	— 10.5	3 1	— 13
125^5	134.9	— 9 4	0 4	— 9 8	4 1	— 14
155	127.0	28.0	12.6	15 4	2 9	13
138	106.6	31 4	18.2	13.2	0.5	13
96	79 7	16.3	15 7	0 6	— 1 8	2
57^5	53.3	4 2	8 2	— 4 0	— 2 6	— 1
26	31.7	— 5 7	0 6	— 6 3	— 1 9	— 4
7	16.9	— 9 9	— 3 9	— 6 0	— 0 8	— 5
—	8.4	— 8 4	— 5.0	— 3.4	0 1	— 4
—	3.0	— 3.0	— 3 9	0.9	0 4	1
—	1.2	— 1.2	— 2.4	1 2	0 5	1
—	0.3	— 0.3	— 1.2	0.9	0.3	1
—	0.3	— 0.3	— 0.5	0 2	0 1	0
—	0.1	— 0.1	— 0.2	0.1	0 1	0
$\Sigma = 1000$		$\Sigma = 214.6$		$\Sigma = 118.4$		$\Sigma = 117$

In the second column is given under C_0 (calculated) the distribution derived according to the simple exponential law; in the fourth column we find the values of the second term in the series having D_3 as factor; from the third and fourth columns is evident that the sum of the differences is lessened by this term from 215 to 118 a thousand. As has been noticed before, the influence of the third term with D_4 is slight.

The sum of the differences remains 12°/₀, also after introducing this term, which can be called satisfactory considering that the total number of observations is not more than:

$$2 \times 31 \times 23 = 1426$$

and that the most unfavourable months have been taken as an example. In fact, from the regular course of the differences it is evident that there might be a possibility of making the differences smaller still by addition of a fourth or a fifth term with D_5 and D_6.

For D_5 we find the value — 0.00036, from which ensues that of by far the greater part the differences are due to incompleteness of the material of observation, so that extension of the series would avail but little.

4. As fitting material for a second application of the method to meteorological quantities all the observations of temperature have been chosen, taken six times a day in the month of July on the same lightship during the years 1882—1906. The number of observations is now six times greater than for the daily-means and amounts to 4516.

On account of this greater number the frequency-curve will have a more regular shape and the obliquity which was easily discernible for the daily-means also for the summer months, will now come more clearly to the front.

The observations are arranged according to the different quarters of the wind, so that we obtain (Table IV) frequencies of the so-called thermic windrose. On board the lightships the direction of the wind is determined in accordance with the indications of the compass; for the period 1882—1906 we can assume that these observed directions of the wind can be reduced to the proper direction by applying as correction the mean deviation, — 15°.

TABLE IV. Frequencies of air-temperatures for different quarters of the wind (Magnetic), Schouwenbank, July, 1882—1906.

	N	*NNE*	*NE*	*ENE*	*E*	*ESE*	*SE*	*SSE*	*S*	*SSW*	*SW*	*WSW*	*W*	*WNW*	*NW*	*NNW*	*C*	Total
10.6—11.5 C	1	—	—	—	—	—	—	—	1	1	—	—	—	1	—	—	—	4
11.6—12.5	4	1	1	—	—	—	—	—	0	0	—	—	1	0	3	13	—	23
12.6—13.5	29	17	5	1	2	2	—	—	1	1	2	2	0	2	13	25	—	102
13.6—14.5	44	26	12	2	11	4	5	4	3	4	15	11	9	20	43	51	3	267
14.6—15.5	71	49	35	21	18	9	13	4	13	9	30	66	69	72	77	49	18	623
15.6—16.5	67	66	80	41	27	14	18	18	19	27	70	164	152	73	50	42	24	952
16.6—17.5	56	38	79	39	35	18	28	15	37	31	94	182	147	51	44	37	37	968
17.6—18.5	34	29	56	38	32	23	25	15	22	22	62	140	119	31	41	26	27	742
18.6—19.5	26	13	48	16	27	13	16	7	14	14	35	67	52	13	21	10	27	419
19.6—20.5	9	10	29	16	16	6	13	4	5	10	19	17	24	6	9	6	18	217
20.6—21.5	4	4	18	10	10	1	6	6	5	4	2	5	6	1	6	3	7	98
21.6—22.5	2	2	7	3	2	4	4	3	3	1	4	2	5	1	2	1	15	61
22.6—23.5	2	2	3	3	1	0	2	1	1	0	1	—	1	0	2	1	4	24
23.6—24.5	—	1	1	0	2	1	—	—	—	1	3	—	—	0	—	—	1	10
24.6—25.5	—	—	1	1	1	—	—	—	—	—	—	—	—	1	—	—	1	5
25.6—26.5	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
Sum	349	258	375	191	185	95	130	77	124	125	337	656	585	272	311	264	182	4516

More clearly than in the numbers of Table IV does the influence of the direction of the wind on the temperature show itself in the mean temperature M and the factor of consistency h, arranged in Table V.

TABLE V.

Direction of wind Magn.	Number of observ.	Mean Temp. M.	h
N	349	13°.10	0.3485
NNE	258	16 33	0.3478
NE	375	17.50	0 3477
ENE	191	17.61	0.3561
E	185	17.68	0.3155
ESE	95	17.53	0 3491
SE	130	17 77	0.3527
SSE	77	17.67	0 3436
S	124	17 39	0.3713
SSW	125	17.38	0.3754
SW	337	17.23	0.4037
WSW	656	17.08	0.5124
W	585	17.10	0.4685
WNW	272	16.32	0.4391
NW	311	16.27	0.3512
NNW	264	15 65	0 3418
Calm	182	18.56	0 3295

From this table is evident that in this summermonth by far the highest temperatures are observed when there are calms; for the rest we have the lowest temperatures with the northerly seawind, the highest with a landwind; the transition from NNE (W 7°.5 E prop. dir.) to NE (N 30° E prop. dir.) is sharp, much sharper than that from SW (N 210° E prop. dir. landwind) to WNW (N 277°.5 E proper dir. seawind).

This sharp difference we do not find for the factor of consistency, which shows for WSW wind a distinct maximum and for calm a minimum.

The numbers of observations being rather slight for many directions of the wind, the numbers of Table IV have been arranged in Table VI to five groups where as much as possible comparable series have been added together.

TABLE VI.

Frequencies deduced from Table IV.

	WNW — *NNE*	*NE* — *E*	*ESE* — *SW*	*WSW* — *W*	*C*	Total
10.6—11.5 C°.	2	—	2	—	—	4
11 6—12.5	21	1	0	1	—	23
12.6—13.5	86	8	6	2	—	102
13.6—14.5	184	25	35	20	3	267
14 6—15.5	318	74	78	135	18	623
15.6—16 5	298	148	166	316	24	952
16 6—17.5	226	153	223	329	37	968
17.6—18.5	161	126	169	259	27	742
18.6—19 5	83	91	99	119	27	419
19.6—20.5	40	61	57	41	18	217
20.6—21 5	18	38	24	11	7	98
21 6—22 5	8	12	19	7	15	61
22.6—23.5	7	7	5	1	4	24
23.6—24 5	1	3	5	—	1	10
24.6—25.5	1	3	—	—	1	5
25.6—26.5	—	1	—	—	—	1
Sum	1454	751	888	1241	182	4516

The comparatively low temperatures for WNW—NNE winds with a small factor of consistency (great distribution) in contrast to the high temperatures and small distribution for WSW—W winds is very clear from this table.

At the same time is evident from these data how the combination of series with different mean values decreases the obliquity in the total, so that we can expect that the obliquity factor D_3 will be considerably smaller for the total series than D_3, calculated for the various series, which is confirmed by the following table.

TABLE VII.

Constants of the frequency-numbers of Table VI.

	M	h	D_3	D_4
WNW—NNE	16°.135	0.3576	— 0.01778	0.00385
NE—E	17.589	0.3428	— 0.01657	0.00343
ESE—SW	17.430	0.3710	— 0 01540	0 00477
WSW W	17.089	0.4869	— 0.01300	0.00297
C	18 555	0.3295	— 0.01153	0.00108
Total	16.971	0.3603	— 0 01116	0.00331

The (negative) obliquity D_3 is therefore strongest for the northerly seawinds with low temperature and decreases further regularly with the azimuth counted from North through East. The symmetrical deviation D_4 is greatest for southerly winds and smallest for calms.

TABLE VIII.

Analysis of the frequencies of Table VI.

O	C_0	$O—C_0$	C_3	$O—C_0—C_3$	C_4	$O—\Sigma C$
1	2.6	— 1.6	— 3 5	1.9	2.9	— 1
5	8.7	— 3.7	— 4 4	0.7	1.0	0
23	27 2	— 4.2	— 3.3	— 0.9	— 3 6	3
59	65.5	— 6.5	4.5	— 11.0	— 8 8	— 2
138	122 7	15.1	15.1	0	— 6.1	6
211	178.4	32.6	14.7	17.9	7.3	11
214	201.2	12.8	— 0 5	13.3	15 4	— 2
164	175.8	— 11.8	— 15.3	3 5	6.4	— 3
93	119.2	— 26.2	— 14.5	— 11.7	— 6 5	— 5
48	62 7	— 14.7	— 4.0	— 10 7	— 8.9	— 2
22	25.5	— 3.5	3.6	— 7.1	— 3 0	— 4
14	8.1	5.9	4.3	1.6	1.1	1
5	2.0	3.0	2.3	0.7	1.7	— 1
2	0.4	1 6	0 8	0.8	0.8	0
1	0.0	1 0	0.2	0 8	0 3	1
$\Sigma = 1000$		$\Sigma = 144.2$		$\Sigma = 82.6$		$\Sigma = 42$

Let us remark here that a negative D_3 refers to the ascending slope of the curves on the left being steeper than the descending slope on the right and that a positive sign of D_4 means that small deviations appear in greater number than would be the case in accordance with the simple exponential law.

In order to show clearly the part played by the various terms of the series in the composition of the curve of distribution a comparison has been given in table VIII, as in table VI, of the observed and calculated frequency-numbers of the last series of table IV; the number of observations 4516 has here been reduced in the first column under O to 1000.

From this table is evident that, if only a great number of observations is at hand, the frequency-curve of the air-temperature can be very satisfactorily determined by the three constants of the series of BRUNS, the total of the differences between observation and calculation amounting in round numbers to 4 %.

Anthropology. — *"Is red hair a nuance or a variety?"* By Prof. L. BOLK.

Concerning the anthropological importance of red hair the literature relating to it contains up till now little more than opinions based upon general impressions or suppositions, founded on statistical data, which when looked at more closely are open to more or less unfavourable criticism. There is in those opinions and suppositions a definite main current according to which it is generally assumed that a closer affinity of redhairiness exists to what, for the sake of brevity, I shall indicate as the blonde race, characterized as to the pigmentation by blonde hair and blue eyes.

The nature of the relation between blonde and red-haired people is expressed by TOPINARD [1]) as follows: the red-haired type has arisen from the blonde type "par une action des milieux". Also BEDDOE and RIPLEY, to mention the principal English and the best known American anthropologist, assume a closer connection between blonde and red hair. VIRCHOW looks upon the subject from a somewhat different standpoint, when he says that redhairiness probably arises in two manners, viz. by a decrease of pigment in brown hair or an increase in blonde hair [2]). This opinion of VIRCHOW is based upon

1) Éléments d'Anthropologie générale. Paris 1885 p. 334

2) Das jedoch scheint mir nicht unwahrscheinlich zu sein, dass es eine doppelte Art von Rothharigkeit giebt, von denen die eine als eine Steigerung des Pigments bei den Blonden, die andere als eine Verminderung desselben bei den Braunen anzusehen ist. Archiv für Anthrop. XVI Bnd. p. 338.