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HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI

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III

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Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **III,** 1.

THE PHOSPHATE EXCRETION IN THE URINE DURING WATER DIURESIS AND PURINE DIURESIS

BY

JOHANNES BOCK AND POUL IVERSEN

1742

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
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Several years ago one of us (Bock) stated that the amount of phosphate in the urine increases by salt diuresis, by sugar diuresis, and especially, by purine diuresis. With regard to water diuresis this was not the same. In most cases Bock[1] found no increase of the phosphate even in profuse water diuresis, in some cases the phosphate was increased but only for short periods. In one experiment (No. 18) by which first water diuresis and afterwards purine diuresis were induced, the amount of phosphate remained quite unchanged during the water diuresis, but was highly increased after theophylline, and the augmentation still continued after the purine diuresis had passed off and the amount of urine returned to its original quantity. Similar results, though not so marked, were obtained in other experiments.

In opposition to Bock's result Baetzner[2] has more recently declared, that in rabbits he almost regularly found the excretion of phosphate in the urine increased during water diuresis. The experiments upon which Baetzner bases his declaration are given in the following table.

A normal estimation before the administration of water has only been made in 4 of Baetzner's 8 experiments, and in each experiment the number of estimations is rather

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[1] J. Bock: Archiv f. exp. Pathol. u. Pharmacol. 58 p. 227. 1908.

[3] W. Baetzner: Archiv f. exp. Pathol. u. Pharmacol. 72 p. 309. 1913.

Baetzner's Experiments.

No.	Time	Urine c. c. in 1 hour	P_2O_5 mgm in 1 hour	
1	1. hour	4	1	At the end of the 1st hour 100 c. c. water
	2. —	12	7.6	
	3. —	55	9.6	
	4. —	40	8.8	
2	1. —	1.8	1.5	At the end of the 1st hour 100 c. c. water
	2. —	1.4	2.0	
	3. —	23.3	3.7	
3	1. —	1	1.5	
	2. —	1.2	2.4	100 c. c. water
	3. —	4	5.1	
	4. —	16	6.1	
4	1. —	2.4	2.5	100 c. c. water
	2. —	2.2	6.2	
	3. —	13	7.1	
5	1. —	5	5.3	1 hour before 100 c. c. water
	2. —	20	14.4	
	3. —	75	24.7	
6	1. —	1.8	3.3	1 hour before 100 c. c. water
	2. —	4	5.6	
7	1. —	6	7.5	$1^1/_2$ hours before 100 c. c. water
8	1. —	6	1	1 hour before 100 c. c. water
	2. —	23.5	4.3	

small (4—1). Experiment 7 counts for nothing, comprising only one estimation and no diuresis taking place. — In experiment 4 and 3 in the first hour after the administration of water, respectively none, and only a very slight augmentation of the urine is found, but in both cases a very considerable increase of phosphate is noted, and during the following hour, when diuresis sets in, the further increase of phosphate is but slight. In experiment 6 the amount of urine is so small that it cannot be considered as a diuresis.

In experiment 1 the phosphates increase considerably during the first hour after the administration of water, but the amount af urine only rises from 4 to 12 c. c. and in the following hours, when a profuse diuresis appears, the further increase of the phosphate is only very small. In Baetzner's experiments 2, 5 and 8 an increase of phosphate was found during the water diuresis, in experiment 5 even a very considerable one. It is however necessary to call attention to a circumstance which makes it impossible to critizise Baetzner's experiments more precisely. In Bock's experiments the urine was always taken with catheter, and the bladder each time rinsed afterwards with distilled water. This was done partly in order to draw off the last traces of urine, and partly to remove the sediment which is very often present in the bladder of the rabbit and may contain large amounts of phosphate. It was very often necessary, at the commencement of the experiments, to rinse the bladder several times with water before the sediment was entirely removed, a procedure which is absolutely necessary, as we have found that such sediments may happen to be washed out with the urine when a profuse diuresis sets in. Baetzner states that in his experiments the urine was taken by catheter and by pressing out the bladder. In the last case, at any rate, the bladder has not been rinsed, which we, as already mentioned, must consider an absolutely necessary proceeding in investigating the excretion of the phosphates. According to the above we cannot admit that the experiments of Baetzner prove the excretion of phosphate to be regularly augmented during water diuresis. —

Bock's experiments cannot however be directly compared with Baetner's, Bock's rabbits being fed partly with oats, which involves an ample excretion of phosphate in the urine, Baetzner's rabbits with green food or with beets, which involves but a slight excretion of phosphate in the urine, the main part of the phosphate being excreted with the fæces.

The fact that after administration of theophylline the amount of phosphate in the urine was always augmented but did not follow the course of the diuresis, and that this augmentation might still continue, when the diuresis had passed off, made Bock suppose that the purine diuretics exercise a stimulating action upon the elements of the kidney by which the phosphates are secreted, and that this action is independent of their action on the mechanism through which the quantity of urine is augmented.

The modern filtration-absorption theory considers the secretion of the urine as the result of a mere filtration of the non-colloid constituents of plasma through the capsule and an absorption of a fluid of unchanging composition very similar to "Locke's fluid" through the tubule cells. We think that this theory must claim that, in water diuresis, very great quantities of water are filtrated and absorbed, the abundant dilute urine containing but a very low percentage of sodium chloride. But if the supposed filtration is increased in water diuresis, the substances which, according to the theory are hardly absorbed — like the phosphates — should be expected to increase always, but this was not the case in Bock's experiments. Furthermore it seems hardly compatible with the said theory that in Bock's experiments the amount of phosphate in the urine was constantly much larger in purine diuresis than in water diuresis and might still be augmented in the later periods, after the purine diuresis had passed off, and the urine was no longer increased.

One thing might be able to subvert the above considerations or make them very uncertain. The concentration of phosphate in the blood plasma during diuresis is quite unknown. The phosphate in plasma might possibly be diminished in water diuresis and increased in purine diuresis — in the last case perhaps on account of a concentration of the blood. In order to settle the problem it was therefore necessary to determine the percentage of phosphate in the plasma during the different phases of the diuresis.

Recently one of us (IVERSEN) has described a micromethod[1] for estimating phosphate in small quantities of blood and plasma. The method is based upon the principle of NEUMANN and renders possible the estimation of quantities from 0.15 to 0.03 mgm *P* with an error of 0.003 mgm. The albumen is precipitated with picric acid. The estimation was mostly made in 1—1.5 c. c. plasma. By this method is estimated what is called the acid soluble phosphorus, but GREENWALD[2] has shown that abt. 90 % of the soluble phosphorus in plasma is due to inorganic phosphate, and the difference of 10 % is of no importance for our investigation. In the urine the total amount of phosphate was estimated by the same method, the organic substances being previously removed by oxydation with nitric acid and sulphuric acid. A small percentage of the phosphate, in the urine too, is present in organic combination, but the amount is so small that we can leave it out of consideration.

The experiments were carried out in the following way: We used large rabbits weighing about 3 Kg. The animals were not anesthetised and only tied up when urine and blood were taken. The urine was always taken with catheter mostly every half hour, and the bladder was each time

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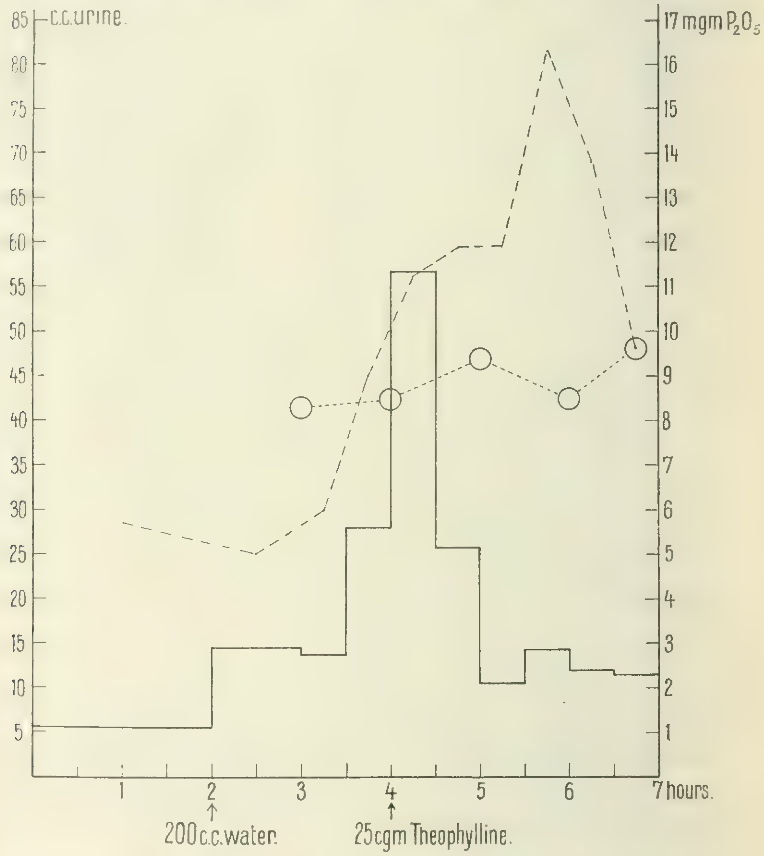
[1] POUL IVERSEN: Biochemische Zeitschrift Bd. 104. S. 22. 1920.

[2] I. GREENWALD: Jurn. of Biol.-chemistry **25** p. 431. 1916.

rinsed with distilled water. After one or two normal estimations a water diuresis was induced and afterwards a theophylline diuresis. In the urine samples the amount of phosphate was estimated as described. The blood was taken from a vein in the ear into a few mgm of sodium oxalate, and the plasma at once separated from the blood corpuscles by centrifuting. As only 3. c. c. blood are required for the estimation of the phosphate in the plasma, it was possible



Curve 1 (exp. 1). (—) urine c. c. in 30 mins. (---) mgm P_2O_5 in the urine. (○----) mgm P_2O_5 in 100 c. c. plasma.

to take 4—5 samples during the experiment without depriving the animal of too much blood. The water (200 c. c. tube water) and the theophylline were always given by means of a stomach tube. The rabbits were mostly fed with beets and oats. In several of the experiments no food was given the last 24 hours before the experiment.

In the following protocols and curves the amount of urine and of excreted phosphate is stated for periods of half an hour corresponding to the interval between the collections of the urine. Only in exp. 3 and in the first estimations in the other experiments the urine is collected at intervals comprising two or more periods as indicated in the protocols. The periods succeeding the administration of water and of theophylline are indicated in the following as water-periods and theophylline-periods.

Experiment 1 (curve 1). Rabbit weight 3200 gm, fed on oats and hay.

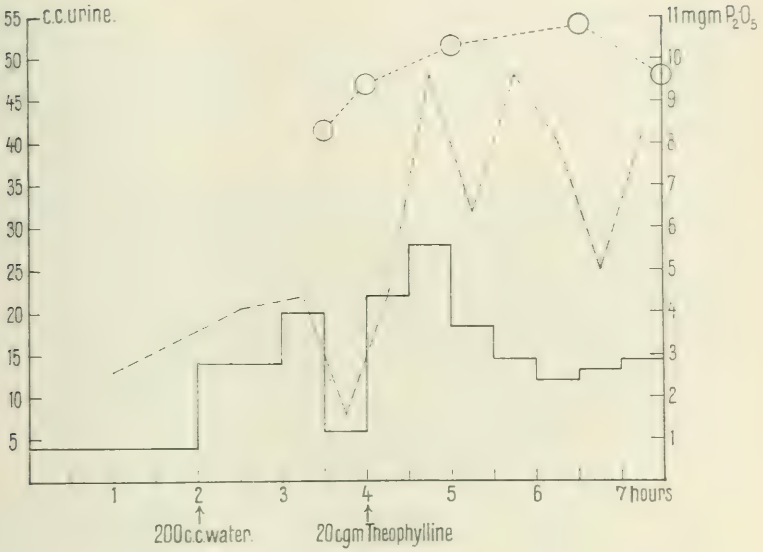
Time	Urine		Plasma	
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	mgm P_2O_5 in 100 c. c.	
$0 - 2^{00}$	5.5	5.7	. .	
2^{00}	. . .	. . .	. .	200 c. c. water
$2^{00} - 3^{00}$	14.4	5.0	. .	
3^{00}	. .	. . .	8.3	
$3^{00} - 3^{30}$	13.7	6.0	. .	
$3^{30} - 4^{00}$	28.2	9.1	. .	
4^{00}	. . .	. . .	8.5	25 cgm theophylline
$4^{00} - 4^{30}$	56.7	11.2	. .	
$4^{30} - 5^{00}$	25.8	11.9	. .	
5^{00}	. . .	. . .	9.4	
$5^{00} - 5^{30}$	10.7	11.9	. .	
$5^{30} - 6^{00}$	14.2	16.3	. .	
6^{00}	. . .	. . .	8.5	
$6^{00} - 6^{30}$	12.0	13.8	. .	
$6^{30} - 7^{00}$	11.5	9.6	. .	
7^{00}	. . .	. . .	9.6	

The phosphate percentage in the plasma varies but little during the experiment. After the administration of water the urine is augmented. Theophylline induces a profuse but short-lasting diuresis, whereupon the urine is rapidly reduced again. The phosphate in the urine, which varies little during the 3 first water-periods, is augmented during the fourth. After theophylline the phosphate in the urine increases during the profuse diuresis but far more when the urine is afterwards considerably diminished.

Experiment 2 (curve 2). Rabbit weight 3200 gm, fed on oats and beets.

Time	Urine		Plasma	
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	mgm P_2O_5 in 100 c. c.	
0 —2^{00}	4.2	2.6	...	
2^{00}	...	..	...	200 c. c. water
2^{00}—3^{00}	14.1	4.1	...	
3^{00}—3^{30}	19.9	4.4	...	
3^{30}	...	..	8.3	
3^{30}—4^{00}	6.0	1.6	...	
4^{00}	...	..	9.4	20 cgm theophylline
4^{00}—4^{30}	22.0	4.4	...	
4^{30}—5^{00}	28.0	9.6	...	
5^{00}	...	..	10.3	
5^{00}—5^{30}	18.4	6.4	...	
5^{30}—6^{00}	14.6	9.4	...	
6^{00}—6^{30}	12.1	8.0	...	
6^{30}	...	..	10.8	
6^{30}—7^{00}	13.3	5.0	...	
7^{00}—7^{30}	14.4	8.3	...	
7^{30}	...	..	9.6	

After the administration of water as well as after theophylline the urine is augmented, but not considerably. The phosphate percentage in the plasma increases somewhat during the last water period and a little more during the early theophylline periods, but is reduced at the end of the experiment. The phosphate in the urine increases a little during the first 3 water-periods and in the fourth is less than during the normal periods. During the theophylline-periods the phosphate is greatly increased and also when, in the subsequent periods, the amount of the urine is less than during the water diuresis.



Curve 2 (exp. 2). (—) urine c. c. in 30 mins. (---) mgm P_2O_5 in the urine. (○----) mgm P_2O_5 in 100 c. c. plasma.

Experiment 3. Rabbit weight 3200 gm, fed on oats and beets.

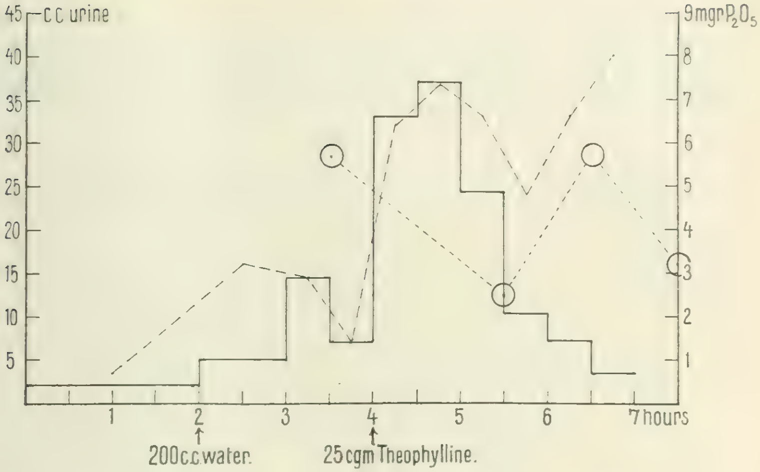
Time	Urine		Plasma	
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	mgm P_2O_5 in 100 c. c.	
$0-2^{00}$	4.1	4.6	...	
$2^{00}-3^{30}$	2.2	5.7	...	
3^{30}	..	..	10.5	20 cgm theophylline
$3^{30}-4^{30}$	9.5	9.2	...	
4^{30}	..	..	10.8	
$4^{30}-5^{30}$	4.6	6.9	...	
5^{30}	..	..	8.9	
$5^{30}-6^{30}$	1.4	6.4	...	
6^{30}	..	..	9.2	

The phosphate percentage in the plasma is almost unchanged during the commencement of the experiment and somewhat lessened at the end. Theophylline induces a rather small increase of the urine but a very marked augmentation of the phosphate in the urine even in the later periods with reduced urine. The two normal estimations show that the phosphate in the urine may vary rather considerably from hour to hour in normal conditions.

Experiment 4 (curve 3). Rabbit weight 2700 gm.

Time	Urine		Plasma	
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	mgm P_2O_5 in 100 c. c.	
0 —2^{00}	2.2	0.7	. .	
2^{00}	. . .	. .	. .	200 c. c. water
2^{00}—3^{00}	5.1	3.2	. .	
3^{00}—3^{30}	14.6	2.9	. .	
3^{30}	. . .	. .	5.7	
3^{30}—4^{00}	6.9	1.4	. .	
4^{00}	. . .	. .	. .	25 cgm theophylline
4^{00}—4^{30}	33.0	6.4	. .	
4^{30}—5^{00}	37.0	7.3	. .	
5^{00}—5^{30}	24.4	6.6	. .	
5^{30}	. . .	. .	2.5	
5^{30}—6^{00}	10.4	4.8	. .	
6^{00}—6^{30}	7.3	6.6	. .	
6^{30}	. . .	. .	5.7	
6^{30}—7^{00}	3.5	8.0	. .	
7^{30}	. . .	. .	3.2	

During the theophylline diuresis the phosphate percentage in the plasma is very considerably reduced, in the following hour it rises and is subsequently reduced. The amount of phosphate is very small in the normal urine and increases after the administration of water, but this increase appears during the first two water-periods (2^{00}—3^{00}), the urine being but slightly augmented. During the 3rd water-period (3^{00}—3^{30}) the phosphate does not increase further, but the urine is considerably augmented. Theophylline induces a profuse diuresis (4^{00}—5^{30}) during which the phosphate in the urine rises greatly, in the following period it is a little diminished, but increases again and reaches the maximum in a period (6^{30}—7^{00}), during which the amount of urine is nearly the same as during the water-periods.

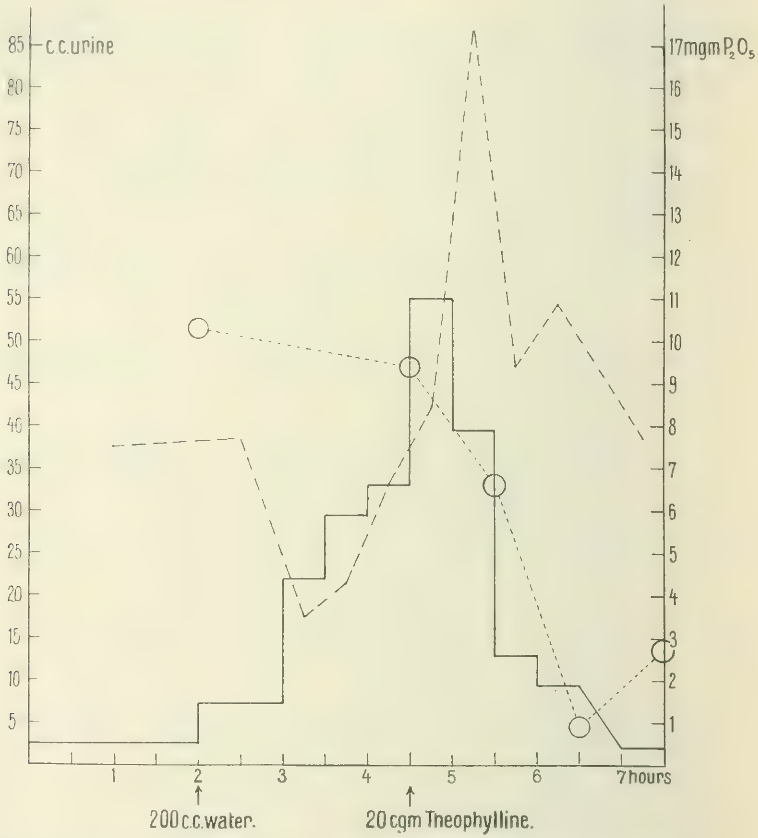


Curve 3 (exp. 4). (—) urine c. c. in 30 mins. (---) mgm P_2O_5 in the urine. (◯---) mgm P_2O_5 in 100 c. c. plasma.

Experiment 5 (curve 4). Rabbit weight 2790 gm, no food during 18 hours.

Time	Urine		Plasma	
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	mgm P_2O_5 in 100 c. c.	
$0-2^{00}$	2.5	7.5	...	
2^{00}	...	...	10.3	200 c. c. water
$2^{00}-3^{00}$	7.3	7.7	...	
$3^{00}-3^{30}$	22.0	3.5	...	
$3^{30}-4^{00}$	29.5	4.3	...	
$4^{00}-4^{30}$	33.1	6.6	...	
4^{30}	...	...	9.4	20 cgm theophylline
$4^{30}-5^{00}$	55.2	8.4	...	
$5^{00}-5^{30}$	39.5	17.3	...	
5^{30}	...	...	6.6	
$5^{30}-6^{00}$	13.2	9.4	...	
$6^{00}-6^{30}$	9.5	10.9	...	
6^{30}	...	...	0.9	
$6^{30}-7^{00}$	..	...	...	
$7^{00}-7^{30}$	4.6	7.7	...	
7^{30}	...	...	2.7	

During the water-periods the phosphate percentage in plasma is only little changed, but is greatly reduced during the theophylline-periods. The phosphate in the urine is lessened during the water diuresis. After theophylline the phosphate increases greatly and the maximum excretion does not coincide with the most profuse diuresis. Though the phosphate percentage in plasma is greatly reduced and the amount of urine is small, the amount of phosphate in the urine during the last periods is much larger than during the profuse water diuresis.

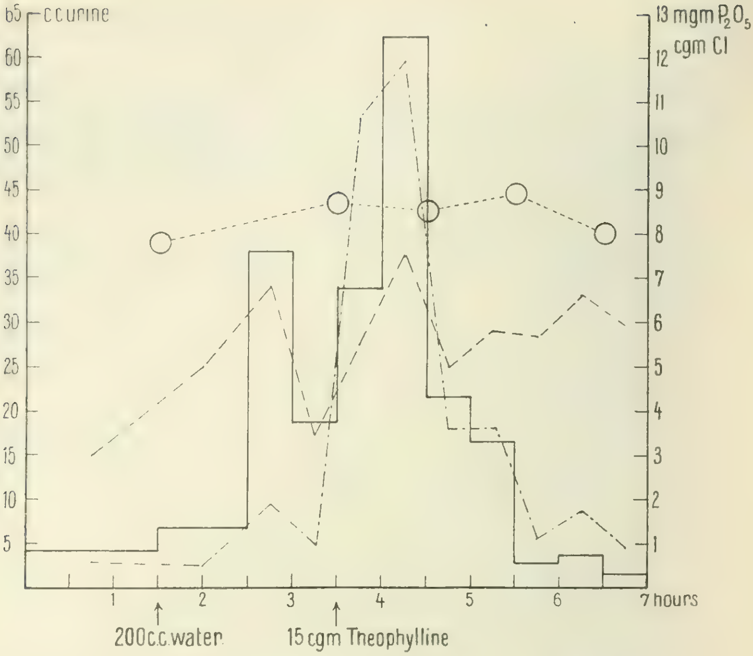


Curve 4 (exp. 5). (—) urine c. c. in 30 mins. (---) mgm P_2O_5 in the urine. (⊙---) mgm P_2O_5 in 100 c. c. plasma.

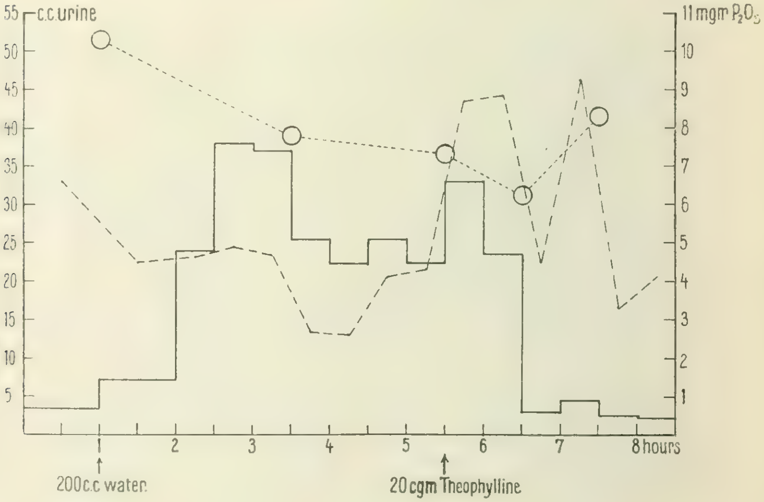
Experiment 6 (curve 5). Rabbit weight 2759 gm no food during 24 hours.

Time	Urine			Plasma	
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	cgm Cl in 30 mins	mgm P_2O_5 in 100 c. c.	
$0 — 1^{30}$	4.2	3.0	0.6	. .	
1^{30}	. . .	. .	. . .	7.8	200 c. c. water
$1^{30}—2^{30}$	6.8	5.0	0.5	. .	
$2^{30}—3^{00}$	38.0	6.8	1.8	. .	
$3^{00}—3^{30}$	18.6	3.5	1.0	. .	
3^{30}	. . .	. .	. . .	8.7	15 cgm theophylline
$3^{30}—4^{00}$	33.8	5.4	10.6	. .	
$4^{00}—4^{30}$	62.1	7.4	11.9	. .	
4^{30}	. . .	. .	. . .	8.5	
$4^{30}—5^{00}$	21.6	5.0	3.6	. .	
$5^{00}—5^{30}$	16.6	5.8	3.6	. .	
5^{30}	. . .	. .	. . .	8.9	
$5^{30}—6^{00}$	2.9	5.6	1.1	. .	
$6^{00}—6^{30}$	3.1	6.6	1.7	. .	
6^{30}	. . .	. .	. . .	8.0	
$6^{30}—7^{00}$	1.6	5.9	0.9	. .	

The phosphate percentage in the plasma changes but little during the different phases of the experiment. During the first two water-periods the urine is but slightly increased, but the phosphate is considerably augmented and further increases when in the third period, diuresis sets in. In the fourth water-period the diuresis is somewhat lessened and the phosphate reduced to nearly the original amount. The phosphate in the urine increases during the theophylline diuresis and remains high when, during the following periods, the urine is reduced to less than during the normal period. In this experiment the chlorides in the urine are also estimated. During the profuse water diuresis ($2^{30}—3^{00}$) the chlorine is but little augmented and the concentration in the urine is very low — 0.05 per cent. During the theophylline diuresis the chlorides in the urine increase very considerably and are subsequently reduced, following the changing amount of the urine rather closely.



Curve 5 (exp. 6). (—) urine c. c. in 30 mins. (---) mgm P_2O_5 in the urine. (—·—·—) cgm Cl in the urine. (◯---) mgm P_2O_5 in 100 c. c. plasma.



Curve 6 (exp. 7). (—) urine c. c. in 30 mins. (---) mgm P_2O_5 in the urine. (◯---) mgm P_2O_5 in 100 c. c. plasma.

Experiment 7 (curve 6). Rabbit weight 2700 gm, no food during 24 hours.

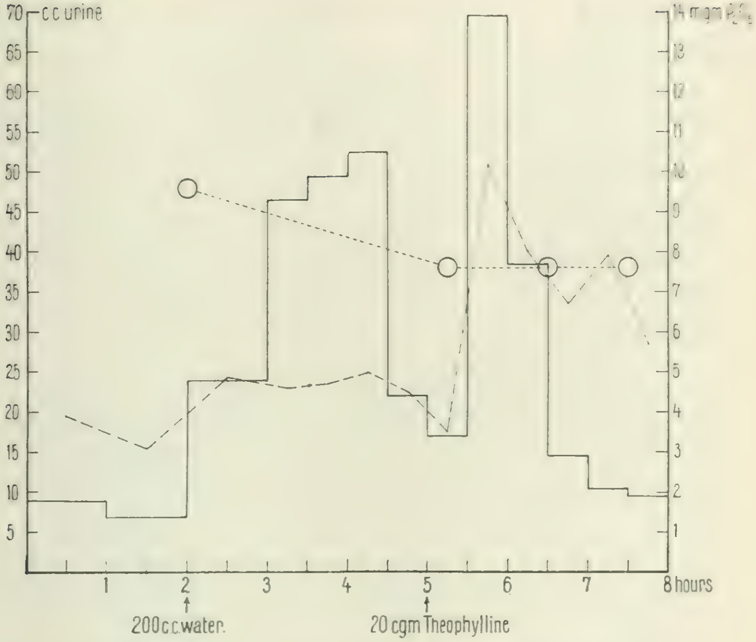
Time	Urine c. c. in 30 mins	Urine mgm P_2O_5 in 30 mins	Plasma mgm P_2O_5 in 100 c. c.	
0 — 1^{00}	3.4	6.6	...	
1^{00}	...	..	10.3	200 c. c. water
1^{00} — 2^{00}	7.3	4.5	...	
2^{00} — 2^{30}	24.0	4.7	...	
2^{30} — 3^{00}	38.1	4.9	...	
3^{00} — 3^{30}	36.1	4.7	...	
3^{30}	...	..	7.8	
3^{30} — 4^{00}	25.6	2.7	...	
4^{00} — 4^{30}	22.1	2.6	...	
4^{30} — 5^{00}	25.6	4.1	.	
5^{00} — 5^{30}	22.6	4.5	...	
5^{30}	...	..	7.3	20 cgm theophylline
5^{30} — 6^{00}	35.3	8.7	...	
6^{00} — 6^{30}	23.5	8.8	...	
6^{30}	...	..	6.2	
6^{30} — 7^{00}	3.0	4.5	...	
7^{00} — 7^{30}	4.6	9.2	...	
7^{30}	...	..	8.3	
7^{30} — 8^{00}	2.1	3.3	...	
8^{00} — 25^{00}	2.0	4.1	...	

The phosphate percentage in the plasma is reduced during the water diuresis and still more during the theophylline diuresis but increases at the end of the experiment. The administration of water induces a profuse and long-lasting diuresis, the subsequently induced theophylline diuresis being not so profuse as the water diuresis. After the administration of water the phosphate in the urine is reduced and remains so during a long series of water-periods. During the first two water-periods 1^{00}—2^{00}, the diuresis having not yet set in, the amount of excreted phosphate is nearly the same as during the profuse water-diuresis. After theophylline the phosphate in the urine increases to nearly twice as much as during the water diuresis, though the amount of urine is less. The maximum excretion of the phosphate takes place in a period (7^{00}—7^{30}) during which the amount of urine is very small.

Experiment 8 (curve 7). Rabbit weight 3000 gm, no food during 24 hours.

Time	Urine		Plasma	
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	mgm P_2O_5 in 100 c. c.	
0 — 1^{00}	8.9	3.9	. .	
1^{00}—2^{00}	6.9	3.1	. .	
2^{00}	. . .	. . .	9.6	200 c. c. water
2^{00}—3^{00}	24.3	4.9	. .	
3^{00}—3^{30}	46.6	4.6	. .	
3^{30}—4^{00}	49.6	4.7	.	
4^{00}—4^{30}	52.8	5.0	. .	
4^{30}—5^{00}	22.0	4.5	. .	
5^{15}	. . .	. . .	7.6	
5^{00}—5^{30}	17.1	3.5	. .	
5^{30}	. . .	. . .	. .	20 cgm theophylline
5^{30}—6^{00}	69.4	10.2	. .	
6^{00}—6^{30}	38.5	8.0	. .	
6^{30}	. . .	. . .	7.6	
6^{30}—7^{00}	14.7	6.7	. .	
7^{00}—7^{30}	10.6	7.9	. .	
7^{30}	. . .	. . .	7.6	
7^{30}—8^{00}	9.8	5.9	. .	

During the water diuresis the phosphate percentage in the plasma lessens somewhat and then remains unchanged during the rest of the experiment. The administration of water induces a profuse and long-lasting diuresis. The amount of phosphate is nearly the same during the different water-periods though the quantity of the urine varies considerably, and is almost the same as in the first normal estimation. During the theophylline diuresis the phosphate in the urine is greatly increased and remains high in the following periods, during which the quantity of the urine is but small.



Curve 7 (exp. 8). (—) urine c. c. in 30 mins. (---) mgm P_2O_5 in the urine. (⊙---) mgm P_2O_5 in 100 c. c. plasma.

Experiment 9. Rabbit weight 2660 gm, fed on beets, no food during 24 hours.

Time	Urine		Plasma	
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	mgm P_2O_5 in 100 c. c.	
$0-1^{00}$	9.7	1.3	..	
$1^{00}-2^{00}$	7.5	1.6	..	
2^{00}	...	..	6.9	
$2^{00}-3^{00}$	4.3	4.9	..	
3^{00}	...	..	..	20 cgm theophylline
$3^{00}-3^{30}$	22.3	9.1	..	
$3^{30}-4^{00}$	21.6	5.7	..	
4^{00}	...	..	4.8	
$4^{00}-4^{30}$	9.6	6.6	..	
$4^{30}-5^{00}$	8.0	5.9	..	
5^{00}	...	..	7.6	

Time	Urine		Plasma
	c. c. in 30 mins	mgm P_2O_5 in 30 mins	mgm P_2O_5 in 100 c. c.
$5^{00}-5^{30}$	9.5	5.7	. .
$5^{30}-6^{00}$	3.7	5.2	. .
6^{00}	. . .	. .	7.8
$6^{00}-6^{30}$	2.9	4.9	. .
$6^{30}-7^{00}$	2.2	5.7	. .
7^{00}	. . .	. .	7.6
$7^{00}-7^{30}$	2.3	4.4	. .

The phosphate percentage in the plasma is reduced during the first two theophylline-periods and increases afterwards. During the first normal periods ($0-2^{00}$) the amount of phosphate in the urine is but small, but increases considerably during the normal periods $2^{00}-3^{00}$. During the first theophylline-period the phosphate in the urine is greatly increased, it then lessens somewhat but remains high during a long series of periods, though the urine is gradually reduced to very small quantities.

Our experiment as well as previous investigations, concerning the same question, show that the amount of phosphate in the urine may, in normal animals, sometimes change from hour to hour to a certain extent. Further it must be noted that the same quantity of water or of theophylline may induce diuresis of rather varying profusion in different animals. Consequently the course of the different experiments may vary somewhat. The main-line of the experiments is however easy to see.

In seven experiments 200 c. c. water were given by means of a stomach tube. In two (No. 2 and No. 4) only a rather slight diuresis was induced and in both cases an augmentation of the phosphate was noted. But in experiment 4 (curve 3) this augmentation is present even in the first two periods after the administration of water during which the urine was only augmented to a very slight degree, and when the amount of urine, in the following water-period 3^{00}—3^{30}, reaches its maximum, there is no further increase of the phosphate. As to exp. 2 (curve 2) it is almost the same, the amount of urine in the first periods being however augmented to a somewhat greater extent. In exp. 1 and 6 the administration of water induces a rather considerable increase of the urine. In exp. 1 the amount of the urine is augmented during each of the four water-periods to the greatest degree during the fourth. The phosphate in the urine is a little lessened during the two first water-periods, rather unchanged during the third, and increased during the fourth. In exp. 6 (curve 5) a considerable increase of the phosphate is noted during the two first water-periods during which the urine is but very slightly augmented; when, in the third water-period (2^{00}—2^{30}), a profuse diuresis sets in, the further increase is less, and during the fourth period 2^{30}—3^{00} the phosphates are reduced nearly to the same amount as in the normal estimation, while the diuresis, though less profuse, is still persistent. In experiments 5, 7 and 8 the water induced a profuse and long-lasting diuresis and consequently particular significance must be attached to these experiments. In exp. 5 and 7 (curves 4 and 6) the amount of phosphate was reduced during the water diuresis, and in exp. 8 (curve 7) the phosphates were but slightly augmented, compared with the excretion in the first normal period. In each of these three experiments the excretion of the phosphate was traced through a great number of periods, and it will be seen from the curves that the amount of phosphate by no means follows the quantity of the urine during the different phases of the diuresis. The experiments and especially those by which a profuse and protracted diuresis was induced (5, 7 and 8) convincingly prove that, in water diuresis, there is no connection between the amount of phosphate excreted and the quantity of the urine. In the periods during which the urine was but little augmented, the amount of phosphate was found to be somewhat increased or somewhat reduced, similarly as in the estimations from hour to hour in normal conditions. And in the periods during which a profuse diuresis took place, the amount of phosphate in the urine most frequently remained rather unchanged compared with the excretion during the normal periods and during those water-periods in which the amount of urine was scarcely augmented. Hence we can only confirm the observations of Bock that a profuse water diuresis does not regularly induce an augmented excretion of the phosphate in the urine.

In the 7 experiments mentioned, 2 hours or more after the administration of water, and in most cases at a moment when the water diuresis had passed off, 15—20 cgm theophylline were given by means of a stomach tube. In two experiments (3 and 9) the theophylline was given without previous administration of water. In each experiment theophylline induced an augmentation of the urine which was rather small in exp. 2 and 3, while in the other 7 experiments a profuse diuresis was induced. In each experiment the phosphates in the urine increased — and in most cases greatly — after the administration of theopylline; thus in exps. 1, 2, 4, 5, 7 and 8 the amount of the phosphate rose to twice or thrice the amount of the normal estimations or of any period during the water diuresis. The theophylline diuresis was mostly of a rather short duration but, during the periods with maximum excretion, more profuse than the water diuresis. Yet in exp. 7 (curve 6) the diuresis during the two water-periods 2^{30}—3^{30} is more profuse than during the period 5^{30}—6^{00} in which the theophylline diuresis reaches its maximum. But the amount of phosphate in the urine is almost twice as large during the theophylline period as during any of the two water-periods mentioned.

The experiments prove that the increase of the phosphate induced by theophylline by no means follows the course of the diuresis. In exps. 1, 4, 5 and 7 (curves 1, 2, 3 and 5) the maximum excretion of the phosphate does not coincide with the most profuse diuresis, in exps. 1, 4 and 7 it appears even in periods in which the urine is reduced to nearly the normal quantity. In each of the experiments, during a long series of the later periods with greatly reduced urine, the excretion of the phosphate still remains augmented, being much larger than in the normal estimations and most frequently larger too than in the water-diuresis. After theophylline, the increase of the phosphate in the urine consequently does not follow the course of the diuresis but is much more persistent than the diuresis, and, as already mentioned, the maximum of excreted phosphate need not at all coincide with the most profuse diuresis. The increase of the urine and the augmentation of the phosphate, which both appear after the administration of theophylline, consequently are not connected, but have to be considered as due to different processes entirely independent of each other as Bock has previously asserted in the paper mentioned above. That the excretion of phosphate produced by theophylline has quite another course than the excretion taking place after the administration of large quantities of water becomes evident merely on considering the curves (f. i. 1, 2, 6 and 7).

In each experiment the percentage of phosphate in the plasma was estimated before, as well as at different moments after, the administration of theophylline, most frequently with intervals of an hour. In experiments 1, 3, 6 and 8 the estimated percentages vary very little after theophylline, in exp. 2 the percentage of the phosphate is at first somewhat increased and subsequently lessened, in exps. 7 and 9 the percentage at the commencement is somewhat reduced and subsequently rises. Most marked were the changes in exps. 4 and 5 in which the percentages of phosphate in the plasma are reduced in a very considerable degree. In exp. 4, at the end of the profuse theophylline diuresis the percentage of phosphate is thus reduced to less than half the original value an hour later, the percentage rises to the original amount and after another hour is reduced again. In exp. 5 the percentage of phosphate in the plasma during the first two hours after theophylline is reduced to a very small value and finally increases a little.

In the hours after the administration of theophylline the percentage of phosphate in the plasma thus either remained rather unchanged or was more or less reduced, sometimes very considerably. It is to be seen (curve 3 and 4) that 1 or 2 hours after the administration of theophylline the quantity of the urine as well as the percentage of phosphate in the plasma may be reduced, and still the amount of phosphate excreted in the urine may be much larger than during the normal periods and during the water diuresis. The experiments prove that the augmented excretion of phosphates in the urine after theophylline depends neither on an increase of the concentration of phosphate in the plasma nor on the quantity of the urine, and consequently they lead us to the view, previously advanced by Bock, that the augmented excretion of the phosphates after the administration of theophylline is due to a specific action of the drug on secretory elements of the kidney, and that these elements are probably not the same as those through which the diuresis is produced.

Our experiments concerning the excretion of phosphate in the urine after the administration of theophylline seem hardly compatible with the modern filtration-absorption theory. And with regard to water diuresis our experiments lead us to a similar result. According to the said theory the phosphates filtrated through the glomerulus are not returned to the blood[1] during the passage through the tubules. Hence if we measure the urine secreted during a certain period and estimate the phosphate percentage in the blood plasma and the amount of phosphate in the urine, we may be able to calculate the amount of fluid filtrated during the same period through the glomerulus. For such a calculation we will choose the period 2^{30}—3^{00} in exp. 6, in which both the phosphate and the chloride in the urine were estimated. During the period 100 c. c. plasma contained 8.4 mgm P_2O_5 (curve 5). According to the theory the amount of phosphate in the urine and in the corresponding glomerular filtrate is the same, and the urine containing 6.8 mgm P_2O_5 $100 \cdot \frac{6.8}{8.4}$ or 81 c. c. fluid ought to be filtrated during the period. The quantity of urine during the period being 38 c. c. $81 \div 38 = 43$ c. c. fluid ought to be absorbed through the tubule cells. According to the theory the absorbed fluid contains chloride in approximately the same concentration in which it is

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[1] A. Cushny: The Secretion of the Urine. 1917 p. 180.

present in normal plasma. The normal rabbit plasma containing 0.38 per cent chlorine (Abderhalden) the absorbed 43 c. c. fluid must consequently contain 163 mgm *Cl*, and the urine during the period containing 19 mgm *Cl* the filtrated 81 c. c. should contain $163 + 19 =$ mgm *Cl* or 0.22 per cent, and the plasma should consequently contain the same percentage of chlorine. But it is a well-known fact that even when large quantities of water are taken by the mouth, the dilution of the blood is exceedingly small and undoubtedly the percentage of chlorine in the plasma is but reduced in an insignificant degree, all the more so because the excretion of chlorine is scarcely augmented in the water diuresis. That the percentage of chlorine in plasma should be reduced during the water diuresis to almost half the normal value is impossible to imagine considering the numerous observations concerning the problem of the dilution of the blood by administration of water by the mouth, and a hypothesis leading to this result cannot be correct.

On the other hand, if we assume the percentage of chlorine in the plasma to be but slightly reduced during water diuresis, this will require, according to the theory, that enormous quantities of fluid are filtrated and absorbed to produce in the present case 38 c. c. urine containing 0.05 per cent chlorine. But the phosphate in the urine only corresponding to 81 c. c. glomerulus filtrate, this assumption must necessarily involve the admission that large quantities of phosphate are absorbed through the tubule cells. An example may illustrate the question. Supposing that the chlorine percentage in plasma is reduced during water diuresis to 90 per cent of the original value (a reduction which is undoubtedly rated too high) the absorbed fluid ought to contain 0.38 per cent and the filtrated fluid 0.342 per cent Cl. During the period 2^{30}—3^{00} mentioned in exp. 6 38 c. c. urine with 0.05 per cent Cl are secreted, and we will suppose x c. c. getting filtrated through the glomerulus and consequently $(x - 38)$ c. c. being absorbed through the tubule cells. The amount of chlorine in the glomerular filtrate being equal to the sum of the chlorine in the absorbed fluid and in the urine, we shall have the following equation

$$\frac{0.342}{100} \cdot x = \frac{0.05}{100} \cdot 38 + \frac{0.38}{100} \cdot (x - 38)$$

which gives $x = 330$ c. c.

A filtration of 330 c. c. would in the present case (100 c. c. plasma containing 8.4 mgm P_2O_5) involve a filtration of 27.7 mgm P_2O_5 but only 6.8 mgm being excreted with the urine, it will be necessary to admit an absorption of 20.9 mgm P_2O_5 thrice as much as excreted in the urine, which is in direct opposition to the above mentioned theory which claims that the phosphate is scarcely returned to the blood. Provided, as is most likely, that the chloride in the plasma, during the water diuresis is less reduced than supposed in the example above, the calculation will give far larger amounts of absorbed fluid and absorbed phosphate.

The results of our investigations concerning the excretion of phosphate under different conditions thus seem hardly compatible with a theory regarding the urine as merely a product of a filtration of deproteinized plasma through the glomerulus and an absorption of a fluid of constant composition through the tubule cells. The investigations being limited to the elimination of the phosphate we shall not try to educe general views as to the activity of the kidney on this base. But our experiments suggest that the excretion of the phosphate is due to an active secretory process taking place in elements of the kidney upon which the purine diuresis may exercise a stimulating effect. The elements through which the excretion of the phosphate is accomplished are most likely not the same as those by which the elimination of water is produced.

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CONTRIBUTIONS TO WEST AUSTRALIAN BOTANY

BY

C. H. OSTENFELD

PART III

C. H. Ostenfeld: ADDITIONS AND NOTES TO THE FLORA OF EXTRA-TROPICAL W. AUSTRALIA
(WITH XII PLATES AND 19 FIGURES IN THE TEXT)

1742

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
1921

PREFACE

In two earlier publications[1] I have dealt with some of the plants which I collected during my visit to Western Australia in 1914.

The bulk of my collection came from the extra-tropical south-western part of the state, and as this part is comparatively well explored with regard to its flora, my collection contains mostly well-known plants. Therefore, I do not find it worth while to publish a full list of all the plants which I brought home.

On identifying the plants it appeared, nevertheless, that the flora in many respects needs a more modern treatment and, in some cases, a revision of the old statements. Also several plants were present which seemed to me to have remained undescribed hitherto; this is not surprising when we take into account the vast area and the richness of its flora. I found it, therefore, necessary to take down notes on distribution, alterations of names, descriptions of new forms, critical remarks etc., successively as the identification of the collection went on. In this manner the following enumeration came into existence.

It contains what I have found worth publishing of my notes, both additions to the geographical distribution of the

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[1] Contributions to West Australian Botany, Part I (Dansk Botanisk Arkiv, Bd. 2, no. 6, 1916) and Part II (ibidem, no. 8, 1918).

species and notes of a more systematical nature. But it is far from a thorough revision. If it might encourage other botanists, especially botanists who are residents of W. A., to study their peculiar and beautiful flora more than has hitherto been the case, my object would have been amply achieved.

The main part of my work has been done in Copenhagen, but as the collection of W. Australian plants in the Botanical Museum there is not extensive, it soon became evident to me that it was necessary to consult larger herbaria, and by the aid of a grant from the Carlsberg Fund I was able to work about 3 weeks in 1919 at Kew where the richest Australian collections are, — at any rate richer than in any other place in Europe. Besides the collections at Kew I have consulted those in the British Museum (Natural History) and have further had some specimens sent on loan from the Berlin Museum. I take this opportunity of thanking the directors of these museums for their kindness, more especially I wish to mention Sir David Prain, the director of Kew Gardens where I worked for a considerable time.

When I began my work I was myself the keeper of the Botanical Museum at Copenhagen, but since then I have moved into another office. Therefore I wish to thank Professor C. Raunkiær, the director of the Botanical Gardens, for the kind permission to continue my studies at the museum.

It has taken some years to bring the naming of the plants to an end, and if I had not obtained assistance from many sides it would have taken still longer. I wish to express my thanks to Mr. Carl Christensen, the present keeper of the Botanical Museum of Copenhagen, for his valuable assistance in the naming of my material of the plant families *Proteaceæ*, *Dilleniaceæ*, *Epacridaceæ*, *Lobeliaceæ*, *Goodeniaceæ* and *Stylidiaceæ*. The families *Gramineæ*, *Leguminosæ* and *Myrtaceæ* (excl. *Eucalyptus*) have been identified by Professors R. PILGER, E. PRITZEL and L. DIELS of Berlin; the latter has further named some few other plants and has assisted me in many other respects. I take this opportunity of offering these gentlemen my best thanks. The paper published by L. DIELS and E. PRITZEL in 1904 is by far the most important paper on the W. Australian flora which has appeared since BENTHAM's Flora.

While working at Kew I had the good fortune to receive advice and help from Dr. O. STAPF, Mr. J. HUTCHINSON and others of the herbarium staff. To them also I owe my best thanks.

Lastly I cannot omit mentioning the valuable assistance rendered to me by Mr. J. H. MAIDEN, director of the Botanical Garden of Melbourne, who also identified my *Eucalypti*, by Professor A. J. EWART, director of the Botanical Garden of Sydney, and by Mr. J. M. BLACK of Adelaide.

In the introduction to my first paper on W. Australian botany (1916) I mentioned the places where I had the opportunity of collecting my material. There also I emphasised the great kindness with which I was treated both by the Government of Western Australia and by several persons. Most of my plants were collected by myself, but my countryman Mr. E. DORPH-PETERSEN brought me numerous specimens from the neighbourhood of Perth, and my friend Mrs. M. DAVIS, proprietress of the St. Omer Hospital, Perth, assisted me in collecting and has later sent me several small collections of herbarium plants. My best thanks are due to both and to the many others, here unnamed, who in one way or another did their share in helping me.

In the following enumeration the sequence of the plant families follows Engler's system (Syllabus der Pflanzenfamilien, 8. ed., 1919), while the species have mostly been arranged according to Bentham's *Flora Australiensis*. The latter work is quoted under each species throughout the whole enumeration, while otherwise I quote only the place where the name of the plant in question was published, and synonyms only where it was found to be of any use.

After the species name and the quotations the localities are given with collection no. and date in brackets. Then follow remarks of different kinds, mostly systematical and critical, but in some cases also biological notes, partly from my observations on the spot.

I. Pteridophyta.

Polypodiaceæ.

Asplenium trichomanes L. sp. pl. (1753) 1080; Benth. Fl. Austr. VII (1878) 745; C. Christensen, Index Filic. (1906) 135.

Yallingup Cave, in fissures of rocks (No. 6; 27. Sept. 1914).

Anogramma leptophylla (L.) Lk., Fil. sp. (1841) 137; C. Christensen, Index Fil. (1906) 58; *Grammitis leptophylla* Sw.; Benth. Fl. Austr. VII (1878) 776.

Yallingup Cave, in rock fissures of the Jarrah forest (No. 3; 27. Sept. 1914).

Notolæna distans R. Br., Prodr. Fl. Nov. Holl. (1810) 146; Benth. Fl. Austr. VII (1878) 774; C. Christensen, Index Fil. (1906) 460; Diels u. Pritzel, Bot. Jahrb. 35 (1904) 60.

Kalgoorlie, in rock fissures (3. Aug. 1914, Gunnar Andersson).

II. Monocotyledones.

Potamogetonaceæ.

Cymodocea and **Posidonia.**

The species of these two genera have been treated in the I. Part of my »Contr. W. Austr. Bot.«, 1916.

Scheuchzeriaceæ.

Triglochin.

A revision of the W. Australian species of *Triglochin* has appeared in the II. Part of my »Contr. W. Austr. Bot.«, 1918.

Hydrocharitaceæ.

Halophila.

The species of this genus have been treated in the I. Part of my »Contr. W. Austr. Bot.«, 1916.

Gramineæ (Determ. by Dr. R. Pilger).

Sorghum halepense (L.) Pers., Syn. I (1805) 101; Benth. Fl. Austr. VII (1878) 540.

York (No. 1399; 25. Nov. 1915, Mrs. M. Davis).

Introduced from the Mediterranean region.

Themeda triandra Forsk. Fl. Aegyp.-Arab. (1775) 178; *Anthistiria ciliata* L. fil. gram. gen. (1779) 35; Benth. Fl. Austr. VII (1878) 542.

Darlington near Perth (No. 28; 28. Aug. 1914, Cecil Andrews).

Ehrharta longiflora Sm. Plant. icon. ined. (1789—91) tab. 32; Stapf, in Fl. Cap. VII (1900) 664; Benth. Fl. Austr. VII (1878) 551; Diels u. Pritzel, Bot. Jahrb. 35 (1904) 69.

York (No. 1404; 25. Nov. 1915, Mrs. M. Davis).

Ehrharta brevifolia Schrad., in Goett. Gelert. Anzeig. III (1821) 2077, et in Schult. f., Syst. VII (1830) 1371; Stapf, in Fl. Cap. VII (1900) 673; Benth. Fl. Austr. VII (1878) 551.

Bayswater (No. 21; 18. Oct. 1914).

Both this and the foregoing species have been introduced from South Africa.

Oryzopsis miliacea (L.) Aschers. et Schweinf., Mém. Inst. Egypt. II (1889) 169; Aschers. u. Graebn. Syn. Mittel-Europ. Fl. II. 1 (1899) 96.

York (No. 1398; 25. Nov. 1915, Mrs. M. Davis).

Introduced from the Mediterranean region.

Stipa elegantissima Labill. Pl. Nov. Holl. I (1804) 23, tab. 29; Benth. Fl. Austr. VII (1878) 565; Diels u. Pritzel, Bot. Jahrb. 35 (1904) 69.

Kalgoorlie (No. 34; 7. Oct. 1914); York (No. 1400, 25. Nov. 1915, Mrs. M. Davis).

Stipa Tuckeri F. v. Müll. Fragm. Phytogr. Austr. XI (1881) 128.

Kalgoorlie (No. 35; 7. Oct. 1914).

Hitherto only known from Victoria and N. S. Wales.

Stipa compressa R. Br. Prodr. Fl. Nov. Holl. (1810) 175; Benth. Fl. Austr. VII (1878) 567.

Perth, King's Park (Nos. 19 and 24; 13. Oct. 1914).

Stipa aff. St. pubescentis R. Br.

Perth, King's Park (No. 23; 13. Oct. 1914).

Stipa trichophylla Benth. Fl. Austr. VII (1878) 570.

Kalgoorlie (Nos. 36 and 37; 7. Oct. 1914).

Calamagrostis filiformis (Forst.) Pilger, comb. nov.; *Avena filif.* Forster fil. Prodr. (1786) 9; *Deyeuxia Forsteri* Kunth, Enum. I (1833) 244; Benth. Fl. Austr. VII (1878) 579.

var. **Preissii** (Nees) Pilger, comb. nov.; *Lachnagrostis Pr.* Nees, in Pl. Preiss. II (1846) 97; *Deyeuxia Forsteri*, var. *Preissii* Benth. l. c.

Kalgoorlie (No. 32; 7. Oct. 1914).

Aira caryophyllea L. sp. pl. (1753) 66; Benth. Fl. Austr. VII (1878) 585; Diels u. Pritzel, Bot. Jahrb. 35 (1904).

Mundaring Weir (No. 16; 13. Sept. 1914); Perth, King's Park (Nos. 17 and 18; 10. Sept. and 13. Oct. 1914).

Aira capillaris Host, Gram. Austr. VI (1809) 20, tab. 35.

York (No. 1396; 25. Nov. 1915, Mrs. M. Davis).

Introduced from Europe.

Danthonia setacea R. Br., Prodr. Fl. Nov. Holl. (1810) 177; Benth. Fl. Austr. VII (1878) 595.

Kalgoorlie (Nos. 33 and 31; 7. Oct. 1914).

Amphipogon turbinatus R. Br., Prodr. Fl. Nov. Holl. (1810) 177; Benth. Fl. Austr. VII (1878) 599, partim; Pilger, apud Diels u. Pritzel, Bot. Jahrb. 35 (1904) 72.

Perth, King's Park (No. 25; 13. Oct. 1914).

Eragrostis setifolia Nees, in Hook. Lond. Journ. II (1843) 419; *E. chætophylla* Steud. Syn. Glum. I (1855) 279; Benth. Fl. Austr. VII (1878) 648.

Kalgoorlie (No. 30; 7. Oct. 1914).

Bromus madritensis L. Amoen. acad. IV (1755) 265; Sp. pl. ed. 2 (1762) 114.

York (No. 1402; 25. Nov. 1915, Mrs. Davis).

Introduced from Europe.

Hordeum murinum L. sp. pl. (1753) 85; Benth. Fl. Austr. VII (1878) 669.

York (No. 1401; 25. Nov. 1915, Mrs. M. Davis).

Introduced from Europe.

Cyperaceæ.

Cyperus tenellus L. fil. Suppl. (1781) 103; Benth. Fl. Austr. VII (1878) 265; Diels u. Pritzel, Bot. Jahrb. 35 (1904) 79.

Armadale, wet and clayey places (Nos. 186 and 193; 20. Sept. 1914); Bayswater, wet places (No. 186 bis; 18. Oct. 1914).

Scirpus cartilagineus (R. Br.) Spreng. Syst. I (1825) 208; Benth. Fl. Austr. VII (1878) 328.

Mundaring Weir, Darling Range (No. 192, 13. Sept. 1914); Armadale, bare and wet soil (No. 188, 20. Sept.

1914); Yallingup Cave, open sandy places in forest (Nos. 190 and 191, 27. Sept, 1914).

The specimens from Yallingup and Mundaring Weir agree well with Preiss' Nos. 1741 and 1742, while those from Armadale represent a much coarser plant which comes near to the fig. B on pl. 143 in Hooker f., Fl. Tasman.

Schoenus cygneus (Nees) Benth. Fl. Austr. VII (1878) 363; *Chætospora cygnea* Nees, in Ann. Nat. Hist. ser. 1, VI (1841) 49; vix *Schoenus cygneus* Nees in Pl. Preiss. II (1846) 81.

Tammin, heath (No. 180; 6. Oct. 1914).

A densely tufted plant with more or less curved slender stems.

Schoenus nanus (Nees) Benth. Fl. Austr. VII (1878) 364; *Chætospora nana* Nees, in Pl. Preiss. II (1846) 85.

Armadale, bare, clayey soil (No. 187; 20. Sept. 1914).

A dwarf, tufted annual (2—3 cm. high).

Evandra aristata R. Br. Prodr. Fl. Nov. Holl. (1810) 239; Benth. Fl. Austr. VII (1878) 424; Benth. in Hook. Icon. pl. pl. 1212; F. v. Müll., Fragm. Phytogr. IX (1875) 18.

I have collected this tall and beautiful plant in the classical place, Albany (No. 184, 20. Oct. 1914), where it was common in turfy swamps.

Bentham (l. c.) and, following him, Pax in Engler u. Prantl., Nat. Pflanzenfam., give the filiform stigmatic branches as 8 in number, but my specimens have always 10, and F. v. Müller (l. c.) says »7—10«. I think it better to alter the diagnosis of the genus to »stigmatic branches 8—10«.

Carex appressa R. Br., Prodr. Fl. Nov. Holl. (1810) 242; Kükenthal, Caricoideæ, in Engler, Das Pflanzenreich (1909)

178, fig. 29 E—J; *C. paniculata* Benth. Fl. Austr. VIII (1878) 440, saltem ex parte.

Yallingup Cave, along rivulets, forming big tufts (No. 197, 28. Sept, 1914).

Restionaceæ.

Anarthria gracilis R. Br. Prodr. Fl. Nov. Holl. (1810) 249; Benth. Fl. Austr. VII (1878) 213.

Palgarup, south of Bridgetown (No. 174; 2. Oct. 1914), male plant, in flower.

Centrolepidaceæ.

Aphelia cyperoides R. Br. Prodr. Fl. Nov. Holl. (1810) 252; Benth. Fl. Austr. VII (1878) 200; Diels u. Pritzel, Bot. Jahrb. 35 (1904) 93.

Bayswater, near Swan River, in a swamp (No. 13; 18. Oct. 1914); Albany, in wet sandy places (No. 12; 20. Oct. 1914).

This species is common at King George's Sound, and Diels (l. c.) says that it reaches as far as the district Stirling. Hence the record of it at Bayswater extends the range considerably.

The Bayswater specimens are taller and more slender than those from Albany; further, the number of bracts in each spike is higher (15—17), but otherwise they agree with them.

Centrolepis Drummondii (Nees) Hieron., in Abhandl. Naturf. Ges. Halle XII (1873) 98; Benth. Fl. Austr. VII (1878) 206.

Yallingup Cave, on sandy soil (No. 14; 26. Sept. 1914).

The specimens are 3—7 cm. high and more or less tinged with purple; the scapes are about 3—4 times as long as the leaves, and the specimens agree well with the description of *C. brevifolia* (Nees) Hieron., but this is said by BENTHAM (l. c.) to be only a synonym for *C. Drummondii.*

Centrolepis polygyna (R. Br.) Hieron., l. c. 96; Bentham, Fl. Austr. VII (1878) 203.

Near Armadale (No. 7; 22. Sept. 1914, E. Dorph-Petersen).

The floral bracts are of a dark chestnut-brown colour with the exception of the long awn; many carpels in the flower.

Amongst the *Triglochin* specimens of Plant. Preiss. No. 2409 (»in arenosis aquosis planitiei prope Perth«, 1839) I have found, in the Copenhagen Herbarium, a single plant of this species.

Centrolepis basiflora nov. sp. Fig. 1.

Plantula minuta annua. Radix fasciculato-fibrillosa. Folia 3 basalia bifaria filiformia, usque ad 15—20 mm. longa, basi vaginantia. Scapus nullus, spicula sessilis. Bracteæ florales 2 bifariæ, foliis simillimæ sed breviores, 7—10 mm. longæ, fere æquilongæ, parte basali in vaginam membranaceam amplificata. Flores 2—3 hermaphroditici, in axilla bractearum bibracteolati; stamina stigmataque e bractearum vaginis eminentia. Filamentum staminis ca. 4 mm. longum, majori parte a bracteola inferiore tectum. Carpidia duo (rarius unum); styli basi connati, stigmata 2 longa capillacea.

Ex affinitate *C. aristatæ* var. *pygmææ* F. v. Müll.

Hab. Austr. occid. ad Armadale prope Perth, solo subhumido, argilloso, subnudo (No. 11; 20. Sept. 1914, florens).

This little plant was very puzzling. It has the habit of DIELS's new genus *Hydatella*, but on closer examination it was found that the floral characters show much affinity to *Centrolepis aristata*, especially to the var. *pygmæa* F. Müll.

(in Benth., Fl. Austr. VII (1878) 207) from Tasmania which was pointed out to me by Dr. O. Stapf of Kew. Nevertheless it is quite distinct from *C. aristata* which grew together with it. The quite sessile spikelet and the rather hyaline vaginal parts of the leafy floral bracts make it easily recognisable. Its minute size explains why it has been overlooked hitherto.

Fig. 1. *Centrolepis basiflora* Ostf. To the left a whole plant, to the right the inflorescence alone. Photo. from specimens preserved in alcohol. ($^3/_1$ nat. size).

Philydraceæ.

Pritzelia pygmæa (R. Br.) F. v. Müll., Descript. Papuan Pl. I (1875) 13; Bentham, Fl. Austr. VII (1878) 74.

This small plant seems to be common in damp places of the south-western part of the state, at least in the coastal region. I have it from Albany (No. 1128; 20. Oct. 1914), Armadale (No. 1129; 20. Sept. 1914) and Bayswater (No. 1130; 18. Oct. 1914) in full flower. The perianth is yellow.

Juncaceæ.

Juncus planifolius R. Br. Prodr. (1810) 259; Benth. Fl. Austr. VII (1878) 125; Buchenau, Juncaceæ, in Das Pflanzenreich IV, 36 (1906) 249, ubi synom.

var. **humilis** nov. var. (Pl. III, Fig. 5). Differt a specie: caulis humilis (10—13 cm.), sat robustus; præter caulem principalem complures caules 2di ordinis minores gracilioresque; folia lata (usque ad 7 mm.) fere ad basin inflorescentiæ attingentia, præcipue basin versus fusco-purpurata; flores atrobrunnei; capitula plerumque 3—4-flora; semina majora.

Albany, on wet sandy soil (No. 148, 20 Oct. 1914).

It is only after much hesitation that I have chosen to place a broad-leaved *Juncus* from Albany (King George's Sound) under *J. planifolius;* its habit is very different from that of typical *J. planifolius*, but the characters point to that species.

Juncus maritimus Lam. var. **australiensis** Buchenau, Monogr. Juncac., in Engler, Bot. Jahrb. XII (1890) 257; Juncaceæ, in Das Pflanzenreich (1906) 155; *J. maritimus* Benth. Fl. Austr. VII (1878) 130.

Swan River near Bayswater (No. 149; 18. Oct. 1914).

Juncus pygmæus Thuill., Fl. envir. Paris (1799) 178; Buchenau, l. c. (1906) 164.

Perth, creeks (J. H. Maiden, 1909, acc. to specimens distributed by Nat. Herbarium of N. S. Wales), introduced.

Juncus capitatus Weig. Obs. bot. (1772), 28; Buchenau, l. c. (1906) 256.

Bayswater (No. 152; 18. Oct. 1914), Armadale (No. 150 a; 20. Sept. 1914) and Albany (No. 151; 20. Oct. 1914), introduced. Seems to be spreading rapidly in the foot-steps of man, as *J. bufonius* has done before it.

Luzula migrata (Buchenau) comb. nov.; *L. campestris*, var. *migrata* Buchenau, in Oesterr. bot. Zeitsch. (1898) 242, et l. c. (1906) 94; *L. campestris* Benth. Fl. Austr. VII (1878) 123.

Perth: King's Park, on sandy soil in open forest (No. 147; 18. Sept. 1914).

The Australian *Luzula* of the species-aggregate *L. campestris* is well defined by the bulbous bases of the stems and the long-stalked flower-clusters, and deserves species rank.

Liliaceæ.

Burchardia umbellata R. Br., Prodr. Fl. Nov. Holl. (1810) 273; Endl. in Pl. Preiss. II (1846) 44; Benth. Fl. Austr. VII (1878) 33 pro max. parte; *B. umb.* β Domin, in Journ. Linn. Soc. XLI (1912) 259; *B. congesta* Lindl. Swan Riv. App. Bot. Reg. (1839) 58; Endl. l. c.; *B. monantha* Domin, l. c., et in Beitr. Fl. u. Pflanzengeogr. Austr. I (1915) 518, tab. X, fig. 1.

Common around Perth (Nos. 104, 106, 1438; flow. in August—September 1914; No. 102, fruiting in Oct. 1914).

Bentham (l. c.) includes all the forms of *Burchardia* under one species reducing Lindley's two species (l. c. 1839) to synonyms; but I agree with Diels (Botan. Jahrb. 35

(1904) 98) who writes: »Per Australiam occidentalem *B. multiflora* Lindl. et *B. congesta* Lindl. fere semper facillime discriminari possunt«. Therefore I do not think it convenient to follow DOMIN (1912, pp. 258—260) who unites them under *B. umbellata* as *α* and *β* and adds a number of varieties under each of them. DOMIN points out that LINDLEY's *B. congesta* is the same as R. BROWN's original *B. umbellata*; consequently we must drop LINDLEY's name and use BROWN's earlier one. Thus we have two species, viz. *B. umbellata* R. Br. and *B. multiflora* Lindl. They differ from each other both in habit and habitat. The true *B. umbellata* (= Domin's *β*) has »foliis caulinis basi haud manifeste dilatatis, sed basi plus minusve amplectente vix latiore insertis«, and the inflorescence is usually rather few-flowered, the flowers on comparatively short stalks, and the anthers before opening yellow or orange-yellow. It prefers rather dry and sandy places and is more slender and taller than *B. multiflora*.

As far as I can judge from the description and drawing, DOMIN's *B. monantha* is nothing but a single- and large-flowered specimen of *B. umbellata*, while his var. *composita* is a luxuriant form.

Burchardia multiflora Lindl. Swan Riv. App. Bot. Reg. (1839) 58; Endl. in Pl. Preiss. II (1846) 44; *B. umbellata α*, Domin (1912) l. c. 259 (var. *multiflora*, var. *ornithogaloides* and var. *strictiflora*).

Common around Perth and Armadale (Nos. 103, 105, 107; Aug.—Sept. 1914).

B. multiflora Lindl. seems to be restricted to W. A. while *B. umbellata* is fairly distributed over the whole of temperate Australia, extending from N. S. Wales to W. A.

Domin (l. c.) characterizes it excellently as follows: "foliis caulinis basi (vagina) manifeste dilatatis, supremis vel bracteis ad vaginas latas reductis, pedicellis plerumque elongatis". He has 3 varieties under it, but I do not think it necessary to use these names as I suppose they indicate mere modifications. To his description I may add that *B. multiflora* has usually more rich-flowered inflorescences and long-stalked flowers, and the anthers are orange-red before opening.

It prefers rather wet and more humous places and is coarser and lower than the true *B. umbellata.*

From Diels's statements (l. c., 98) it seems as if he has used the names *B. congesta* and *B. multiflora* in a sense opposite to that used here, which is in accordance with the fact that R. Brown's *B. umbellata* is the same as Lindley's *B. congesta.*

Asphodelus fistulosus L. sp. pl. (1753) 309.

Geraldton, among the dunes along a road, in flower and fruit (No. 76; 29. Oct. 1914).

This common Mediterranean plant was not before recorded from W. Australia; and I must admit that my specimens at first gave me some trouble, as I did not expect to have to do with an introduced plant, as it grew freely among the dunes at some distance from Geraldton, although along a road.

I have grown it in Copenhagen from seeds from Geraldton, and have made some notes on the cultivated specimens. The flower is only open one day and is self-fertilizing. The perianth is white with a redbrown (CC 43[1]) midvein, the outer segments oblong-ovate, the inner ovate.

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[1] CC = Klincksieck et Valette, Code des Couleurs. Paris, 1908.

Filaments white with hairy basal parts hiding the ovary, otherwise glabrous, dilated above, but narrowed again under the anther. Pollen orange-red (CC 126). Style as long as the stamens; 3 globose, papillose, pink stigmas. Fruit nearly globose with emarginate apex, somewhat transversally rugose. Seeds triangular, black, not shining, transversally rugose. Fruiting pedicel double as long as the fruit, somewhat thickened.

Bulbine semibarbata (R. Br.) Haw. Rev. Pl. Succ. (1821) 33; Benth. Fl. Austr. VII (1878) 35; *Anthericum semibarbatum* R. Br. Prodr. Fl. Nov. Holl. (1810) 275.

Yallingup Cave, under shrubs, in flower (No. 112; 26. Sept. 1914).

Thysanotus tuberosus R. Br., Prodr. Nov. Holl. (1810) 282; Benth. Fl. Austr. VII (1878) 41.

Albany, in full flower (No. 84; 21. Oct. 1914).

Some specimens collected at Albany agree well with *T. tuberosus*, which is mainly an Eastern species; but Bentham (l. c., p. 42) says that he has seen specimens from W. A. "not distinguishable from some eastern forms of *T. tuberosus*", and in Kew Herb. W. A.-specimens from Westbourne, Dwalgarup (presd. by F. D. Godman 1915) are present.

On the whole the species of the genus *Thysanotus* are not well defined and require further observations; probably too many species have been created.

Thysanotus tenellus Endl. in Pl. Preiss. II. 1 (1846) 37; Benth. Fl. Austr. VII (1878) 40; *T. tenuis* Lindl. Bot. Reg. 24, 1838, tab. 50.

Armadale, in open forest (No. 82; 20. Sept. 1914).

Perhaps this species is not specifically different from

T. isantherus R. Br., the only distinction being the inequality of the anthers.

Chamæscilla corymbosa (R. Br.) F. v. Müll., Fragm. Phytogr. Austr. VII (1869—71) 68; Benth. Fl. Austr. VII (1878) 48; *Cæsia corymbosa* R. Br. Prodr. Fl. Nov. Holl. (1810) 277.

Near Perth (No. 79; 23. Aug. 1914, flowering, leg. E. Dorph-Petersen); Armadale, low-lying clayey soil (No. 77; 20. Sept. 1914, in fruit); Yallingup Cave, sandy soil in open forest (No. 78; 26. Sept. 1914, in flower).

This species is doubtless a common plant in the whole southwestern corner of the State.

Chamæscilla versicolor (Lindl.) comb. nov.; *Ch. corymbosa* var. *versicolor* Domin, Journ. Linn. Soc. XLI (1912) 263; *Cæsia versicolor* Lindl. Swan Riv. App. Bot. Reg. (1839) 57; *C. corymbosa* var. *versicolor* Baker, Journ. Linn. Soc. XV (1877) 361.

Greenmount (Darling Range) near Perth (No. 80; 13. Sept. 1914, in full flower).

This plant is mostly considered as a form or variety of *Ch. corymbosa*, but I think it is sufficiently distinct to be taken as a species. To Domin's diagnosis (l. c.): "Planta elata plus 3 dm alta, scapis foliis duplo longioribus, inflorescentia magna composita, floribus plerumque majoribus plus 8 mm latis" (errore calami "longis"), I may add the following distinctive marks from the flowers: in *Ch. corymbosa* the anthers are small and short (1—1,2 mm long) and the filaments more than double as long (2—4 mm), while in *Ch. versicolor* the anthers are larger (1,8—2 mm long) and the filaments not much longer than the anthers (2—3 mm long).

This character and the larger and broader leaves (only

2—3 in number) are, together with other minor differences, so valuable that the plant deserves specific range.

Tricoryne humilis Endl. in Pl. Preiss. II 1 (1846) 36; Benth. Fl. Austr. VII (1878) 53.

Armadale, on low-lying ground, in full flower (No. 114; 20. Sept. 1914).

The grass-like stem-leaves and outer bracts characterize this species.

Tricoryne elatior R. Br. Prodr. Fl. Nov. Holl. (1810) 278; Benth. Fl. Austr. VII (1878) 52.

A very variable species. I have what I call the typical form with the stem-leaves reduced, from several places near Perth (No. 115, near Armadale, 20. Sept., and No. 113, near Perth, 13. Sept. 1914, E. Dorph-Petersen).

A somewhat luxuriant form has better developed stem-leaves. It agrees with Kew Herb.'s specimens of *T. scabra* R. Br. (foliis caulinis gramineis, præcique inferioribus) and seems fairly common in W. Australia. My specimens were collected in Perth, King's Park (No. 117; 26. Oct. 1914). The variety seems to flower a little later than the main form.

Quite the opposite of this variety is a depauperate specimen from Albany (No. 116; 20. Oct. 1914) with reduced stem-leaves and single flowers; perhaps it is identical with *T. tenella* R. Br. l. c.

Agrostocrinum scabrum (R. Br.) comb. nov.; *A. stypandroides* F. v. Müll., Fragm. Phytogr. Austr. II (1860) 95, VII (1869—71) 65; Benth. Fl. Austr. VII (1878) 36, et aliis; *Stypandra scabra* R. Br. Prodr. (1810) 279; Endl. in Pl. Preiss. II (1846) 35.

Armadale, on low-lying ground, common (Nos. 89—91; 4. and 20. Sept. 1914).

It is necessary, according to the rules of nomenclature, to use R. Brown's species name instead of F. v. Müller's.

Cæsia parviflora R. Br. Prodr. Fl. Nov. Holl. (1810) 277; Benth, Fl. Austr. VII (1878) 47; *C. occidentalis* R. Br. l. c.; Endl. in Pl. Preiss II. 1 (1846) 33; Baker in Journ. Linn. Soc. XV (1877) 358.

Albany, in flower and with young fruit (No. 111; 21. Oct. 1914).

Some specimens (Pl. II, Fig. 3) with unbranched stems and whitish-green flowers collected on sandy soil at Albany agree very well with specimens of *C. parviflora* from Victoria and Tasmania, and I think this species (including what has been named *C. occidentalis*) occurs along the whole southern part of Australia from east to west.

Bentham (l. c.) suggests that it is "perhaps the only species in West Australia", but this suggestion is evidently wrong as I have brought home one other species, viz.:

Cæsia micrantha Lindl. Swan Riv. App. Bot. Reg. (1839) 57; Endl. in Pl. Preiss. II 1 (1846) 34.

Yallingup Cave (No. 110; 27. Sept. 1914, flowering); Perth, Kings Park (No. 108; 9. Sept. 1914, in full flower; No. 109; 13. Oct. 1914, with ripe fruit).

It is with some doubt that I use Lindley's name for this species, as his diagnosis is very brief, but especially on taking also Endlicher's short description (l. c.) into consideration and on comparison with his description of *C. occidentalis*, I think it allowable to revive an old name instead of creating a new one.

The plant in question (Pl. II, Fig. 4) approaches the

Eastern *C. vittata*, but it differs by the leaves reaching the top of the stem, and by the much smaller flowers on longer stalks; the perianth is dull purplish-brownish or whitish-brownish and inconspicuous.

The stems are 30—50 cm high with few long branches, leaves long linear, grass-like (up to 7 mm broad); flowers numerous, perianth only ca. 4 mm long, on pedicels several times longer. It is a much higher and more robust plant than the preceding species, the leaves of which are only 1—2 mm broad and the pedicels shorter than the whitish-green perianth.

Bentham (l. c.) has taken *C. micrantha* Lindl. as a synonym for *C. parviflora* R. Br., but I think he is wrong in doing so, at least as regards *C. micrantha*, a, *major* Endlicher (l. c.), which is undoubtedly our species.

Corynotheca micrantha (Lindl.) Macbride, Contr. Gray Herb. Harvard Univ. LVI (1918) 3; *C. dichotoma* F. v. Müll. Fragm. Phytogr. Austr. VII (1870) 68; Benth. Fl. Austr. VII (1878) 50; *Asparagus micranthus* Lindl. Swan Riv. App. Bot. Reg. (1839) 58; *Thysanotus micranthus* Endl. in Pl. Preiss. II. 1 (1846) 36; *Cæsia dichotoma* F. v. Müll. Fragm. Phytogr. Austr. I (1859) 215.

Perth, King's Park, on dry and sandy soil (No. 118; 13. Oct. 1914).

The changing of the species name is necessary according to the rules of nomenclature. This plant (Pl. I, Fig. 2) is one of the most singular Liliaceæ of W. A. by its many times repeated and regular dichotomy; the leaves are reduced to small scarious bracts.

It sèems to have a wide range towards the north as E. Cheel (K. Svenska Vet. Akad. Handl. Bd. 52, No. 10, 1916, p. 5) records it from "near Broome, Dampiers Land", collected by the Swedish zoologist Dr. E. Mjöberg in 1911.

Stypandra glauca R. Br., Prodr. Fl. Nov. Holl. (1810) 279; Benth. Fl. Austr. VII (1878) 53.

Besides the main form which was collected at Albany (No. 95; 21. Oct. 1914), a large-flowered and tall and robust form was brought home from Darlington near Perth (No. 94; 28. Aug. 1914, C. Andrews). It answers to the var. *grandiflora* (Lindl.) Baker (in Journ. Linn. Soc. XV (1877) 356; *S. grandiflora* Lindl. Swan Riv. App. Bot. Reg. (1839) 57).

Dianella revoluta R. Br. Prodr. Fl. Nov. Holl. (1810) 280; Endl. in Pl. Preiss. II. 1 (1846) 39; Benth. Fl. Austr. VII (1878) 15; *D. longifolia* Bot. Reg. tab. 734, not of R. Br.

Perth, King's Park, on sandy soil (No. 93; 15. Oct. 1914, flowers not yet open; No. 1311; 20. Nov. 1914, in full flower, Mrs. M. Davis).

The *Dianella*'s of Australia have been much confused with regard to their species names. The plant from King's Park is coarse and vigorous (70—80 cm high) with richly branched divaricate inflorescence, about as high as the leaves; pedicels a little longer than the flowers (10—15 mm); perianth leaves ovate-oblong (7—8 mm long), 7-nerved; anthers dark, shorter than the filament; upper part of filament much swollen, yellow, lower part somewhat twisted. I identify it with *D. revoluta* of R. Brown; it is the same form which Endlicher (l. c.) mentions from Freemantle observing that it differs from the eastern form only in "statura multo robustiore paniculisque magis divisis".

var. **brevicaulis** nov. var. (Pl. I, Fig. 1). Caulis foliis duplo vel ultra brevior, 20—25 cm alta; folia usque ad 65 cm longa, revoluta; pedicelli ca. 20 mm longi; flores tenues;

folia perianthii oblongo-linearia, 7—8 mm longa, indistincte 5-nervia, staminibus distincte longiora; filamenta antheris breviora, parte incrassata parva, parte basali non plicata. Ceterum ut *D. revoluta*.

Yallingup Cave, along a rivulet, in flower (No. 92; 27. Sept. 1914).

It appears from the above descriptions that my *Dianella* from Yallingup Cave is rather different from the typical *D. revoluta* as I have it from Perth; but as I have not much material at my disposal, and no fruiting specimens, I prefer to leave it as a variety under the said species. It seems to flower earlier.

Bartlingia grandiflora (Lindl.) F. v. Müll. Cens. (1882) 118; *Laxmannia grandiflora* Lindl. Swan Riv. App. Bot. Reg. (1839) 56, tab. 7; Benth. Fl. Austr. VII (1878) 64; *L. squarrosa* Endl. in Pl. Preiss. II. 1 (1846) 42, ex parte, non Lindl.

Vicinity of Perth (No. 1346; 1915, Mrs. Davis).

As pointed out by F. v. Müller (Fragm. Phytogr. VII (1870) 88) the name *Laxmannia* R. Br. is preoccupied by *Laxmannia* Forst. (*Petrobium* R. Br.), a genus of Compositæ, and Baron v. Müller has later (l. c. 1882) made the necessary changes using the name *Bartlingia* proposed by himself in 1870.

As far as my material allows of any judgment the genus needs a thorough revision, and I think too many species have been created, especially by Endlicher (l. c.).

Bartlingia paleacea (F. v. Müll.) comb. nov.; *Laxmannia paleacea* F. v. Müll. Fragm. Phytog. Austr. I (1859) 159; *L. grandiflora*, var. *paleacea* Benth. Fl. Austr. VII (1878) 64, ex max. parte.

Tammin, heath on sandy soil (No. 100 b; 6. Oct. 1914).

I think that the plant from Tammin (Pl. III, Fig. 2), which agrees exactly with specimens in the Kew Herb. "from between Esperance Bay and Fraser's Range" (leg. Dumpter), is sufficiently different from *B. grandiflora* to be kept as a separate species, not as a variety as Bentham (l. c.) has done. As I have not seen Müller's type specimens from Philip's River, I am not quite sure that the name is correct. The species in question differs from *B. grandiflora* by the very numerous empty outer bracts which are of a light chestnut-brown colour, and by the hairiness of the long bristles of the leaf-sheaths (they are smooth in *B. grandiflora*). It seems to be a species which occurs more inland than the others.

Bentham quotes Preiss' No. 1588 under his var. *paleacea*, but the Copenhagen set of Preiss's plants contains both typical *B. grandiflora* and *B. squarrosa* under No. 1588 and no *B. paleacea*.

Bartlingia squarrosa (Lindl.) F. v. Müll. Cens. (1882) 118; *Laxmannia squarrosa* Lindl. Swan Riv. App. Bot. Reg. (1839) 56; Benth. Fl. Austr. VII (1878) 64; *L. grandiflora* Endl. in Pl. Preiss. II (1846) 42, non Lindl.

Armadale, on sandy soil (No. 100 a; 4. Sept. 1914); Perth, King's Park, sandy soil (No. 98; 13. Oct. 1914).

Bartlingia minor (R. Br.) F. v. Müll. Cens. (1882) 118; *Laxmannia minor* R. Br. Prodr. Fl. Nov. Holl. (1810) 286; Benth. Fl. Austr. VII (1878) 65; *L. Roei* Endl., in Pl. Preiss. II (1846) 42.

Albany (No. 99; 21. Oct. 1914).

Johnsonia hirta Lindl. Swan Riv. App. Bot. Reg. (1839) 57, tab. 7; F. v. Müll. Fragm. Phytogr. VII (1870) 87; *J.*

pubescens Lindl. l. c.; Benth. Fl. Austr. VII (1878) 68; Domin, in Journ. Linn. Soc., vol. 41 (1912) 265.

Environs of Perth (Nr. 121; 23. Aug. 1914, E. Dorph-Petersen).

As *J. hirta* and *J. pubescens* have been described on the same page by LINDLEY (l. c.), but are only forms of the same species, F. v. MÜLLER (l. c.) has correctly taken the name first printed of the two as the valid one, while BENTHAM, DOMIN, and others wrongly use the second name. It seems to be a very variable species, as I quite agree with DOMIN (l. c.) in including ENDLICHER's three species under it.

We have at present only two well-distinguished species of the genus, viz. *J. hirta* and *J. lupulina* R. Br., the latter a dominant feature in the vegetation of the southernmost corner of the state. I have it from Albany (No. 120; 21. Oct. 1914) and Palgarup near Bridgetown (No. 119; 2. Oct. 1914).

Borya nitida Labill. Pl. Nov., Holl. I (1804) 81, tab. 107; Benth. Fl. Austr. VII (1878) 71.

Of this variable species I have collected a somewhat aberrant form (Pl. III, Fig. 6) with densely placed, short and broad leaves with long pungent points; it formed dense cushions on low-lying heath at Tammin (No. 101; 6. Oct. 1914), and was completely killed by the exceptional draught.

Typical specimens were collected at Mundaring Weir (No. 98; 13. Sept.) and Armadale (No. 97; 20. Sept. 1914), growing in clayey soil, in full flower.

Dasypogon Hookeri Drummond, in Hook. Lond. Journ. Bot. II (1843) 168; Benth. Fl. Austr. VII (1878) 119; Diels, Pflanzenwelt v. West-Austr. (1906) 116.

Near Yallingup Cave (No. 134; 30. Sept. 1914).

In the Jarrah forest somewhat north of the Yallingup

Cave I met with this singular "grass-tree". As pointed out by L. Diels (l. c.) it has a very restricted area of distribution, being confined to the southernmost corner of the west coast of the state.

Acanthocarpus Preissii Lehm. in Pl. Preiss. II (1848) 274; Benth. Fl. Austr. VII (1878) 111; Diels in Engl. Bot. Jahrb. vol. 35 (1904) 102; *A. mucronatus* Macbride, Contr. Gray Herb. Harvard Univ. LVI (1918) 4; an *Xerotes mucronata* R. Br. Prodr. Fl. Nov. Holl. (1810) 260?

Yallingup Cave, amongst shrubs near the shore (No. 127; 26. Sept. 1914); Geraldton, among the dunes (No. 138; 29. Oct. 1914).

This species seems to be widely distributed along the west coast of the State. It had ripe fruits in October at Geraldton.

Lomandra Endlicheri (F. v. Müll.) Ewart, Proc. Roy. Soc. Victoria 28 (N. S.) II (1916) 219; *Xerotes Endlicheri* F. v. Müll., Fragm. Phytogr. Austr. VIII (1874) 205; Benth. Fl. Austr. VII (1878) 101.

Environs of Perth (No. 123; 9. Aug. 1914, E. Dorph-Petersen; No. 122; 30. Aug., idem); Big Brook, South of Bridgetown, in the Karri forest (No. 126; 2. Oct. 1914; imperfect specimens).

Lomandra cæspitosa (Benth.) Ewart, l. c. 220; *Xerotes cæspitosa* Benth. Fl. Austr. VII (1878) 104.

Cottesloe (No. 125; 23. Aug. 1914, Cecil Andrews).

Lomandra Sonderi (F. v. Müll.) Ewart, l. c. 219; *Xerotes Sonderi* F. v. Müll. Fragm. Phytogr. Austr. VIII (1874) 206; Benth. Fl. Austr. VII (1878) 99.

Yallingup Cave, in forest (No. 124; 29. Sept. 1914, in fruit).

Hæmodoraceæ.

Hæmodorum sparsiflorum F. v. Müll. Fragm. Phytogr. Austr. VII (1870) 117; Benth. Fl. Austr. VI (1873) 420; Diels u. Pritzel, Engl. Botan. Jahrb. **35** (1904) 106.

Bayswater, in sandy swamp (No. 72; 18. Oct. 1914, in flower).

Hæmodorum spicatum R. Br. Prodr. Fl. Nov. Holl. (1810) 300; Benth. Fl. Austr. VI (1873) 420.

Perth, King's Park (No. 75; 15. Oct. 1914, flowering just begun); same locality (No. 1313; 20. Nov. 1914, Mrs. M. Davis, flowering over, only very few of the flowers have set fruit).

Hæmodorum laxum R. Br. Prodr. Fl. Nov. Holl. (1810) 300; Benth. Fl. Austr. VI (1873) 421; Diels u. Pritzel, Engl. Bot. Jahrb. 35 (1904) 106.

I agree with Diels (l. c.) in referring Preiss' No. 1629 to this species, not as Bentham (l. c.) has done to *H. paniculatum*. Also Preiss' No. 1422 which is not specifically identified in *Pl. Preiss.* belongs to *H. laxum* as far as the specimens in the Botan. Mus. of Copenhagen go. Localities are not given for any of these Nos.

Hæmodorum paniculatum Lindl. Swan River, App. Botan. Reg. (1839) 44; Benth. Fl. Austr. VI (1873) 420.

To this species which is, as Bentham says, very near *H. laxum*, I refer some flowering specimens from Perth, King's Park (No. 74; 15. Oct. 1914).

Hæmodorum simplex Lindl. Swan River, App. Botan. Reg. (1839) 44; Benth. Fl. Austr. VI (1873) 421.

Bayswater, sandy soil near Swan River, with young fruits (No. 73; 18. Oct. 1914).

This species seems to flower earlier than the others. It differs from these in the shape of the anthers: they are small and elliptic.

Amaryllidaceæ.

Phlebocarya ciliata R. Br. Prodr. Fl. Nov. Holl. (1810) 301; Benth. Fl. Austr. VI (1873) 424.

var. *lævis* (Lindl.) Benth. l. c. 425; *Ph. lævis* Lindl., Swan River App. Botan. Reg. (1839) 43.

Perth, King's Park, common on sandy soil in the open forest, in full flower (No. 38; 4. Oct. 1914). Flowers whitish.

The plant agrees well with Lindley's description and with specimens in Kew Herbarium and Preiss' No. 1558; therefore I refer it to var. *lævis* Benth; but I am not sure that the type of *Ph. ciliata* of R. Br. is at all different from var. *lævis* (Lindl.).

Hypoxis occidentalis Benth. Fl. Austr. VI (1873) 451.

Environs of Perth (No. 71; 16. Aug. 1914, E. Dorph-Petersen).

Bentham (l. c, 450) refers Preiss' No. 1601 with some doubt to the eastern and southern *H. glabella*, but I think it better to refer it to *H. occidentalis* which is characterized by the long (oblong-linear) ovary, but varies as regards the base of the anthers and the length of the stigmas.

H. leptantha Benth. (l. c., 451) must be included under *H. occidentalis*, as suggested already by Bentham himself. F. v. Müller (Sec. Census, 1889, 195—96) has omitted it.

Tribonanthes Endl.

The species *T. brachypetala* Lindl. and *T. longipetala*

Lindl. seem to be common on humous-sandy and wet soil in the Swan River region, while *T. australis* Endl. takes their place around King George's Sound. They flower in July—August and have fruits in October (November). As BENTHAM (Fl. Austr. VI, 426) remarks, "the species appear to be very variable and difficult to distinguish".

Conostylis R. Br.

What has been said about *Tribonanthes* as regards the polymorphism, is even more appropriate in the case of the genus *Conostylis*; the definition of the species and the limits between them are very arbitrary. In the following I have used the definitions given by BENTHAM (Fl. Austr.) and shall restrict myself to a few remarks, as this genus requires a thorough revision based upon ampler material and studies in nature.

Conostylis setosa Lindl. Swan River, App. Bot. Reg. (1839) 44, tab. VI A; Benth. Fl. Austr. VI (1873) 431.

Greenmount, Darling Range near Perth (No. 58; 13. Sept. 1914).

My plant agrees very well with *C. setosa* as represented by PREISS' No. 1408, but it differs from LINDLEY's fig. (l. c.) in the colour. LINDLEY gives to his *C. setosa* the usual yellow colour of the perianth, but the perianth colour in my specimen was of a pale dull-pink or purple. In this respect it comes near to *C. discolor* Endl., but it has the much larger flowers of *C. setosa*. In the Kew Herb. there are specimens collected by CECIL ANDREWS at Armadale (19. Oct. 1901, No. 959), they have the same colour, and Mr. Andrews has remarked on the label: "Differs in colour from rest of the genus. Fl. white, often tipped with pink or purple". Also the many specimens collected by DRUMMOND seem to have the same pale colour. It is therefore probable that this character is special for *C. setosa* and that the colouring of the plate in Lindley's paper is erroneous.

Conostylis aurea Lindl. Swan River, App. Bot. Reg. (1839) 44; Benth. Fl. Austr. VI (1873) 432.

Bayswater, sandy heath (No. 56; 18. Oct. 1914).

Conostylis setigera R. Br. Prodr. Fl. Nov. Holl. (1810) 300; Benth. Fl. Austr. VI (1873) 432.

Common around Perth (Nos. 54, 60, 64) and also collected at Albany (No. 65; 21. Oct. 1914).

Conostylis psyllium Endl. in Pl. Preiss. II, 1 (1846) 21; Benth. Fl. Austr. VI (1873) 433; Domin, Journ. Linn. Soc. XLI (1912) 256.

Greenbushes, north of Bridgetown, on gravels (No. 52; 30. Sept. 1914).

A very striking little plant forming dense tufts.

Conostylis juncea Endl. Nov. Stirp. dec. (1839) 19; Plantæ Preiss. II, 1 (1846) 23; Benth. Fl. Austr. VI (1873) 434; *C. involucrata* Endl., Pl. Preiss. II, 1 (1846) 23; Benth l. c.

Bayswater, sandy heath (No. 57; 18. Oct. 1914), leaves subterete, very narrow; environs of Perth (No. 63; 16. Aug. 1914, E. Dorph-Petersen), leaves subterete, very narrow.

Var. *involucrata* (Endl.) comb. nov.: Perth, Victoria Park (No. 62; 18. Sept. 1914, E. Dorph-Petersen), leaves flat, striate.

F. v. Müller has (Fragm. Phytogeogr. Austr. VIII, 1872, 19) united *C. juncea* and *C. involucrata* into one species, and I quite agree with him. The only point of difference is the shape of the leaves, those of *C. juncea* (see Pl. II, Fig. 2) being terete and obscurely striate, those of *C. involucrata*

(Pl. II, Fig. 1) being linear, flat and striate. In my material I have specimens with flat and striate, others with terete or subterete and faintly striate leaves. Also the specimens in the Kew Herb. are rather variable as regards the leaves. Therefore I find it correct to have only one species of which we may take the flat-leaved form as var. *involucrata* (Endl.).

Conostylis candicans Endl. Nov. Stirp. Dec. (1839) 20; Pl. Preiss. II, 1 (1846) 16; Benth. Fl. Austr. VI (1873) 436.

Environs of Perth (No. 66; 11. Aug. 1914, Cecil Andrews).

As the material at hand is very scanty, the identification is somewhat doubtful.

Conostylis bracteata Endl. Pl. Preiss. II, 1 (1846) 16; Benth. Fl. Austr. VI (1873) 437 (an *C. bracteata* Lindl.?).

Environs of Perth (No. 61; 23. Aug. 1914, E. Dorph-Petersen); King's Park (No. 55; 13. Oct. 1914), a more slender plant.

Conostylis aculeata R. Br. Prodr. Fl. Nov. Holl. (1810) 300; Bot. Magaz. tab. 2989; Endl., in Pl. Preiss. II, 1 (1846) 18; Benth. Fl. Austr. VI (1873) 438.

Yallingup Cave, on sandy places in open forest (No. 59; 26. Sept. 1914).

My specimens are somewhat proliferous, the floral scapes about as long as the leaves, and the leaves rather narrow; they seem to be in some respects intermediate between *C. Preissii* and *C. aculeata*.

Conostylis cymosa F. v. Müll., in Benth. Fl. Austr. VI (1873) 439.

Yornup, south of Bridgetown (No. 53; 2. Oct. 1914).

A distinct species which is related to *C. aculeata*.

Macropodia fuliginosa (Hook.) comb. nov.; *Anigozanthos fuliginosus* Hook., Botan. Magaz. tab. 4291 (1847); F. v. Müller, Sec. Census (1889) 195; *Macropidia fumosa* J. Drumm. in Hook., Journ. of Bot. VII (1855) 57; *Macropodia fumosa* Benth. Fl. Austr. VI (1873) 447.

Moora (No. 39; 27. Oct. 1914, comm. by Mrs. M. Davis).

The changing of species name seems necessary according to the rule of priority. The peculiar "Black Kangoroo Paw" does not occur in the neighbourhood of Perth; it has a rather restricted area of occurrence and seems to avoid the more rainy districts.

Anigozanthos humilis Lindl., Swan Riv. App. Bot. Reg. (1839) 46, tab. 63 (colore florum male picto); Benth. Fl. Austr. VI (1873) 444; Domin, Beitr. z. Flora u. Pflanzengeogr. Austr. I (1915) 528, tab. X, fig. 2 (bona).

Common around Perth in sandy places (Nos. 45, 47, 48, 49, 1362, 1448); Moora (No. 1417; 25. Sept. 1915, Miss G. Davis).

Anigozanthos viridis Endl., in Pl. Preiss. II 1 (1846) 25; Benth. Fl. Austr. VII (1873) 445.

Vicinity of Perth: Cannington, in wet places (No. 41; 22. Sept. 1914, E. Dorph-Petersen).

As given by Bentham (l. c.) the filaments are nearly as long as the anthers.

Anigozanthos Manglesii D. Don, in Sweet, Brit. Flow. Gard., Sec. ser., tab. 265 (1836); Benth. Fl. Austr. VI (1873) 445.

Common around Perth in sandy places (Nos. 50, 51, 1361).

Besides the type two colour varieties were found, the latter perhaps a hybrid:

var. **flavescens** Ostf. nov. var. Lanugine in parte inferiore florum (ovario) pallide flavescente, in parte superiore viridescente.

Perth, King's Park (No. 42; 13. Oct. 1914), a few specimens growing together with the typical form.

This variety is mentioned by BENTHAM (l. c.).

var. **virescens** Ostf. nov. var. Lanugine in parte inferiore florum (ovario) sordide viride, ceterum ut in typo viridissimo, sed in pedunculis scapoque sordide erubescente; filamentis antheris duplo brevioribus.

Environs of Perth (No. 46; 16. Aug. 1914, E. Dorph-Petersen).

This variety was brought to me by Mr. E. DORPH-PETERSEN; it looks rather like *A. viridis*, but differs in the dull red wool of the scape and peduncles and in the filaments being at least twice as short as the anthers. Unfortunately no basal leaves are present; the scape leaves are narrower than in the typical *A. Manglesii*. All the distinguishing marks point to the plant being an intermediate (hybrid?) between *A. Manglesii* and *A. viridis*, but further observations on this point are necessary.

Anigozanthos bicolor Endl., in Pl. Preiss. II 1 (1846) 26; Benth. Fl. Austr. VI (1773) 446.

Yornup, south of Bridgetown (No. 40; 2. Oct. 1914).

The specimens agree well with BENTHAM's var. *major* (l. c.). It has much resemblance to *A. Manglesii*, but differs in the following: Leaves shorter and narrower, their back-keel with ciliate hairs (present also in Endlicher's type, Preiss' No. 1417, but wanting in *A. Manglesii*); flowers about 25—26 mm long; filaments shorter than the anthers, but much longer than in *A. Manglesii*.

Perhaps this is the same plant as that which K. Domin (Journ. Linn. Soc. XLI, 1912, 257) has named *A. Manglesii* var. *leptophylla* Domin, and which came from the same area (Bridgetown to Kojonup and Slab Hut Gully).

Anigozanthos flavida Redouté, Les Liliacées, no. et tab. 176 (1807); Benth. Fl. Austr. VI (1873) 443.

Palgarup, south of Bridgetown (No. 44; 2. Oct. 1914), not yet flowering; Albany, common in wet places (No. 43; 20. Oct. 1914), flowering hardly yet begun.

This large and tall plant flowers much later than the other species.

Iridaceæ.

Romulea rosea (L.) Eckl., Topogr. Verzeichn., 1. Lief. (1827) 19; Beguinot, Revis. monogr. Romulea, in Malpighia vol. 23 (1909) 65; *R. cruciata* A. J. Ewart in Proc. Roy. Soc. Victoria, vol. 19, N. S. (1906) 43, pl. XII, and vol. 22, N. S. (1909) 325; *R. bulbocodium* C. H. Wright in Kew Bull. (1908) 307.

Environs of Perth, common (Nos. 174, 175, 176, 177).

The so-called "Guilford Grass" is a very common and troublesome weed in the surroundings of Perth and adjacent places. The grass-like leaves often cover the ground completely and look like fine grass, but they are of no use at all as the cattle does not eat them. The nice rose-coloured flowers are only open in the forenoon; they appear in the spring (August—September) and the seeds are ripe at the end of October. There seems to be some variability as regards the size and the intensity of the colour of the flower.

As to the name of this plant which has no doubt come from South Africa and has now spread widely over Australia (cfr. Ewart, l. c.), I follow the monographer of the genus

Dr. A. Beguinot, who (l. c. p. 65) refers the Australian plant to *R. rosea*. A. J. Ewart (l. c. 1906) has referred it to *R. cruciata*, but, according to Beguinot, this name is often misinterpreted and ought to be omitted. Ewart shows that transverse sections of the leaves of the Australian plant come very near to those of *R. rosea*, and so there is in reality not much difference of opinion between him and Beguinot. In an additional note (l. c. 1909) he refers to Beguinot's preliminary survey of the genus, but the monograph itself was as that time not available to him.

In a note on "Romulea as a pest in Australia" C. H. Wright (l. c.) has referred the species to *R. bulbocodium*, but this is only because he includes *R. rosea* under that species. Taking all things together I think we may safely name the Australian plant *R. rosea*, as Beguinot has done.

Homeria collina (Thunb.) Vent. Dec. Gen. Nov. (1808) 5.

Bayswater, on low ground along a road-side near Swan River, in fruit (No. 168; 18. Oct. 1914).

A South African species which has escaped from cultivation.

Babiana plicata (Thunb.) Ker. Gawl., Bot. Magaz., tab. 576 (1802).

Armadale, on low ground along a road-side, in flower (No. 166; 20. Sept. 1914).

Also a South African species which has escaped from cultivation.

Patersonia R. Br.

F. v. Müller (Fragm. Phytogr. Austr. VII (1869) 31) has taken up Labillardière's earlier name *Genosiris* (1804) instead of R. Brown's name *Patersonia* (Botan. Magaz., 1807), and he is quite right in doing so. When nevertheless I continue to use the commonly accepted *Patersonia*, it is because it is in the list of *nomina conservanda,* adopted by the International Congress of Vienna, 1905; but I admit that there is no other real reason for doing so, as Labillardière's planche and description (Nov. Holl. Pl. spec. I, p. 13, pl. 9) cannot possibly be mistaken.

The species of this genus are difficult to identify and a thorough revision is much needed, but it must be carried out upon living specimens as the flowers are very delicate.

Patersonia occidentalis R. Br. Prodr. Fl. Nov. Holl. (1810) 304; Benth. Fl. Austr. VI (1873) 403.

This species seems very variable; I have specimens (No. 173) which I refer hereto, in which the leaves are 6—8 mm broad. It was common on sandy soil (heaths) around Perth (Nos. 173 and 1446) and flowered in Sept.—Octob.

Patersonia xanthina Oldfield et F. v. Müll., in Fragm. Phytogr. Austr. I (1859) 214; Benth. Fl. Austr. VI (1873) 404; *P. umbrosa,* var. *xanthina* Domin, Journ. Linn. Soc. XLI (1912) 254.

Jarnadup, south of Bridgetown (No. 169; 1. Oct. 1914).

This species is characterized by the very long and slender spathe-leaves besides the yellow flowers. There is no reason to reduce it to a variety of *P. umbrosa* which is a much stouter species.

Patersonia longiscapa Sweet, Fl. Austr. t. 39 (1828); Benth. Fl. Austr. VI (1873) 402.

Big Brook, south of Bridgetown, in a swamp

(No. 172; 2. Oct. 1914); Albany, swamp (No. 171; 22. Oct. 1914).

With some doubt I refer my plants from Albany and from Big Brook State Saw-mill (Pl. III, Fig. 4) to the Eastern and Southern *P. longiscapa*, as understood by BENTHAM and MÜLLER, but I cannot find any difference at all between my specimens and specimens of *P. longiscapa* from Grampians, Victoria, leg. C. Walter, communicated to the Botanical Museum of Copenhagen by the late F. v. Müller; neither do the Kew specimens disagree. My specimens agree with *P. longiscapa* in all essential parts as well as in habit, only the leaves are somewhat longer and narrower (ab. 2 mm broad).

Perhaps this is *P. Roei* Endl. in Pl. Preiss. II, 1 (1846) 31, of which I have not seen any specimens.

Patersonia pygmæa Lindl. Swan River App. Bot. Reg. (1839) 58; Benth. Fl. Austr. VI (1873) 405.

Wilgarup, south of Bridgetown (No. 170; 1. Oct. 1914).

The specimens (Pl. III, Fig. 3) differ from the description in having the floral scapes glabrous; but this is also the case in several specimens in the Kew Herb.

Orthrosanthus laxus (Endl.) Benth. Fl. Austr. VI (1873) 411; *Libertia laxa* Endl. in Pl. Preiss. II, 1 (1846) 32.

Mundaring Weir, Darling Range (No. 167; 13. Sept. 1914); Perth, King's Park.

Orthrosanthus polystachyus Benth. Fl. Austr. VI (1873) 411.

Big Brook, south of Bridgetown, in a swamp (No. 165; 2. Oct. 1914).

A tall species with sky-blue flowers, smaller than in *O. laxus*.

Orchidaceæ.

Calochilus Robertsonii Benth., Fl. Austr. VI (1873) 315; F. v. Müll. Sec. Census (1889) 189.

Albany, in a swamp (No. 218; 20. Oct. 1914).

In Bentham's Flora this species is only recorded from Victoria, but in F. v. Müller, Sec. Census, also W. A. is given.

Thelymitra fasciculata R. Fitzgerald, Austral. Orch. vol. II, part 5 (1895).

Bayswater, in a swamp (No. 248; 18. Oct. 1914).

My specimens agree very well with this species both according to the plate and the description. The author says that it is very near *T. ixioides* and has been overlooked, or confounded with it.

Thelymitra flexuosa Endl. Nov. Stirp. Dec. (1839) 23; Benth. Fl. Austr. VI (1873) 322.

Yornup, south of Bridgetown (No. 209; 2. Oct. 1914).

Diuris Purdiei Diels, Journ. Muell. Bot. Soc. W. Austr. No. II (1903) 79; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 117.

Cannington, near Perth (No. 246; 22. Sept. 1914, E. Dorph-Petersen).

The specimens agree with the description given by L. Diels (l. c.); also the locality is nearly the same as that given by him.

Prasophyllum hians Rchb. f., Beitr. system. Pflanzenk. (1871) 61; Benth. Fl. Austr. VI (1873) 338.

Near Perth (Nos. 204 and 206; 23. Aug. 1914, E. Dorph-Petersen; 18. Sept. 1914, Cecil Andrews); Moora (No. 1418; 25. Sept. 1915, Miss G. Davis).

Microtis atrata Lindl. Swan Riv. App. Bot. Reg. (1839) 54; Benth. Fl. Austr. VI (1873) 349.

Bayswater, in a swamp (No. 201; 18. Oct. 1914).

Pterostylis nana R. Br., var. **pyramidalis** (Ldl.) Ewart, Proc. R. Soc. Victoria 24 (1911) 72; *P. pyramidalis* Lindl. Swan Riv. App. Bot. Reg. (1839) 53; Benth. Fl. Austr. VI (1873) 357; Diels u. Pritzel, Bot. Jahrb. 35 (1905) 119.

Yallingup Cave, in fissures of rocks (No. 241; 27. Sept. 1914).

Already F. v. Müller has united *P. nana* R. Br. and *P. pyramidalis* Lindl. into one species (e. g. F. v. Müller and A. Morrison, List of Extra-tropic W. Austr. Plants, in Yearbook for W. A., Perth 1902, 335), and K. Domin (Journ. Linn. Soc. 1912, 250) follows him.

I find it most convenient to follow Ewart (l. c.) who treats *P. pyramidalis* as a variety of *P. nana*.

Pterostylis Sargenti C. Andrews, Journ. W. Austr. Nat. Hist. Soc. II (1905) 57.

The discoverer of this interesting species Mr. O. H. Sargent has kindly sent me some specimens from York (No. 242; 25. Aug. 1914).

Caladenia R. Br.

The species of this genus are rather difficult to treat. Some authors (e. g. Bentham and F. v. Müller) unite several forms into one species, while others (e. g. R. Fitzgerald) split them into numerous species.

I have compared my specimens with the ample material in the Kew Herbarium and named them in accordance with the result of my comparison, also making use of

R. Fitzgerald's coloured figures in his large work on Australian Orchids.

Under the popular name of "Spider Orchids" several species with much elongated petals and sepals are comprised.

The two species *C. filamentosa* R. Br. and *C. longicauda* Lindl. seem to be very common, but besides them I have two others:

Caladenia reticulata R. Fitzgerald, in Gardener's Chronicle 1882 I, 462.

Barrabupp, south-east of Busselton (No. 257; 20. Sept. 1914, Miss E. Brooks).

The specimens are rather incomplete, but the flowers agree exactly with flowers of *C. reticulata* in the Kew Herbarium.

Caladenia macrostylis R. Fitzgerald, in Gardener's Chronicle 1882 I, 462.

Yornup, south of Bridgetown (No. 233; 2. Oct. 1914).

Only one specimen (Pl. III, Fig. 1) was collected, but it agrees very well with specimens and description of *C. macrostylis*.

Caladenia discoidea Lindl. Swan Riv. App. Bot. Reg. (1839) 52; Benth. Fl. Austr. VI (1873) 380.

Near Perth, one specimen (No. 224; 23. Aug. 1914, E. Dorph-Petersen).

Caladenia unita R. Fitzgerald, in Gardener's Chronicle 1882 I, 461.

Albany, sandy and damp soil (No. 220; 21. Oct. 1914).

This species stands near *C. reptans* Ldl., but is larger, and the flowers are easily distinguished by the more or less united lateral sepals.

Caladenia Purdieana C. Andrews, Journ. Muell. Soc. W. Austr., I, No. 10 (1902) 39.

Albany, sandy and damp soil (No. 219; 21. Oct. 1914).

My specimens agree well with authentic specimens of this species preserved in the Kew Herbarium.

Caladenia Gertrudæ nov. sp. (Fig. 2).

E sect. *Eucaladenia.* Caulis 10—12 cm altus, biflorus, pilis longis albis patentibus villosus, e tubere ovoideo subterraneo natus. Folium basilare unicum, 3—3,5 cm longum, ovato-cordatum, amplectens, subacutum, supra pilis albis longis, ad margines pilis brevioribus ciliatum, subtus epilosum. Bracteæ foliosæ tres, oblongæ, acutæ, subtus et ad margines pilis longis villosæ, supra epilosæ. Ovarium ± striatum villosissimum, petiolo subæquilongum. Sepala petalaque subæqualia, ovata, subacuta, 15—18 mm longa, multinervia, sparse hirsuta, pallide roseo-lilacina, labello columnaque subduplo longiora. Labellum indivisum, late ovatum, 6 mm latum, 10 mm longum, acuminatum, acumine reflexo; calli parvi numerosi, longitu-

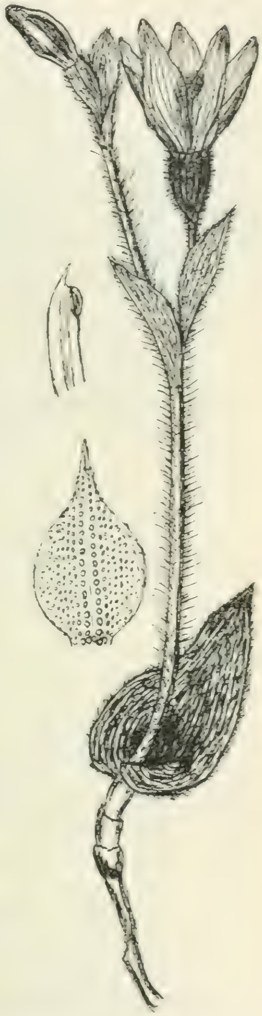

Fig. 2. *Caladenia Gertrudæ* Ostf. A whole plant in nat. size. Columna and labellum enlarged (2 : 1).

dinaliter multiseriati, mediani maximi, ad margines graduatim minores; columna leviter curvata, apice mucronata.

Yallingup Cave, in open forest (No. 225; 26. Sept. 1914).

This new species comes near to *C. gemmata* as regards the undivided, broadly ovate labellum and the broad basal leaf, but the sepals and petals are subacute and the labellum half as long as the sepals; therefore I have placed it in the section *Eucaladenia* where it is easily recognised by the ovate-cordate, clasping leaf. It is very hairy like *C. sericea*, but has not the 3-lobed labellum of the latter. The calli are small, but numerous, arranged in longitudinal rows, the median ones largest, then gradually diminishing towards the margins. The apex of the labellum is reflexed (in fig. 2 drawn in an artificially erect position).

As far as the literature and material at my disposal go, this species seems to be undescribed, although very distinct from all the others.

I have named it after my daughter Miss Gertrud H. Ostenfeld who has assisted me by drawing several of my specimens of W. Australian plants.

III. Dicotyledones, Choripetalæ.

Casuarinaceæ.

Casuarina Fraseriana Miq., in Verhandl. K. Nederlandsch. Inst., 1. Kl. XIII (1848) 59, tab. 6 D; Benth. Fl. Austr. VI (1873) 199; Diels u. Pritzel, Bot. Jahrb. 35 (1904) 121.

Perth, King's Park (No. 321; 15. Oct. 1914); Yallingup Cave, in the forest (No. 320; 27. Sept. 1914).

This species is easily recognisable by its cones, but they are not sessile, as Diels (l. c.) describes them, but borne on short stalks.

The specimens from Yallingup Cave (Fig. 3a) have much larger cones than those from King's Park (Fig. 3b), but otherwise the plants seem to be identical.

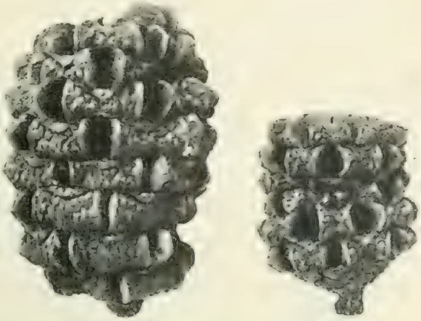

Fig. 3. *Casuarina Fraseriana* Miq., cones. *a*, from Yallingup Cave, *b*, from Perth, King's Park. (Nat. size).

Casuarina desussata Benth., in Fl. Austr. VI (1873) 200.

Big Brook State Mill, S. of Bridgetown, in the Karri forest (No. 319; 2. Oct. 1914).

This rare species is very distinct from all others. It is a small tree with acutely quadrangular branchlets, and 4-merous whorls. In my specimens (Pl. IV, Fig. 1) there are young male inflorescences on the same branches which bear ripe cones; the species is thus monoecious. The cones (Fig. 4) have numerous small tubercles between the hardly protruding valves. Achenes are broadly obovate with the lower half black and the upper half transparent with the exception of a dark midrib. The male spikes (1—2 cm long) are terminal on the branchlets and their leaf-whorls are 4-merous, the scales are acute with convex backs, greenish with pale-brownish tips and ciliolate margins.

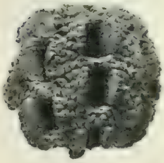

Fig. 4. *Casuarina desussata* Benth., cone. (Nat. size).

I have compared my specimens with the rather poor type specimens in Kew Herb. (from Cape Riche) and they agree exactly.

Casuarina lepidophloia F. v. Müll., Fragm. Phytogr. Austr. X (1877) 115.

Kalgoorlie (No. 323; 7. Oct. 1914).

Near Kalgoorlie I collected a *Casuarina* with immature cones (Pl. IV, Fig. 2), which I identify with *C. lepidophloia* described by F. v. Müller upon specimens from the interior of S. Austr. and N. S. Wales. His description is not complete owing to the absence of any flowers, but it fits my plant so well that I think it allowable to use his name for it. It is near *C. glauca* Sieb., and several so-labelled specimens in the Kew Herb. from the Eremæan (interior) part of Australia belong to the same species, which seems to have a wide range.

From *C. glauca* it differs in the 9—11-merous sheath-whorls, in the puberulous young branchlets and the light grayish colour of the older branchlets. The small cones are covered with a very short and adpressed clothing of light-brown hairs, the bracts are much thickened towards the apex and with a small prolongated point between the thickened parts; the valves are very prominent, not much thickened (resembling in shape the valves of *C. equisetifolia* Forst.). Male flowers are unknown.

Casuarina Huegeliana Miq., in Pl. Preiss. I. 4 (1845) 640; Benth. Fl. Austr. VI (1873) 196; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 125.

Tammin (No. 316; 6. Oct. 1914).

In spite of the statements in Pl. Preiss. and by Diels (l. c.) that *C. Huegeliana* is a tree, I refer to this species a medium-sized shrub which grew amongst “mallee shrubs” at Tammin. It agrees in all essential characters with *C. Huegeliana*. The cone (Fig. 5) is cylindrical, longer than that figured by Diels, but answering well to Bentham’s description.

Casuarina acutivalvis F. v. Müll., Fragm. Phytogr. Austr. X (1876) 61.

Tammin (No. 322; 6. Oct. 1914), a tall shrub.

In the Kew. Herb. there are some specimens of a *Casuarina* named *C. acutivalvis* and collected by R. Helms in the Victoria Desert (Camp 59), 28. Sept. 1891. They agree well with a plant (Pl. V) which I collected at Tammin. The most striking marks are found in the large cones with their very prominent, long-pointed valves.

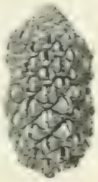

Fig. 5. *Casuarina Huegeliana* Miq., nearly ripe cone. (Nat. size).

F. v. Müller's description (l. c.) is rather incomplete. The branchlets and their leaf-whorls are much like those of *C. glauca;* the whorls are usually 11-merous. The male plant (Pl. V, to the left) which was hitherto undescribed, has terminal male spikes (2—4 cm long) with 12—15 internodes; the sheaths are subcampanulate, pale-brownish with dense white clothing towards the base, and brown, long, deciduous, subulate teeth. The cones (Fig. 6) are rather large (ca. 2—3 cm), ovoid or cylindrical, the bracts rather small, apiculate, the valves very prominent, ending in a long point, the surface is brown-purple and more or less hairy. Achenes black with as transparent wing with a dark midrib and dark margins (or at least one of the margins dark).

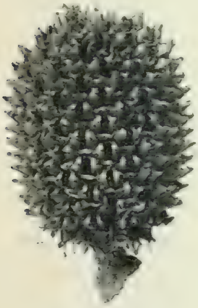

Fig. 6. *Casuarina acutivalvis* F. v. Müll., cone. (Nat. size).

Urticaceæ.

Parietaria debilis G. Forst., Fl. ins. Austr. prodr. (1786) 73; Benth. Fl. Austr. VI (1873) 188.

Yallingup Cave (no. 1257; 26. Sept. 1914); on naked soil, a small annual plant.

Proteaceæ (determ. by C. Christensen and C. H. Ostenfeld).

Petrophila longifolia R. Br., Proteac. nov. (1830) 5; Benth. Fl. Austr. V (1870) 322.

Cannington, damp heath, in flower (No. 656; 4. Sept. 1914).

Petrophila ericifolia R. Br., Proteac. nov. (1830) 5; Benth. Fl. Austr. (1870) 331; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 133, Fig. 12.

Tammin, heath (No. 690; 6. Oct. 1914); Meckering (No. 691; 20. Sept. 1914, O. H. Sargent).

Petrophila conifera Meissn., in Hook. Kew. Journ. VII (1855) 67; Benth. Fl. Austr. (1870) 335.

Tammin, heath (No. 692; 6. Oct. 1914).

Adenanthos cygnorum Diels, in Bot. Jahrb. 35 (1904) 138; *A. apiculata* Meissn. in Pl. Preiss. I (1845) 514, non R. Br.; *A. sericea* Benth. Fl. Austr. V (1870) 354 ex parte, non Labill.

Perth, common (No. 683; 26. Oct. 1914, and No. 1323; 17. Dec. 1914, Mrs. Davis).

Diels (l. c.) has pointed out that already Meissner (l. c.) had distinguished between the *A. sericea* Labill. of King George's Sound and the similar plant from Swan River district which he referred to R. Brown's *A. apiculata*. This reference was wrong, but the distinction between the two species is real. They differ greatly in the different kind of hairiness on the leaf-segments. In *A. sericea* the segments are silky-hairy, while in *A. cygnorum* (= *A. apiculata* Meissn.) they are hairy by distant long hairs and more densely set short hairs, without any silky aspect; also the apex of the segments is different, in *A. sericea* with a tuft of white hairs, in *A. cygnorum* more or less callous and with no hairs or a few hairs.

A. J. EWART (Proc. Roy. Soc. Victoria 20, N. S. II, 1907, 127) does not believe in keeping the two forms distinct and says that if DIELS "had seen No. 788 as well as No. 787 (of Pl. Preiss.) he would probably not have made this error". PREISS' No. 787 is from Perth (and is Meissner's *A. apiculata)*, while his No. 788 is from Princess Royal Harbour (and is Meissner's *A. sericea)*. I do not know if DIELS has seen both, but in the herb. of Copenhagen they are present, and after having examined them carefully I must agree with DIELS, not with EWART. These two numbers show that the two forms are distinct, although of course closely related. Therefore I find it better to keep DIELS's name for the plant from the Swan River district; all the more so after I have had occasion to examine the rich material of the said plants in Kew Herbarium.

Adenanthos intermedius Ostf. nov. sp. (Pl. VI, Fig. 2).

Sect. *Eurylæma*. Frutex 35—50 cm altus; caules erecti, pilis patentibus longis et pubescentia curta densa tecti. Folia obovata, 2,5—3 cm longa, ca. 1 cm lata, obtusa, apice callosa, in petiolo brevissimo sensim attenuata, in sicco distincte 3-nervosa, juniorum marginibus pilis longis sparse instructis, veteriorum marginibus pilis destitutis, sed cicatricibus minimis pilorum indistincte erosis. Pedunculi ca. 0,5 cm longi, patenti-villosi; bracteæ acutæ, extus villosæ. Florum forma et structura fere ut in *A. barbigera*, sed stigmate minore crassioreque. *A. barbigerae* arcte affinis, sed faciliter foliorum characteribus distinguendus.

Hab. Austr. occ. prope Yallingup Cave (No. 674; 30.

Sept. 1914), typus. In herb. Kew. etiam ex "Hill m. Cooginup, Oldfield" et "Yallingup and Cape Naturaliste, A. Dorrien-Smith, 1910" (partim; *A. obovatus* etiam adest).

This new species has more the habit of *A. obovatus* Labill., but the characters of *A. barbigera* Lindl. It seems that *A. obovatus* is distributed over the whole south-western area, while *A. barbigera* is confined to the Swan River district, and the new species comes in south of it, in the extreme south-western corner.

Both *A. barbigera* (Pl. VI, Fig. 1) and *A. obovatus* (Pl. VI, Figs. 3 and 4) are rather variable with regard to the shape of the leaves, but although intermediate between them the new species seems fairly distinct.

Simsia latifolia R. Br. Proteac. nov. (1830) 9; *Stirlingia latif.* Steud. Nomencl. Bot. ed. 2 (1841); Benth. Fl. Austr. V (1870) 358. *St. paniculata* Lindl. Swan Riv. App. Bot. Reg. (1839) 30.

var. **gracilis** Ostf. nov. var.; Syn. *Stirl. latifolia* Meissn. in Pl. Preiss. I 4 (1845) 517. Differt a typo foliorum laciniis anguste-linearibus, statura graciliore paniculaque simpliciore, floribus minoribus. (Pl. VII, Fig. 1).

Hab. ad flum. Cygnorum: Swan River Colony (1842, Herb. Kew); In arenosis sylvæ ad ripam flum. Cygnorum prope peninsulam, 30. Sept. 1839, Herb. Preiss. no. 767; Guildford, near Perth ("narrow-leaved form"), Cecil Andrews 1st. Coll. No. 751, 22. 9. 1901; Perth, King's Park (Ostenfeld, No. 681, 13. Oct. 1914), typus.

Already Bentham (l. c.) mentions that *S. latifolia* varies much with regard to the leaves etc. and points out that Preiss' no. 767 represents a narrow-leaved form. Meissner in Pl. Preiss. (l. c.) has two species, viz. *S. latifolia* Steud., to which he refers no. 767, and *S. paniculata* Lindl. with Preiss' no. 769. The latter is the common broad-leaved form, which, I suppose, answers to the type of *Simsia latifolia* R. Br. (Pl. II. Fig. 2). If we think the narrow-leaved form worth naming, we must give it a new name.

It (Pl. VII, Fig. 1) looks very different from the ordinary *S. latifolia*, and my specimens flowered about 3 weeks later than the typical plant. It seems as if we have to do with a late-flowering race, perhaps a kind of season-dimorphism, and in such cases we often find morphological differences as well.

Isopogon sphærocephalus Lindl. Swan Riv. App. Bot. Reg. (1839) 34; Benth. Fl. Austr. V (1870) 340.

Greenmount, Darling Range, flowering begun (No. 705; 13. Sept. 1914); Kalamunda (29. July 1914, Gunnar Andersson).

Synaphea dilatata R. Br., Transact. Linn. Soc. X (1809) 156; Benth. Fl. Austr. V (1870) 360.

Yallingup Cave, sandy soil in open forest, flowering (No. 657; 26. Sept. 1914).

Synaphea petiolaris R. Br., Transact. Linn. Soc. X (1809) 156; Benth. Fl. Austr. V (1870) 361.

Armadale, sandy places (No. 661; 4. Sept. 1914); vicinity of Perth (No. 1377; 1915, Mrs. Davis).

Synaphea acutiloba Meissn. in Pl. Preiss. I (1845) 528; Benth. Fl. Austr. V (1870) 361.

Cannington, on damp heath (No. 660; 4. Sept. 1914, E. Dorph-Petersen).

This species seems to be quite distinct from *S. petiolaris*, not a mere variety, as suggested by BENTHAM (l. c.).

Conospermum teretifolium R. Br., Transact. Linn. Soc. X (1809) 155; Benth. Fl. Austr. V (1870) 365.

Perth, King's Park (No. 682; 26. Oct. 1914).

Conospermum crassinervium Meissn., in Hook. Kew Journ. IV (1852) 184; Benth. Fl. Austr. V (1870) 375.

Moora (No. 684; 24. Oct. 1914, comm. Mrs. Davis).

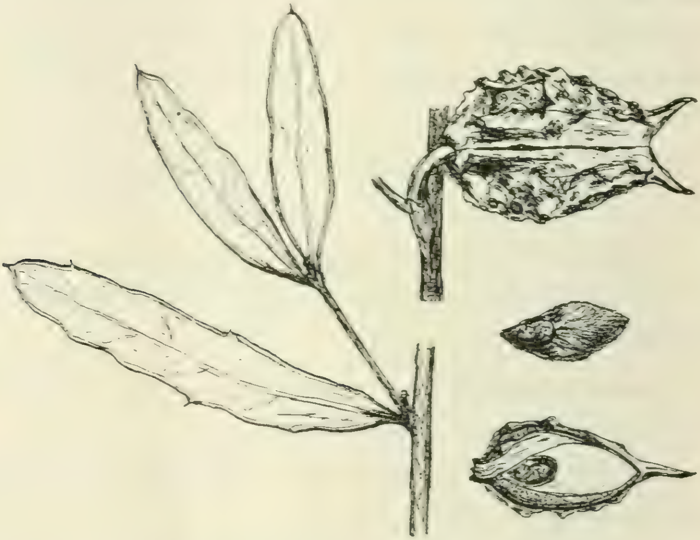

Fig. 7. *Hakea oleifolia* R. Br. (Nat. size).

Hakea platysperma Hook. Icon. pl., tab. 433 (1842); Benth. Fl. Austr. V (1870) 505.

Tammin, in Mallee shrub, a tall shrub with ripe fruits (No. 716; 6. Oct. 1914).

Hakea oleifolia R. Br., Transact. Linn. Soc. X (1809) 185; Benth. Fl. Austr. V (1876) 527.

Yallingup Cave, a small tree in the forest (No. 699; 28. Sept. 1914, with ripe fruits). Fig. 7.

Hakea multilineata Meissn. in Pl. Preiss. II (1847) 261; Benth. Fl. Austr. V (1870) 518.

Fig. 8. *Hakea multilineata* Meissn. To the left a branch with leaves and floral buds, to the right ripe capsules. (About $^2/_3$ nat. size).

Tammin, a small tree in the Mallee shrub (No. 700; 6. Oct. 1914, with ripe fruits). Fig. 8.

Loranthaceæ.

Loranthus linophyllus Fenzl, var. **Preissii** (Miq.) comb. nov.; *L. Preissii* Miq., in Pl. Preiss I (1844) 280; *L. linophyllus* Benth. Fl. Austr. III (1866) 393 ex parte.

It seems to me that the glabrous form of *L. linophyllus* which was described by Miquel as *L. Preissii*, deserves to be maintained as a variety. It grows on *Acacia* in the coastal area (on the dunes) and is rather common: Geraldton (No. 558; 28. Oct. 1914) and Carnarvon (No. 557; 31. Oct. 1914).

Polygonaceæ.

Polygonum aviculare L. sp. pl. (1753) 362; Benth. Fl. Austr. V (1870) 267.

York (No. 1391; 25. Nov. 1915, Mrs. Davis); introduced.

Rumex acetosella L. sp. pl. (1753) 338; Benth. Fl. Austr. V (1870) 265.

York (No. 1395; 25. Nov. 1915, Mrs. Davis); introduced.

The specimens belong to the more southern subspecies *angiocarpus* Murb. of this widely distributed weed.

Chenopodiaceæ.

My material of this family has been worked out by Dr. O. Paulsen, in my »Contrib. W. Austr. Bot.« II (1918).

Amarantaceæ.

Trichinium spathulatum R. Br. Prodr. Fl. Nov. Holl. (1810) 415; Benth. Fl. Austr. V (1870) 236.

Vicinity of Perth (No. 1365; Mrs. Davis 1915); York (No. 285; 30. Aug. 1914, O. H. Sargent); Kalgoorlie (No. 286; 7. Oct. 1914).

Trichinium sericostachyum Nees, in Pl. Preiss. I (1845) 627; Benth. Fl. Austr. V (1870) 234 ex parte; *T. roseum* Benth. l. c. ex parte; vix *T. floribundum* Moq.

Yallingup Cave, sandy soil (No. 284; 26. Sept. 1914).

My plant agrees well with the Copenhagen specimen of Pl. Preiss. no. 1372, upon which number *T. sericostachyum* Nees is based; on the other hand it agrees with the Kew specimens of *T. roseum* Moq. It has only two perfect anthers.

It seems to me that *T. sericostachyum* Nees is the same as Bentham's *T. roseum*, perhaps also as Moquin's *T. roseum*, while *T. floribundum* Moq., based on Drummond's plant No. 149 and quoted by Bentham as synonymous with *T. sericostachyum* Nees., is another plant. The Kew specimens of Drummond's plant are rather different from Preiss' plant.

Ptilotus villosiflorus F. v. Müll. Fragm. Phytogr. Austr. III (1863); Benth. Fl. Austr. V (1870) 245; Ostenfeld, Contr. W. Austr. Bot. II (1918) 15; *Alternanthera polycephala* Benth. Fl. Austr. V (1870) 251.

Geraldton (No. 281; 28. Oct. 1914), in dune depressions; Carnarvon, common on dunes (No. 354; 31. Oct. 1914).

This plant seems to be widely distributed along the more arid part of the coast of W. Austr. In the Kew Herb. there are specimens which I refer to it, from the following places: Between Ashburton and de Gray Rivers, E. Clement, purchased Aug. 1900; Carnarvon, Mouth of Gascoyne River, A. Morrison, 24. IX. 1905; N. W. New Holland, Bynoe (sub. nom. *Alternanthera angustifolia*, determ. Moquin); Greville Island, Reports Harbour, N. W., Bynoe (type of *Alternanthera polycephala*, Benth., which name therefore should be dropped); Between Moore and Murchison Rivers, Drummond 1853 (sub. nom *Ptil. macrostachys*, determ. Bentham).

When we add to these localities my records quoted in Part II (1918) of »Contr. W. Austr. Bot.«, we get a distribution from Port Hedland in the north to Moore River in the south.

Perhaps *Ptil. chamæcladus* Diels (Bot. Jahrb. 35, 1904, 193) of which I have not seen the specimens, is a procumbent form of this species.

Aizoaceæ.

Macarthuria australis Hueg., in Endl. Enum. pl. Hüg, (1837) 11; Hook. Icon. pl. tab. 408; Pl. Preiss. I (1844) 229 et II (1848) 360; Benth. Fl. Austr. III (1866) 332.

Common on sandy soil in King's Park, Perth (Nos. 275, 28. Aug. 1914; 276, 26. Oct. 1914; No. 1337, 28. July 1915, Mrs. M. Davis). Flowering in the spring (August) and with young fruit in October.

While collecting this interesting plant in King's Park I had the opportunity of making some observations on its ecology and on the structure of the flowers.

Fig. 9 shows a plant taken in the spring. From the short erect rhizome several shoots appear: (I) one is an old dead erect branched stem, (II) two (one of which, to the left, has been broken of) are leafless flowering branched stems, and (III) two are young leaf-bearing shoots. The dead branched stem has undoubtedly had flowers and fruits the year before. The now flowering branched stems have thickened bases formed by a somewhat swollen and burnt bark, a feature which is characteristic of many plants growing in sandy soil in W. A. and mentioned by L. Diels.[1] He suggests that it may be a protection against the strong heat of the sun-baked soil.

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[1] L. Diels: Über Wurzelkork bei Pflanzen stark erwärmter Böden. Flora, N. F., Bd. XI, 1918, pp. 490—502.

Fig. 9. *Macarthuria australis* Hueg., I—III, three successive years' growth. (About ²/₅ nat. size.)

The stems are green and assimilating, and the flowers appear in clusters in the axils of leaf-bases the blades of which have disappeared. The flower clusters have no foliage leaves, only small scaly bracts. These stems are about one year old. The short young shoots with well-developed oblong-lanceolate foliage leaves have just begun to grow and are only a few weeks old. I suppose that these shoots in the course of the vegetation period grow out to erect branched stems with foliage leaves, and then, when the dry summer-heat sets in, shed their leaves, and stand with naked green axes until next spring when flower clusters appear in axils of the leaf-bases.

The plant figured thus shows three years' growth; each stem has a duration of two vegetation periods, one in which it is purely vegetative and assimilating, and the second in which it is mainly flowering, but still is capable of some assimilation by means of the green tissue of the stem itself. The mode of growth has consequently a strong likeness to that which we know in *Rubus* species, e. g. *R. idæus*.

The white flowers (Fig. 10) have a strong honey-smell and are visited by dipterous insects. The honey is secreted by a glandular disc situated around the base of the ovary and is kept in the cup formed by the basal parts of the stamens. The flowers are somewhat proterandrous; in the male stage the stamens stand erect in the flowers and the pistils are small; in the female stage the stamens bend outwards and

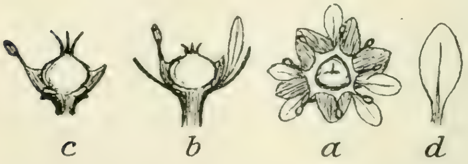

Fig. 10. *Macarthuria australis* Hueg. Flower biology. *a.* A flower seen from above. *b.* Longitudinal section of a flower in the male stage. *c*, the same of a flower in the female stage. *d.* A petal. (Enlarged).

the pistils have grown to a larger size. In all the flowers I observed 5 green sepals, 5 stalked white petals, slightly longer than the sepals, and 8 stamens and 3 free pistils. The fruit (not seen ripe) is a few-seeded capsule.

Tetragonia eremæa Ostf. nov. sp. (Pl. VIII).

Annua, + prostrata; caules complures rosulati vel singuli, usque ad 7 cm longi. Planta tota, præcipue in partibus junioribus et in floribus, pilis pellucidis vesiculosis, sat longis acutisque ± dense instructa ("pruinosa"). Folia petiolata obovato-oblonga, obtusa. Flores parvi subsessiles axillares, plerumque solitarii. Sepala 4 oblongo-deltoidea, fere duplo quam latiora longiora, obtusa, extus pilis pellucidis dense ornata. Stamina 4, antheris didymis. Stigmata 4—6 (plerumque 4). Fructus compresso-quadrangulati, sub-quadrialati, alis duabus oppositis majoribus, duabus vel pluribus minoribus, quam longiores latiores, apice intra sepala dentibus 4—6 obtusis a putamine emerso formatis; semina 4—6.

Ex affinitate *T. dipteræ*, sed pilis fructibusque faciliter cognoscitur.

Kalgoorlie (No. 640; 7. Oct. 1914).

This rather small and inconspicuous plant is undoubtedly near to *T. diptera* F. v. Müll. (Fragm. Phytogr. Austr. XI (1878) 8) which has been described from specimens from Shark's Bay, where also Diels and Pritzel (Engl. Bot. Jahrb. 35 (1904) 197) have found it again. But my plant differs from it by the peculiar pellucid unicellular hairs, which are present more or less sparsely, over the whole plant, more numerously on the upper (younger) parts and on the flowers. Further the fruits are irregularly 4-winged with two larger and two or several smaller wings.

Tetragonia implexicoma Hook. f., Fl. Tasman. I (1855) 148; Benth. Fl. Austr. I (1866) 326; F. v. Müller, Key to Vict. Pl. fig. 40.

Yallingup Cave (No. 1114; 26. Sept. 1914).

This well-defined species is a perennial undershrub with decumbent woody stems from which herbaceous short shoots and also elongated shoots appear, both kinds bearing the inconspicuous yellow flowers in the axils of the leaves.

Pax (in Engler u. Prantl, Natürl. Pflanzenfam. III. 1 b, 1889, 44) places it together with *T. expansa* Mur. and others in a section *Tetragonoides* D. C. of annual and biennial herbs. This is hardly correct as regards the species in question.

It has its home in the littoral shrub vegetation of extratropical Australia.

Mesembryanthemum tumidulum Haw., Syn. pl. succul. (1812) 286; Rev. 129; Salm-Dyck, Mesemb. § 37, Fig. 3; Sonder, Fl. Cap. II (1861—62) 426; A. Berger, Mesembryanth. (1908) 114.

Albany (No. 277; 21. Oct. 1914).

West of Albany, growing on the coast cliffs, I found a *Mesembryanthemum* in the fruiting stage. By its many-flowered inflorescences it differed much from the two Australian species and doubtless represents an introduction from South Africa. As far as the somewhat incomplete material permits one to judge, it agrees better with *M. tumidulum* Haw. than with the allied species *M. umbellatum* L. and *M. multiflorum* Haw.

M. æquilaterale Haw., misc. nat. (1803) 77; Bentham Fl. Austr. III (1866) 324.

Yallingup Cave, near the coast (No. 279; 26. Sept. 1914); Kalgoorlie (No. 278; 7. Oct. 1914).

A plant which I refer to this common species was collected at Kalgoorlie. It differed from the typical coastal plant by the rather blunt apex of the leaves and a more connate leaf-base. The specimens are too incomplete for closer examination.

Portulacaceæ.

Calandrinia polyandra (Hook.) Benth. Fl. Austr. I (1863) 172.

Carnarvon, in dune depressions (No. 633, 31. Oct. 1914).

Calandrinia calyptrata Hook. f., in Hook. Icon. pl. (1840) tab. 296; Benth. Fl. Austr. I (1863) 174.

Yallingup Cave, on naked soil (No. 637; 27. Sept. 1914).

Calandrinia corrigioloides F. v. Müll., in Benth. Fl. Austr. I (1863) 175; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 200.

Perth, King's Park, open sandy soil (No. 634; 10. Sept. 1914).

Diels (l. c.) gives the stems as "humifusi," in my species they are erect or ascending.

Calandrinia brevipedata F. v. Müll,, Fragm. Phytogr. Austr. X (1876) 69.

Yallingup Cave, open sandy soil (No. 639; 26. Sept. 1914).

In this species the stems are prostrate, often until 35 cm long. The small flowers are white as in the preceding species.

Caryophyllaceæ.

All the *Caryoaphyllaceæ* reported below are European species which have been introduced by man and have now more or less established themselves as weeds.

Silene gallica L. sp. pl. (1753) 417; Benth. Fl. Austr. I (1863) 155.

York (No. 1387; 25. Nov. 1915, Mrs. Davis).

Tunica prolifera (L.) Scop. Fl. Carn. (1772) 299.

Busselton, on a grassy lawn (No. 289; 30. Sept. 1914).

Cerastium glomeratum Thuill. Fl. Par. ed. 2 (1799) 226; *C. vulgatum* Benth. Fl. Austr. I (1863) 157, ex parte.

Perth, garden weed in St. Omer Hospital (No. 290; 31. Aug. 1914); Armadale, in a yard (20. Sept. 1914).

The specimens belong to the apetalous variety: var. *apetalum* Mert. et Koch, Deutsch. Fl. III (1831) 339.

Sagina apetala Arduino, Animadv. bot. spec. II (1764) tab. 8, 22; *S. procumbens* Benth. Fl. Austr. I (1863) 160, ex parte.

Armadale, weed in a yard (No. 293; 20. Sept. 1914); Vicinity of Perth (1915, Mrs. Davis); York (1915, Mrs. Davis).

Spergula arvensis L. Sp. pl. (1753) 440; Benth. Fl. Austr. I (1863) 161.

York (No. 1394; 25. Nov. 1915, Mrs. Davis).

The specimens belong to var. *vulgaris* (Boenn.) Mert. et Koch, with seeds with small whitish papillæ.

Spergularia campestris (L.) Aschers. Fl. Prov. Brandenb. II (1859) 25; *S. rubra* (L.) Pers.; Benth. Fl. Austr. I (1863) 161.

Yallingup Cave, on open sandy soil (Nos. 291 and 292; 27. Sept. 1914).

Spergularia Bocconei (Soleirol) Steud. Nomencl. ed. 2. I (1840) 123, 125; Ascherson u. Graebner, Syn. Mitteleurop. Fl., vol. V (1919) 849.

York (No. 1450; 25. Nov. 1915, Mrs. Davis).

Polycarpon tetraphyllum L. Syst. ed. 10 (1759) 881; Benth. Fl. Austr. I (1863) 163.

Yallingup Cave house, a weed (No. 294; 28. Sept. 1914).

Ranunculaceæ.

Clematis pubescens Hueg. Enum. pl. (1837) 1; *C. aristata* R. Br., c. *occidentalis* Benth. Fl. Austr. I (1863) 6.

Jarnadup, south of Bridgetown, in forest (No. 728; 1. Oct. 1914).

Clematis microphylla D. C. var. **linearifolia** (Steud.) comb. nov.; *C. microphylla*, var. *occidentalis* Benth. Fl. Austr. I (1863) 8; *C. linearifolia* Steud. in Pl. Preiss. II (1848) 262.

Yallingup Cave, on coastal shrubs (No. 727; 26. Sept. 1914); Geraldton, on dune shrubs (No. 1193; 28. Oct. 1914).

Ranunculus lappaceus Sm., in Rees' Cyclopædia (1815) XXIX; Benth. Fl. Austr. I (1863) 12.

Yallingup Cave, in forest and along a rivulet (Nos. 725 and 726; 26. Sept. 1914).

Ranunculus parviflorus L. var. **australis** Benth. Fl. Austr. I (1863) 14.

Yallingup Cave, on damp soil along a rivulet (No. 724; 27. Sept. 1914).

The Australian plant is perhaps a distinct species; as BENTHAM (l. c. 15) has mentioned, the achenes are smaller than in the European form; besides the tubercles on their sides are not so closely set and the short beak of the style is not so curved.

Ranunculus muricatus L. Sp. pl. (1753) 555; Benth. Fl. Austr. I (1863) 15.

Bayswater, in a swamp near Swan River (No. 723;

18. Oct. 1914); Yallingup Cave, on damp soil along a rivulet (No. 722; 27. Sept. 1914).

This introduced species seems to spread widely in W. Australia as in the other Australian States.

Lauraceæ.

Cassytha.

As Diels and Pritzel (Bot. Jahrb. 35, 1904, 202) remark, this genus requires a thorough revision.

Cassytha pubescens R. Br. Prodr. Fl. Nov. Holl. (1810) 404; Benth. Fl. Austr. V (1870) 310.

Geraldton, on shrubs in the dune area (No. 414; 28. Oct. 1914).

I am not quite sure that the W. A. plant is the same as that from the Eastern States and Tasmania.

Cassytha racemosa Nees, in Pl. Preiss. I (1845) 621; Benth. Fl. Austr. V (1870) 312.

Perth, King's Park (No. 415; 10. Sept. 1914); Geraldton, common in the dune area (No. 413; 28. Oct. 1914).

Cassytha pomiformis Nees, in Pl. Preiss. I (1845) 620; Benth. Fl. Austr. V (1870) 313.

Yallingup Cave, in the forest (No. 416; 26. Sept. 1914).

This species has thickened pedicels on fruiting specimens, hence the species name, as the fruit and the thickened pedicel together are "pomiform". As Diels and Pritzel (l. c.) point out the true species is pubescent, not glabrous as said by Bentham (l. c.).

Cruciferæ.

Heliophila pusilla L. fil. Suppl. pl. (1781) 297; *H. pumila* (sic!) Benth. Fl. Austr. I (1863) 65; Diels u. Pritzel, Bot. Jahrb. 35 (1904) 203.

Perth, King's Park, common (Nos. 364, 365; 10. Sept. and 13. Oct. 1914).

This South-African plant has been growing as a weed in the Swan River area for a long time.

Coronopus didymus (L.) Sm. Fl. Brit. II (1800) 691; *Senebiera d.* Benth. Fl. Austr. I (1863) 83.

York (No. 1390; 25. Nov. 1915, Mrs. Davis), introduced.

Stenopetalum lineare R. Br., in D. C. Syst. Veg. I (1821) 513; Benth. Fl. Austr. I (1863); Sp. Moore, Journ. Linn. Soc. vol. 34 (1899) 177; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 202.

Kalgoorlie, in fruit (No. 367; 7. Oct. 1914).

Stenopetalum robustum Endl. var. **gracile** (Bunge) comb. nov.; *S. gracile* Bunge, in Pl. Preiss. I (1844) 257.

Near Perth (No. 366; 13. Sept. 1914, E. Dorph-Petersen).

Alyssum linifolium Steph., in Willd. sp. pl. III (1800) 467; Benth. Fl. Austr. I (1863) 71; Sp. Moore, l. c. 177.

Kalgoorlie, in fruit (No. 368; 7. Oct. 1914).

Blennodia brevipes F. v. Müll., in Trans. Phil. Soc. Vict. I (1860) 100, ex Benth. Fl. Austr. I (1863) 75; Sp. Moore, Journ. Linn. Soc. vol. 34 (1899) 177; *Erysimum br.* F. v. Müll., in Linnæa 25 (1852) 367.

Kalgoorlie, in fruit (No. 369; 7. Oct. 1914).

Droseraceæ.

Drosera bulbigena A. Morrison, in Transact. & Proc. Bot. Soc. Edinburgh XXII (1904) 417; Diels, Droseraceæ, in Das Pflanzenreich, IV, 112 (1906) 116.

Armadale, damp naked soil (No. 384; 20. Sept. 1914).

This little *Drosera* seems to be very rare. My specimens agree exactly with the type specimens present in Kew. Herb. (Cannington, Lower Canning River, 26. Sept. 1903, A. Morrison).

Drosera Mensiesii R. Br. var. **penicillaris** (Benth.) Diels, in Das Pflanzenreich, IV, 112 (1906) 117; *D. penicillaris* Benth. Fl. Austr. II (1864) 467.

Perth, King's Park (No. 1443; 1. Sept. 1915, Mrs. Davis); Armadale (No. 379; 4. Sept. 1914); Albany (No. 378; 20. Oct. 1914).

Drosera rosulata Lehm. Pugill. VIII (1844) 36; Benth. Fl. Austr. II (1864) 462; Diels, in Das Pflanzenreich (1906) 125.

Albany (No. 383; 20. Oct. 1914).

Some sterile leaf-rosettes from Albany agree with *D. rosulata* which has hitherto only been known from the Swan River area.

Crassulaceæ.

Crassula (*Tillæa*). The W. Australian species of this genus are dealt with in my »Contr. to W. Austr. Bot.«, II (1918).

Pittosporaceæ.

Marianthus erubescens Putterlick, in Nov. Stirp. Mus. Vind. decad. VII (1839) 60; Pl. Preiss. I, 2 (1844) 197; Benth. Fl. Austr. I (1863) 120, ex parte.

Yallingup Cave, in a rich and damp cleft (No. 1015; 28. Sept. 1914).

My specimens (Pl. IX, Fig. 1) have broadly elliptic leaves, as Putterlick (Pl. Preiss. p. 197) says about his species (foliis inferioribus late ellipticis; superioribus oblongo-ellipticis), and specimens answering to this description and agreeing with my plant are in Kew Herb. from: Kalgan

River, Oldfield; King George's Sound (Herb. Hook.); N.W. Plantagenet, E. Pritzel, no. 955; Bridgetown to Kojonup and Slab Hut Gully, A. Dorrien-Smith 1910. I think this plant is the true *M. erubescens* Putterl.

Bentham's description ("leaves narrow, oblong-lanceolate or linear") seems to cover another plant and is probably drawn from Drummond's specimens (1848), which are rather different. Granted that *M. purpureus* Turcz. (Bull. Moscou, 1854, 364) are based upon Drummond's plant, we have here a name for it; it no doubt deserves a specific name.

Marianthus gracilis Ostf. nov. sp. (Pl. IX, Fig. 2).

Sect. *Normales.* Species volubilis gracilis caulibus novellis sericeo-pilosis mox glabratis. Folia glabra (juvenalia sparse pilis longis albis instructa), 2—4 cm longa, cuneato-oblonga vel elliptica, in petiolo brevissimo sensim attenuata, distante et grosse dentata dentibus 1—2, ± patentibus, acuta, coriacea, margine revoluta. Cyma 3—5-flora, pedunculata, 1—5 cm longa, gracilis, ± pilosa, bracteis pluribus linearibus, pilosis. Pedicelli, 2—6 mm longi, dense pilosi. Flores desunt. Fructus immaturi, glabri, fusiformi-cylindrici, utrinque attenuati, stylo filiformi stigmateque haud incrassato instructi.

Yallingup Cave, a twiner in the forest (No. 1018; 26. Sept. 1914).

Although I have no flowers, only young fruits in my specimens, and therefore cannot say anything about the sepals, petals and stamens, I think the present plant is sufficiently distinct from the other species of *Marianthus* to be described as new. Its slenderness and the shape of the leaves resemble *M. tenuis* Benth., but its inflorescence is that of *M. candidus* Hueg. and *M. coeruleo-punctatus* Klotsch from which it is otherwise different.

Sollya fusiformis (Labill.) comb. nov.; *Sollya heterophylla* Lindl. Bot. Regist. XVII (1831), tab. 1460; Benth. Fl. Austr. I (1863) 126; *Billardiera fusiformis* Labill. Pl. Nov. Holl. I. (1804) 65, tab. 90.

Perth, King's Park (No. 1017; 25. Oct. 1914); Albany (No. 1016; 21. Oct. 1914).

I cannot see any obstacle to using LABILLARDIÈRE'S much earlier species name. His description is usable and the plate is very good. I admit that he gives "Van Diemen" as "habitatio", but this is evidently a "lapsus calami" instead of King George's Sound.

Leguminosæ (determ. by Dr. E. Pritzel).

Oxylobium lanceolatum (Vent.) Ostf. comb. nov.; *O. callistachys* Benth. Fl. Austr. II (1864) 16; Diels u. Pritzel, in Engl. Bot. Jahrb. 35 (1904) 223; *Callistachys lanceolata* Vent. Jard. Malm. (1803) 115, tab. 115.

Yallingup Cave, along a rivulet (No. 490; 27. Sept. 1914); Albany (No. 435; 20. Oct. 1914, a broad-leaved, silky-haired form; No. 442; 20. Oct. 1914, a narrow-leaved, glabrous form).

No doubt several species are included under the name *O. callistachys* Bth.

Oxylobium Drummondii Meissn., in Pl. Preiss. I (1844) 30; *O. cuneatum* Bth. Fl. Austr. II (1864) 24, ex parte.

Darlington (No. 471; 28. Aug. 1914, Cecil Andrews).

Chorizema cordatum Ldl. Bot. Reg. (1838) tab. 10; Benth. Fl. Austr. II (1864) 28.

Bridgetown, in the forest (No. 480; 1. Oct. 1914).

Chorizema diversifolium A. DC., Pl. rar. Jard. Gen. 7e. note (1836) 44, tab. 8; Benth. Fl. Austr. II (1864) 29.

Yallingup Cave, in the forest (No. 478; 27. Sept. 1914).

Gompholobium ovatum Meissn., in Pl. Preiss. I (1844) 35; Benth. Fl. Austr. II (1864) 42; Diels u. Pritzel, in Engl. Bot. Jahrb. 35 (1904) 233.

Jarnadup, south of Bridgetown (No. 484; 2. Oct. 1914).

Sphærolobium lineare (Benth.) Ostf. comb. nov.; *S. euchilus* Benth. Fl. Austr. II (1864) 67; *Euchilus linearis* Benth., in Hueg. Enum. pl. (1837) 35.

York (No. 463; 25. Aug. 1914, O. H. Sargent); near Perth (No. 455; 9. Aug. 1914, E. Dorph-Petersen).

Bossiæa linophylla R. Br., in Ait. Hort. Kew. ed. 2. IV (1812) 268; Benth. Fl. Austr. II (1864) 162; Diels u. Pritzel, Engl. Bot. Jahrb. 35 (1904) 263.

Yallingup Cave, in the forest (No. 485; 26. Sept. 1914); Jarnadup, south of Bridgetown (No. 486; 2. Oct. 1914).

Templetonia egena (F. v. Müll.) Benth. Fl. Austr. II (1864) 170; Diels u. Pritzel, in Engl. Bot. Jahrb. 35 (1904) 265.

Kalgoorlie (No. 492; 8. Oct. 1914).

Medicago denticulata Willd. Sp. pl. III (1800) 1415; Benth. Fl. Austr. II (1864) 186.

York, introduced (No. 1392, 25. Nov. 1915, Mrs. M. Davis).

Trifolium procumbens L. Fl. Suec. (1755) 261; Benth. Fl. Austr. II (1864) 186.

York, introduced (No. 1386, 25. Nov. 1914, Mrs. M. Davis).

Trifolium parviflorum Ehrh. Beitr. VII (1792) 167.

Albany, damp soil, introduced (No. 445; 20. Oct. 1914).

Trifolium tomentosum L. Sp. pl. (1753) 771; Diels u. Pritzel, in Engl. Bot. Jahrb. 35 (1904) 267.

Perth, introduced, road in King's Park (No. 448; 12. Sept. 1914); York, introduced (No. 1449; 25. Nov. 1915, Mrs. Davis).

Cassia sophera L., var. **pubescens** Benth., Fl. Austr. II (1864) 283.

York, prob. introduced or cultivated (No. 1385; 25. Nov. 1915, Mrs. M. Davis).

Acacia colletioides A. Cunn., var. **nyssophylla** (F. v. Müll.) Benth. Fl. Austr. II (1864) 326; Pritzel, in Engler, Bot. Jahrb. 35 (1904) 290.

Tammin, in open forest (No. 548; Oct. 1914).

Acacia genistoides A. Cunn., in Benth. Fl. Austr. II (1864) 330; Pritzel, in Engl. Bot. Jahrb. 35 (1904) 292.

Kalgoorlie (No. 1111; 7. Oct. 1914).

Acacia erinacea Benth., var. **microphylla** E. Pritzel, in Engl. Bot. Jahrb. 35 (1904) 299.

Tammin, in open forest (No. 534; 6. Oct. 1914.)

Acacia Merrallii F. v. Müll., var. **tamminensis** E. Pritzel, in Engl. Bot. Jahrb. 35 (1904) 299.

Tammin, in open forest (No. 547; 6. Oct. 1914).

Acacia spodiosperma F. v. Müll., in Proc. Linn. Soc. N. S. Wales, vol. 3 (1868) 164; Ewart, in Proc. R. Soc. Victoria 22 (N. S.), I (1909) 91; *A. leucosperma* (F. v. Müll.) E. Pritzel, in Eng. Bot. Jahrb. 35 (1904) 302.

Carnarvon, on dunes (No. 553; 31. Oct. 1914).

According to A. J. Ewart (l. c.) the name *A. leucosperma* given by E. Pritzel (l. c.) to this characteristic species must be dropped for F. v. Müller's much earlier name.

Acacia rostellifera Benth., in Hook, Lond. Journ. I (1842) 356; Fl. Austr. II (1864) 368; Pritzel, in Engl. Bot. Jahrb. 35 (1904) 302.

Yallingup Cave, in shrub near the shore (No. 537; 26. Sept. 1914); Geraldton, on dunes (No. 552; 28. Oct. 1914).

Acacia heteroclita Meissn., in Pl. Preiss. I (1844) 18; Benth. Fl. Austr. II (1864) 381; Pritzel, in Engl. Bot. Jahrb. 35 (1904) 304.

Yallingup Cave, in forest (No. 545; 27. Sept. 1914).

Acacia coriacea D. C., Mém. Legum. (1825) 446; Benth. Fl. Austr. II (1864) 385.

Carnarvon, on dunes (No. 550; 31. Oct. 1914).

Acacia cyperophylla F. v. Müll., in Benth. Fl. Austr. II (1864) 400; Pritzel, in Engl. Bot. Jahrh. 35 (1904) 307.

Kalgoorlie (No. 1112; 7. Oct. 1914).

Geraniaceæ.

Geranium molle L. Sp. pl. (1753) 682.

Perth (F. Stoward, No. 324, in Herb. Kew). Introduced.

Geranium pilosum Forst. Prodr. (1786) 91; Nees, in Pl. Preiss. I, 2 (1844) 162; Knuth, Geraniaceæ, in Das Pflanzenreich (1912) 75; *G. dissectum* Benth. Fl. Austr. I (1863) 296 pro max. parte, non L.

Yallingup Cave, open forest (No. 403; 28. Sept. 1914).

My specimens represent a more hairy form of *G. pilosum* Forst. than the true New Zealand plant, but the differences are too small to keep them distinct.

In Kew Herb. I have seen the same plant — with patent white, rather long hairs on the stems, pedicels, petioles and ± on the leaf-lamina — from the following W. A. localities: Avon, F. v. Müller; Swan River, Drummond, both in fruit and flower; Yallingup and Cape Naturaliste, A. Dorrien-Smith, 1910.

Besides this plant W. Australia has another form with shorter, adpressed (not patent) hairs, which has been described as *G. australe* Nees, in Pl. Preiss. I (1844) 162. I think it is hardly distinct enough to be kept as a species, but it deserves at least a varietal name: *G. pilosum* Forst., var. *australe* (Nees) comb. nov.

In Kew Herb. it is present from two W. Australian localities, viz. Bridgetown to Kojonup and Slab Hut Gully, A. Dorrien-Smith 1910, and Westbourne, Dwarganup, C. B. Carter, no. 22, Febr. 1915. In the other Australian States it seems more common.

R. KNUTH (l. c. 52) has *G. australe* Nees as a variety of *G. dissectum* L., but this is evidently wrong, and is perhaps caused by the unhappy treatment of the Australian *Geranium's* by BENTHAM. The true *G. dissectum* L. with shortly and softly haired capsule-lobes, judging by the rich Australian *Geranium* material at Kew, has only been found in Australia around Melbourne, most probably introduced from Europe. All the other specimens in the herbaria belong to quite another section (*Chilensia* R. KNUTH) of the genus and are distinguished by the stiff and coarse hairs on the back of the capsule lobes and by the ± tuberous root.

Erodium cygnorum Nees, in Plant. Preiss. I (1844) 162; Benth. Fl. Austr. I (1863) 297; R. Knuth, Geraniaceæ in Das Pflanzenreich (1912) 249.

Kalgoorlie (No. 410, 7. Oct. 1914), low fruiting specimens.

From seeds taken from the wild specimens I have had this species in culture. It is an annual which rises to the height of until 50 cm, erect or ascending. The umbels are usually 3-flowered, the peduncle about as long as the leaf, the pedicels about three times as long as the sepals. Sepals pointed (with a short mucro), ca. 5 mm long, green, distantly and sparingly hairy on the back. Petals blue-violet (C C[1] 481), faintly 3-veined, with white-bearded base, obovate, ca. 6 mm long. Filaments white, lower half broad; anthers orange-yellow. Fruit carpels hispid, beak 3—4 cm long.

Erodium cicutarium (L.) L. Hérit. ex Ait. Hort. Kew. ed. II (1789) 414; Benth. Fl. Austr. I (1863) 298; R. Knuth, Geraniaceæ, l. c. 274.

This species has established itself widely in the State. I collected it at Perth (No. 408, 23. Aug.), at Kalgoorlie (No. 407, 7. Oct.) and at Yallingup Cave House (No. 409, 26. Sept. 1914).

Pelargonium australe Willd. Spec. pl. III (1800) 675; Sweet, Geran. I (1820—22) tab. 68; R. Knuth, Geraniaceæ in Das Pflanzenreich (1912) 409; Benth. Fl. Austr. I (1863) 298 ex parte; non Jacq. Eclog. Plant.; *P. glomeratum* Jacq. Eclog. Plant. var. 1 (1816) 146, tab. 98; *P. crinitum* Nees, et var. *congestum* Nees in Plant. Preiss. I (1844) 163 (?); *P. littorale* Huegel in Enum. Pl. Hueg. (1837) 44; *P. Drummondii* Turcz. Bull. Mosc. 1858, 421.

To this species I, with some doubt, refer a *Pelargonium*, which was common on sandy soil in King's Park, Perth (No. 404, 13. Oct. 1914) and which I also saw at Cottesloe and near Fremantle. It is the same species which L. Diels

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[1] C C = Klincksieck et Valette, Code des Couleurs, Paris 1908.

(Pflanzenwelt West Australiens (1906) 207) mentions as common in the coastal dune area.

The *Pelargonium* forms of Australia are rather confused; Bentham (l. c.) reduces them to only two species. But to judge from the herbarium material available, I think there are several more species. The recent monograph by R. Knuth (l. c.) allows three species, and I agree with him that *P. australe* and *P. inodorum* are distinct from each other, but whether the West-Australian *P. australe* is the same as the East-Australian I dare not decide; perhaps it would be better to take it as a separate species and then name it: *P. littorale* Hueg.

Pelargonium inodorum Willd. Hort. Berol. I (1806) tab. 34; Enum. II (1809) 702; Sweet, Geran. I (1820—22) tab. 56; R. Knuth, Geraniaceæ l. c. 409; *P. australe* Jacq. Eclog. plant. var. 1 (1816) tab. 100; non Willd.; *P. australe* var. *erodioides* (Hook.) Benth. Fl. Austr. I (1863) 299; *P. stenanthum* Turcz. Bull. Mosc. 1858, 149.

This species is more slender than the foregoing and the hairiness not nearly so dense, consisting only of long spreading hairs (no short and dense pubescence); the flowers are smaller and the petals hardly exceed the sepals.

The identification of this species is not so doubtful as that of the former, but I am not sure to which of them Nees' *P. crinitum* belongs.

Jacquin (l. c.) has evidently made a mistake in calling the small-flowered Australian *Pelargonium* by Willdenows's name *P. australe* and creating the new name *P. glomeratum* Jacq. for the real *P. australe* Willd.

I found *P. inodorum* in the open forest on sandy soil near Yallingup Cave house in the first flowering stage (Nos. 405 and 406; 26. Sept. 1914).

Oxalidaceæ.

Oxalis cernua Thunb., Diss. Oxalis (1781) 14 (tab. 2); Harwey and Sonder, Fl. Cap. I (1859—60) 348.

Perth, found in the suburban area near Swan River (No. 630; 13. Sept. 1914, E. Dorph-Petersen).

As far as I am aware this Cape plant has not been recorded before from W. A. From its home it has spread to the Mediterranean region, the Canaries, Madeira etc.

O. corniculata L. Sp. pl. (1753) 435; Benth. Fl. Austr. I (1863) 301.

Perth: in the environs (No. 631; 16. Aug. 1914, E. Dorph-Petersen).

Linaceæ.

Linum gallicum L. Sp. pl. ed. 2 (1762) 401.

Bridgetown (No. 417; 1. Oct. 1914); Armadale, on open clayey soil (No. 1120, 20. Sept. 1914), an introduced weed.

Zygophyllaceæ.

Nitraria Schoberi L. sp. pl. ed. 2 (1762) 639; Benth. Fl. Austr. I (1863) 291.

Carnarvon, an erect shrub with unripe fruits (No. 833; 31. Oct. 1914).

Zygophyllum fruticulosum D. C. Prodr. I (1824) 705; Benth. Fl. Austr. I (1863) 294; Diels u. Pritzel, in Botan. Jahrb. 35 (1904) 315.

Geraldton, a scandent undershrub, common in the dune area (No. 831; 28. Oct. 1914). The ripe fruits are about 20 mm long and broad (Fig. 11, a).

Zygophyllum eremæum (Diels pro. var.) Ostf. n. sp.; *Z. fruticulosum* var. *eremœum* Diels, in Diels u. Pritzel, Botan. Jahrb. 35 (1904) 315.

Differt a *Z. fruticuloso* praeter charactera a clar. Diels indicata nervatura et magnitudine multo minore fructus alorum. Certe est species propria.

Kalgoorlie (No. 832; 8. Oct. 1914).

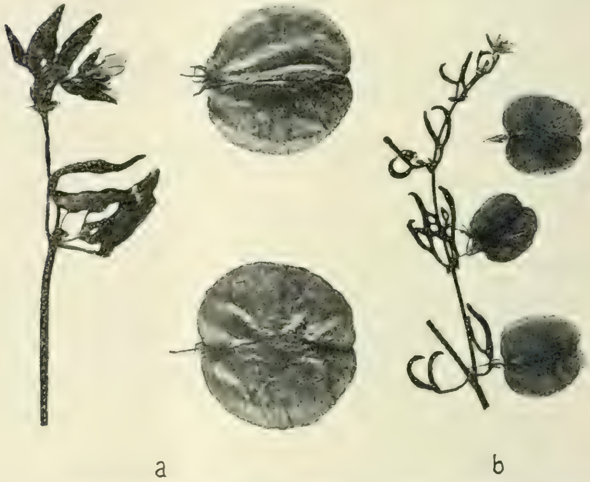

Fig. 11. *a, Zygophyllum fruticulosum* DC., from Geraldton. *b, Zygophyllum eremœum* (Diels) Ostf., from Kalgoorlie. (Nat. size).

As given by Diels (l. c.) this species occurs in the arid interior. It has straight, not scandent branches; the leaflets are linear, and the winged fruit is smaller than in *Z. fruticulosum* (nearly ripe fruits are only 10 mm long and ca. 8 mm broad). The nervature of the fruit-wings is also quite different. (Fig. 11 b).

In Kew herbarium specimens of this plant are present from: Victoria desert, camp 54 (Elder Expl. Exp., coll. R. Helms, 17. 9. 91); Boulder, W. D. Campbell, 21. 9. 1900; Coolgardie, E. Kelso, Oct. 1900; W. Australia, coll. Dr. W. H. Ince;

Z. frutic. var. floribus parvis albis, West Australian Goldfields, Spencer Moore 1895.

Rutaceæ.

Boronia heterophylla F. v. Müll. Fragm. Phytogr. Austr. II (1861) 98; Benth. Fl. Austr. I (1863) 315.

This beautiful species with large pink flowers was sent me from the environs of Albany (No. 739; 27. Aug. 1914; No. 1405; 29. Aug. 1915, in full flower, E. Douglas).

Boronia alata Sm., Transact. Linn. Soc. VIII (1807) 283; Benth. Fl. Austr. I (1863) 312.

Yallingup Cave, near a rivulet, a strongly scented shrub with pink flowers (No. 745; 27. Sept. 1914, in flower and with fruit).

Boronia spathulata Lindl. Swan Riv. App. Bot. Reg. (1839) 17; Benth. Fl. Austr. I (1863) 327.

Wilgarup, south of Bridgetown (No. 744; 1. Oct. 1914); Albany (No. 746; 20. Oct. 1914).

BENTHAM (l. c.) considers *B. dichotoma* Lindl. (Bot. Reg. (1841) under no. 47) as a tall variety of *B. spathulata* (var. *elatior*), but this is evidently erroneous. *B. dichotoma* Lindl. is a distinct species which is easily distinguished by the characters given by LINDLEY and BENTHAM. Another character is that it has glandular hairs on the pedicels (while *B. spathulata* is glabrous).

B. dichotoma Lindl. is present in the Kew Herb. from the following localities: Vasse River, Mrs. Molly; Swan River, Drummond coll. 1843, no. 38; Preston River, Oldfield; W. Austr., Miss K. F. Logue of Udoe, Apr. 1888; Distr. Wellington, Pritzel no. 95, 1900.

Asterolasia grandiflora (Hook.) Benth. Fl. Austr. I (1863) 352; *Phebalium gr.* Hook. Icon. Pl. (1848) tab. 724.

This rare plant was sent me by Mr. O. H. SARGENT of York (No. 743; 30. Aug. 1914).

Diplolæna R. Br. The species of this W. Australian genus are rather difficult to separate from each other. DESFONTAINES (1817) originally described two species. BARTLING (in Pl. Preiss. 1844) had two more, one of which was previously described by HOOKER in his text to the plate of *D. Dampieri* Desf. (1844). BENTHAM in Fl. Austr. (1863) kept all four species separate, adding a variety to one of them. F. von MÜLLER (Fragm. Phytogr. Austr. IX, 106) on the other hand united all into one species *D. Dampieri*, saying: "Discrimina specifica inter hanc et D. grandifloram, D. angustifoliam et D. microcephalam non detexi".

After a careful examination of a fairly ample material containing specimens sent from DESFONTAINES to HORNEMANN in Copenhagen, PREISS's specimens, and the collections in Kew and the British Museum I feel convinced that the genus comprises several closely related, but distinguishable forms[1].

A key mainly based upon the tomentum of the leaves will elucidate some of the distinguishing characters.

A. Leaves linear, glabrous above, tomentose underneath, tomentum consisting of both coarser and smaller (shorter) stellate hairs D. angustifolia Hook.
B. Leaves broader, oblong to obovate.
  a. Upperside of the leaves ± tomentose, underside with a dense tomentum of uniform short stellate hairs.
    1. Flower-heads and leaves large; outer floral bracts broadly ovate, inner ones broadly elliptical .. D. grandiflora Desf.

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[1] I have not had access to the descriptions of two species (and have not seen the specimens): viz. *D. Huegelii* hort. in Hamb. Gartenz. II (1846) 8, and *D. speciosa* Brongn. in Rev. Hortic. Ser. II. IV (1845—46) 133. They are not quoted by Bentham in 1863.

2. Flower-heads and leaves small; bracts lanceolate.
D. microcephala Bartl.

b. Upperside of the leaves glabrous or only slightly tomentose, underside tomentose, tomentum consisting of both coarser and smaller (shorter) stellate hairs.

1. Flower-heads and leaves large; outer floral bracts oblong-triangular, inner ones oblong......... D. Dampieri Desf.

2. Flower-heads and leaves small; outer floral bracts rather narrow, inner ones narrow-lanceolate.
D. Drummondii (Benth.) comb. nov.

c. Upperside of the leaves with coarse black stellate hairs; the same black hairs rather densely placed along the nerves on the underside, more scattered on the other parts.
D. Andrewsii n. sp.

Diplolæna grandiflora Desf., in Mém. Mus. de Paris III (1817) 45, tab. 19; Benth. Fl. Austr. I (1863) 358.

Of this species I have seen DESFONTAINES' specimens in the Herbarium of Copenhagen. In Kew Herb. there are specimens, probably from the same source, viz. "Nouv. Holl. côte occ., îles stériles, Voy. aux Terres australes, Capt. Baudin. 1801"; further the following: Dick Hartog's Isl., Voy, of H. M. S. Herald, Milne, and Shark's Bay, Capt. Denham. In the Herb. of the British Museum there are specimens from Shark's Bay (M. Leschenault); Houtmanns Abrolhos (Wickham & Stokes, 1840) and Dick Hartog's Island (A. Cunningham, Jan. 1822). Some specimens from Champion Bay (Burges) differ in the nearly glabrous upperside of the leaves and are perhaps better placed under *D. Dampieri.*

From these data it appears that *D. grandiflora* inhabits the more tropical parts of the west coast of W. A.

Diplolæna Dampieri Desf., in Mém. Mus. de Paris III (1817) 452, tab. 20; Hooker, Botan. Magaz. (1844) tab. 4059; Benth. Fl. Austr. I (1863) 358.

This species seems to be distributed along the whole west coast from Cape Leeuwin to Murchison River. I have seen the following specimens: Yallingup Cave, near the sea (Ostenfeld, No. 736, 26. Sept. 1914); Yallingup and Cape Naturaliste (A. Dorrien-Smith, 1910); Fremantle (Oldfield); Busselton (F. Stoward, 1917, Nr. 926); Between Perth and K. Georges' Sound (Harvey, 1854); Swan River (Drummond; Mr. Mylne); Geraldton, on dunes (Ostenfeld, No. 735, 28. Oct. 1914); Nouv. Holl. (ded. Desfontaines); Rottnest Island (Gould, from Gilbert, Aug. 1839); Shark's Bay (M. Leschenault).

Diplolæna Drummondii (Benth.) Ostf. nov. comb.; *D. microcephala*, var. *Drummondii* Benth., Fl. Austr. I (1863) 358.

I consider Bentham's variety of *D. microcephala* to be a separate species. The tomentum of the leaves consists of a dense clothing of coarser and smaller hairs on the underside and a ± dense clothing of smaller hairs on the upper side, as well as on the outer side of all bracts. The bracts are rather narrow, lanceolate and subacute. The flower heads are small.

Of this species I have seen the following specimens (all in the British Museum and Kew Herb.): Swan River (Drummond, 1839, no. 91); Vicinity of Fremantle (Gilbert, 1842, no. 180); Gravelly and rocky places in Darling Range, Smith Mill, 17 miles E. of Perth (Cecil Andrews, 8. Nov. 1902, 1st coll. no. 110, sub. nom. *D. Dampieri*); Between Perth and K. George's Sound (Harvey 1854, sub nom. *D. microcephala*); Mittlers Creek (Maxwell); Darling Range (Collie); Distr. Wellington, in silvis subumbrosis mont. Darling Range (E. Pritzel, X. 1901, no. 799, sub nom. *D. microcephala*).

This species seems to be distributed from Swan River southwards, but not along the coast, more on the slopes of the mountains.

Diplolæna microcephala Bartl. in Pl. Preiss. I (1844) 173; Benth. Fl. Austr. I (1863) 358.

Of this species, which has the same uniform and dense tomentum as *D. grandiflora*, I have seen OLDFIELD's specimens from Murchison R. (in Kew. Herb.) and (in the British Museum) specimens from Wangoa Hills (Gilbert, 1842, No. 229), from Fenterden (Aug. 1916, F. Stoward, No. 927), Kellerberrin (July 1914, F. Stoward, No. 928), and Dowerin (July 1917, F. Stoward, No. 929).

Diplolæna angustifolia Hook. in Bot. Magaz. (1844) under No. 4059; Benth. Fl. Austr. I (1863) 358; *D. salicifolia* Bartl. in Pl. Preiss. I (1844) 173.

Seems to be a very distinct species, easily recognisable by its linear leaves. I have seen Preiss' No. 2020 upon which BARTLING described his *D. salicifolia*. Further (in Herb. Kew. and British Museum) specimens from Swan River (Drummond), from near Fremantle (Gilbert, Aug. 1839), and from S. W. Australia (I. S. Roe). They probably all came from the Swan River district.

Diplolæna Andrewsii Ostf. nov. sp. Folia oblongo-obovata, obtusa, supra pilis stellatis nigris numerosis, subtus pilis stellatis nigris præcipue ad nervos dense tecta; capitula admodum parva, bracteæ exteriores late ovatæ pilis stellatis tectæ, interiores longiores, obtusæ, ellipticæ, brunneæ marginibus angustis membranaceis.

This new species is easily distinguished by the peculiar tomentum of coarse black stellate hairs. It is in the Kew Herb. and in the British Museum with the following notes: "*Diplolæna* sp., Among granite rocks in Darling Range, Swan View, 14 m. NE. of Perth, 10. Oct. 1901 (Cecil Andrews, Fl. of W. Austr., 1st Coll. No. 109). Probably a var. of *D.*

microcephala Bartl., but the bracts are more like those of *D. grandiflora* Desf. Shrub of 2—3 feet."

I have named it in honour of the discoverer Mr. Cecil Andrews, Director of Education, Perth, who has contributed much to our knowledge of the flora of W. Australia.

Tremandraceæ.

Tetratheca platycaula (Benth.) comb. nov.; *T. affinis* var. *platycaula* Benth. Fl. Austr. I (1863) 133; Diels u. Pritzel, Bot. Jahrb. 35 (1904) 330.

Differt a *T. affini* caulibus alatis usque ad 8 mm latis, florumque dimensionibus majoribus etc. (Fig. 12, 2).

Jarnadup, south of Bridgetown (No. 1092; 3. Oct. 1914); common along the Bridgetown railway line.

As Bentham (l. c.) has pointed out, his var. *platycaula* differs from *T. affinis* in broader winged branches, larger flowers, and 4 ovules in each cell of the ovary. I feel convinced that it is an independent species which is well separated from the true *T. affinis* Endl. (which I have collected at Albany, No. 1096, 21. Oct. 1914; see Fig. 12, 1).

T. platycaula inhabits the rich forest country of the Blackwood district, while *T. affinis* has its home in the coastal area of the south.

Tetratheca hirsuta Lindl. Swan Riv. App. Bot. Reg. (1839) 38; Bot. Reg. (1844), tab. 67; Benth. Fl. Austr. I (1863) 134; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 330.

Mundaring Weir, Darling Range (No. 1093; 13. Sept. 1914); Vicinity of Perth (No. 1356; Mrs. Davis, 1915).

var. **epilobioides** (Steetz) Diels u. Pritzel, Botan. Jahrb. 35 (1904) 330; *T. epilobioides* Steetz, in Pl. Preiss. I, 2 (1844) 218.

Fig. 12. 1. *Tetratheca affinis* Endl. 2. *Tetratheca platycaula* (Benth.) Ostf. ($^{7}/_{12}$ nat. size).

Vicinity of Perth (No. 1355; Mrs. Davis, 1915).

Differs from the main species in smaller and narrower leaves and smaller flowers.

Tremandra diffusa R. Br., in D. C. Prodrom. I (1824) 344; Benth. Fl. Austr. I (1863) 137.

Jarnadup, south of Bridgetown (No. 1130; 2. Oct. 1914).

A decumbent diffuse shrub with dull-red sepals and white petals. The specimens collected are more stellate-hairy than usual, according to the description by BENTHAM (l. c.).

Euphorbiaceæ.

Euphorbia terracina L. Sp. pl. ed. 2 (1762) 654.

Geraldton, on the dunes, an erect annual (No. 402; 28. Oct. 1914).

This Mediterranean species was found in numbers in the same dune area where also *Asphodolus fistulosus* L. (see p. 18) was present.

Celastraceæ.

Psammomya chorethroides (F. v. Müll.) Diels et Loesener, in Botan. Jahrb. 35 (1904) 340, fig. 41; *Logania ch.* F. v. Müll., in Vict. Naturalist VI (1889) 118.

Tammin, heath (No. 295; 6. Oct. 1914).

This interesting aphyllous shrub was rediscovered by me in the same locality where DIELS and PRITZEL collected it.

Stackhousiaceæ.

The recent monograph by R. PAMPANINI and G. BARGAGLI-PETRUCCI (Bull. l'Herb. Boissier, 2. ser., vol. V, 1905) has been consulted.

Stackhousia Brunonis (Endl.) Benth. seems to be a very variable species or, more probably, an aggregate of species, but the forms in my collection do not fit in with the varieties given by PAMPANINI (l. c. pp. 1152—1153).

Rhamnaceæ.

Trymalium spathulatum (Labill.) comb. nov.; *T. Billardieri* Fenzl, in Huegel, Enum. pl. (1837) 75; Benth. Fl. Austr. I (1863) 423; *Ceanothus spathulatus* Labill., Pl. Nov. Holl. I (1804) 60, tab. 84.

Yallingup Cave (No. 733; 28. Sept. 1914).

According to the rules of nomenclature it is necessary to take up LABILLARDIÈRE's earlier species name for this well-known shrub.

var. **tomentosum** Reissek, in Pl. Preiss. II (1848) 282; *T. Bill.*, var. *hirsutum* Benth., Fl. Austr. I (1863) 424; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 352.

Darlington (No. 732; 28. Aug. 1914, Cecil Andrews).

This variety seems well separated from the main species.

Cryptandra arbutiflora Fenzl, in Huegel, Enum. pl. (1837) 26; Benth. Fl. Austr. I (1863) 444.

Vicinity of Perth (No. 729; Aug. 1914); Kalamunda (29. July 1914, Gunnar Andersson).

Cryptandra tubulosa Fenzl, in Huegel, Enum. pl. (1837) 26; *C. arbutiflora*, var. *tubulosa* Benth. Fl. Austr. I (1863) 444.

Perth, King's Park (No. 943; 10. Sept. 1914).

I think this plant ought to be considered a separate species (se Fig. 13, 2) which differs from *C. arbutiflora* (Fig. 13, 1) in the longer and more slender calyx tube and the narrower and longer leaves etc.

Malvaceæ.

Modiola caroliniana (L.) G. Don, Gen. Syst. I (1831) 466.

Yallingup Cave, damp places along a rivulet, flowers redbrown (No. 562; 27. Sept. 1914).

This American species has spread as a weed to many foreign countries, but has not before been recorded from W. Austr.

Plagianthus repens Sp. Moore, in Journ. Linn., Soc. vol. 34 (1899) 179.

Kalgoorlie (No. 560; 7. Oct. 1914).

Sida intricata F. v. Müll., in Trans. Phil. Soc. Vict. I (1860) 19, ex Benth. Fl. Austr. I (1863) 193.

Kalgoorlie (No. 565; 7. Oct. 1914).

A plant which answers well to this species as represented in the Kew Herb., but rather coarser than usual, was collected in the arid area near Kalgoorlie.

Sida spinosa L. Sp. pl. (1753) 683; Benth. Fl. Austr. I (1863) 196; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 363.

Carnarvon, on the dunes near the jetty (No. 559; 31. Oct. 1914); Onslow, Mouth of Ashburton River (Alex. Morrison, 13. Oct. 1905; Kew Herb.).

This is a further southward extension of the geographical range of this common tropical weed.

Fig. 13. *1. Cryptandra arbutiflora* Fenzl. (Preiss' No. 465). *2. Cryptandra tubulosa* Fenzl. (7/12 nat. size).

Sida Hookeriana Miq., in Pl. Preiss. I (1844) 242; Benth. Fl. Austr. I (1863) 197.

Yallingup Cave, on open soil in the forest (Nos. 563 and 564; 26. Sept. 1914).

It occurs both in an erect and in a prostrate form; the flowers are white, the corolla slightly longer than the calyx.

Cienfugosia hakeifolia (Giord.) Hochreutiner, in Ann. Conserv. et Jard. bot. Genève VI (1902) 56; *Fugosia h.* Hook.; Benth. Fl. Austr. I (1863) 220.

Geraldton, common on the dunes (No. 561; 28. Oct. 1914).

Hochreutiner (l. c.) has transferred the pretty *Fugosia hakeifolia*, a dominant feature of the dune area, to the genus *Cienfugosia* Cav.

Sterculiaceæ.

Guichenotia ledifolia J. Gay, in Mém. Mus. Paris VII (1821) 449; Benth. Fl. Austr. I (1863) 258; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 377.

Yallingup Cave, among shrubs (No. 768; 28. Sept. 1914).

This locality forms a link between the area of occurrence farther north and that in the district of Eyre.

Thomasia cognata Steud., in Pl. Preiss. I (1844) 232; Benth. Fl. Austr. I (1863) 254; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 375.

Yallingup Cave, among shrubs near the sea (No. 767; 26. Sept. 1914).

Dilleniaceæ (determ. by Carl Christensen and C. H. Ostenfeld).

Hibbertia inconspicua Ostf. nov. sp. (Pl. X, Fig. c, and Textfig. 14, b).

Sect. *Cyclandra.* Fruticulus erectus vel adscendens, 30-

35 cm altus, omnino papillis minutis acutis vel pilis minutis brevissimis densissimisque tectus; præter papillas pili longi villosi patentes in caulibus, pedunculis et sepalorum partibus exterioribus obsiti. Folia oblongo-obovata, usque ad 15 mm longa, basin versus angustata, subsessilia, subcoriacea, intergerrima, obtusa, supra (matura saltem) epilosa, subtus et ad margines pilis longis albis subappressis ornata. Flores singuli in axillis, et foliis et bracteis brunneis membranaceis instructi, pedunculati (pedunculi ca. 5—10 mm longi). Sepala 5 ovata, exteriora acuminata vel acuta, interiora subobtusa. Petala obovato-obcordata, emarginata, dimidio sepalis longiora. Stamina libera, ca. 20, staminodia non observata; carpelli 3 glabri; styli filiformes, staminibus paullo longiores. Fructus ignoti.

Fig. 14. Stamens and carpels of *a*, *Hibbertia pulchra* Ostf. and *b*, *Hibbertia inconspicua* Ostf. (photo.; about $^3/_1$ nat. size).

Ex affinitate *H. potentillifloræ* F. v. Müll., sed differt: planta in omnibus partibus minor, tomentum diversum, pedunculi breviores, carpellorum numerus diversus etc.

Jarnadup, south of Bridgetown (No. 310; 2. Oct. 1914).

After having compared this plant with the rich material of *Hibbertia* at Kew I find it a hitherto undescribed species which is nearest to the much coarser *H. potentilliflora* F. v. Müll.

Hibbertia pulchra Ostf. nov. sp. (Pl. X, Fig. a and Textfig. 14 a).

Sect. *Candollea*. Fruticulus gracilis multiramosus erectus vel adscendens, 25—30 cm altus, glaber, ramis virgatis. Folia subcoriacea, oblongo-linearia vel spathulata, obtusa, ad 15 mm longa, subtus (saltem in sicco) nervo mediano crasso instructa, superficie punctis minimis ornata. Flores singuli, in axillis sessiles, foliis 3 minoribus et bracteis 3 ovato-cordatis acuminatis brunneo-membranaceis ciliolatisque instructi. Sepala 5 glabra vel apicem versus parce ciliolata, late ovata, acuminata, brunneo-membranacea parte mediana atrobrunnea. Petala late obovata, quam sepala longiora. Stamina 2 libera, reliqua in 3 fasciculis trigeminis posita. Carpella 3, ad basin paullo cohærentes, glabri, styli filiformes staminibus sub-æquilongi.

Ex affinitate *H. teretifoliæ* Turcz., sed differt: folia sparsiora, majora et latiora, flores majores, etc.

Palgarup, south of Bridgetown (No. 309; 2. Oct. 1914).

This little pretty and richly flowering shrub has perhaps been confused with *H. teretifolia* from which it seems well distinguishable. It was met with in several places on the railway in the Bridgetown district.

Hibbertia teretifolia (Turcz.) F. v. Müll. Fragm. Phytogr. Austr. IV (1864) 117; *Candollea t.* Turcz. in Bull. Moscou (1849) 7; Benth. Fl. Austr. I (1863) 43.

Vicinity of Perth (No. 1360, 1915, Mrs. Davis). (Pl. X, fig. b).

From the rich material present in Kew Herb. it seems as if two species are hidden under the name of *H. teretifolia;* and a revision of the whole material and comparison with the species of *Pleurandra* described by STEETZ in Pl. Preiss. I (1844, pp. 264—265) will probably result in the revival of some of Steetz's species. Perhaps also the new species described above is to be found under one of Steetz's names; but I have no access to the nos. of Pl. Preiss. in question.

Hibbertia grossulariifolia Salisb. Parad. Lond. t. 73 (1806); Botan. Magaz. tab. 1218; Benth. Fl. Austr. I (1863) 37.

Yallingup Cave (No. 313; 26. Sept. 1914), a prostrate undershrub (sometimes creeping); in the open forest, on sandy soil.

Hibbertia Cunninghamii Aiton, in Hook. Bot. Magaz., tab. 318 (1832); Benth. Fl. Austr. I (1863) 39.

Yallingup Cave (No. 312; 26. Sept. 1914), in the open forest; a slender undershrub, partly decumbent.

Hibbertia stellaris Endl., in Huegel, Enum. pl. (1837) 3; Benth. Fl. Austr. I (1863) 41.

Palgarup, south of Bridgetown (No. 311; 1. Oct. 1914), in damp places, common.

Hibbertia tetrandra (Lindl.) Gilg, in Engler u. Prantl, Natürl. Pflanzenfam. III, 6 (1895) 118; *Candollea tetrandra* Lindl. Bot. Reg. (1842) misc. 39, and (1843) tab. 50; Benth. Fl. Austr. I (1863) 42.

Yallingup Cave (No. 308; 26. Sept. 1914), an erect shrub.

Hibbertia subvaginata (Steud.) comb. nov.; *H. polygonoides* F. v. Müll. Fragm. Phytogr. Austr. IV (1864) 116; *H. glaberrima* (Steud.) Gilg, in Engler u. Prantl. Natürl. Pflanzenfam. III, 6 (1895) 118; *Candollea subvaginata* Steud., in Pl. Preiss. I (1844) 275; *C. glaberrima* Steud, ibid. 274; Benth. Fl. Austr. I (1863) 45; non *Hibbertia glaberrima* F. v. Müll., l. c. III (1862) 1.

Environs of Perth (No. 304; 9. Aug. 1914, leg. E. Dorph-Petersen).

The synonymy of this species is rather confused, but it seems to us that according to the rules of international nomenclature it must bear the name *H. subvaginata* (Steud.).

Hibbertia montana Steud., var. **major** Benth. Fl. Austr. I (1863) 35; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 384.

Darlington (No. 302; 28. Aug. 1914, Cecil Andrews).

This variety is very different from the true *H. montana*, and ought perhaps be taken as a separate species.

Frankeniaceæ, see »Contr. W. Austr. Bot. II« (1918), where I have given a revision of the W. Australian species of the genus **Frankenia.**

Violaceæ.

Jonidium calycinum (D. C.) Steud. Nomencl. bot. II (1840) 813; Benth. Fl. Austr. I (1863) 104; *Hybanthus calycinus* F. v. Müll., Fragm. Phytogr. Austr. X (1877) 81.

This species is common around Perth, growing in sandy places of the open forest. It extends southwards in the coastal region, e. g. found at Yallingup Cave (No. 828; 29. Sept. 1914).

By BENTHAM (l. c.) it is given as “a glabrous perennial”, but in several specimens examined by me, the leaves are covered (more or less sparingly) with short and thick white hair-papillæ, especially along the margins (No. 826, Vicinity of Perth, Cecil Andrews, Aug. 1914; No. 828 (partly), Yallingup Cave, Sept. 1914); otherwise these specimens do not differ from the typical form.

Jonidium debilissimum F. v. Müll., Fragm. Phytogr. Austr. XI (1878) 4, ut syn. sub *Hybantho;* Diels u. Pritzel, in Botan. Jahrb. 35 (1904) 391.

Jarnadup, south of Bridgetown (No. 429; 2. Oct. 1914).

This species seems to be restricted to the most rainy region (the south coast and adjoining districts). Kew Herb. has it from Lowden (Max Koch, No. 2003, 1910, in silvis umbrosis).

Thymelæaceæ.

Pimelea spectabilis Lindl. Bot. Reg. (1841) tab. 33; Benth. Fl. Austr. VI (1873) 9.

Yallingup Cave, in forest (No. 784; 27. Sept. 1914, flowers white); Mundaring Weir (No. 782; 13. Sept. 1914, flowers pale-rose).

Pimelea rosea R. Br. Prodr. Fl. Nov. Holl. (1810) 360; Benth. Fl. Austr. VI (1873) 10; Botan. Magaz. tab. 1458; *P. Hendersonii* Graham in Botan. Magaz. tab. 3721.

The white flowered form is present in the Swan district (No. 783; 13. Sept. 1914, Mundaring Weir); rose-coloured flowers are found farther towards the south: Yallingup Cave (Nos. 786 (light pink) and 788 (dark pink); 26. Sept. 1914).

var. **calocephala** Meissn. in Pl. Preiss. I (1845) 602.

This pretty variety ought perhaps to be elevated to specific range, but I leave it for closer examination.

Vicinity of Perth (No. 1369; 1915, leg. Mrs. M. Davis).

It seems to be restricted to the Swan district.

Pimelea angustifolia R. Br. Prodr. Fl. Nov. Holl. (1810) 360; Benth. Fl. Austr. VI (1873) 13; Diels u. Pritzel, in Botan. Jahrb. 35 (1904) 394.

Tammin; heath (No. 790; 6. Oct. 1914).

The specimens are very interesting by the much thickened corky bark of the stem-bases (see p. 56).

Pimelea physodes Hook. Icon. pl. tab. 865 (1852); Benth. Fl. Austr. VI (1873) 5; Diels u. Pritzel, l. c. 395.

Qualup, a railway station between Katanning and Donnybrook (No. 1336; 20. July 1915, leg. E. Douglas).

This extraordinary species was sent me under the name of "Qualup Bells".

Pimelea imbricata R. Br. var. **nana** (Grah.) comb. nov.; *P. imbr.* var. 3, *piligera* Benth. Fl. Austr. VI (1873) 21; *P. nana* Graham, in Edinb. New. Phil. Journ. 29 (1840) 174.

Near Cannington (No. 787; 22. Sept. 1914, E. Dorph-Petersen); Tammin (No. 780; 6. Oct. 1914).

It seems necessary to change BENTHAM'S varietal name for the much earlier *P. nana* Graham.

Pimelea Gilgiana E. Pritzel, in Botan. Jahrb. 35 (1904) 396, fig. 46. (Determ. by Dr. L. Diels).

Geraldton, amongst the dunes (No. 775; 28. Oct. 1914), in fruit.

This species was described by E. PRITZEL (l. c.) from flowering specimens from the same area.

Pimelea longiflora R. Br. Prodr. Fl. Nov. Holl. (1810) 361; Benth. Fl. Austr. VI (1873) 34.

Palgarup, south of Bridgetown, swampy ground (No. 789; 2. Oct. 1914).

Lythraceæ.

Lythrum hyssopifolia L. Sp. pl. (1753) 447; Benth. Fl. Austr. III (1866) 299; F. v. Müller and A. Morrison, in W. Austr. Yearbook (1902) 319.

Near Bayswater, in a damp place not far from Swan River (No. 1122; 18. Oct. 1914).

The species is usually an annual, but my specimens show that under favourable conditions it may become a perennial.

Nyctaginiaceæ.

Boerhaavia plumbaginea Cavanil. Icon. et descript. pl., II (1793) 7, tab. 112; *B. repanda* Willd. sp. pl. I (1797) 22; Benth. Fl. Austr. V (1870) 228.

A plant which agrees with this species was collected at Geraldton (No. 628; 28. Oct. 1914).

Oenotheraceæ.

Epilobium junceum Soland., in Forst. Prodr. app. (1786) 90; Haussknecht, Monogr. Epilob. (1884) 238; *E. glabellum* F. v. Müller, 2. Cens. Austr. Pl. (1889) 84.

A plant collected at Albany, King George's Sound (No. 629; 21. Oct. 1914) belongs to var. **canescens** (Huegel) Hausskn. l. c. (p. 240) (= *E. canescens* Huegel, in Enum. pl. Hueg. (1837) 44).

Myrtaceæ (determ. by Dr. L. Diels; *Eucalyptus* by I. H. Maiden).

Verticordia stylotricha Diels, in Engler, Bot. Jahrb. 35 (1904) 403.

Tammin, sandy heath (No. 568; 6. Oct. 1914).

Chamæleucium megalopetalum F. v. Müll., in Benth. Fl. Austr. III (1866) 38.

Albany (No. 1408; 29. Aug. 1915, Mr. E. Douglas).

Calythrix breviseta Lindl. Swan Riv. App. Bot. Reg. (1839) 5; Benth. Fl. Austr. III (1866) 43.

Tammin (No. 595; 6 Oct. 1914, "forma microphylla").

Calythrix brevifolia Meissn., in Journ. Linn. Soc. I (1857) 46; Benth. Fl. Austr. III (1866) 45.

Moora (No. 1430; 25. Sept. 1915, Miss G. Davis).

Thryptomene Davisiæ Diels nov. sp.

Frutex gracilis, multiramosus ramulis ultimis tenuibus gracilibus cortice pallide cinereo vel albido obtectis. Folia brevissime petiolata, crassa, oblongo-obovata, ± erecta, apice extrorsum patentia, 2.8—4 mm longa, 1.2—1.5 mm lata. Flores sessiles, bracteolis 2 præter medianam scarioso-petaloideis tubo longioribus præditi. Calycis tubus turbinatus, circ. 15-costatus, omnino adnatus, 1.5 mm longus, lobi subreniformes, scarioso-petaloidei, persistentes, 1.5 mm longi, 2.5 mm lati. Petala roseo-albida, 2.5 mm longa, 3 mm lata, persistentia. Stamina 10, incurva, filamentis quam antheræ atro-purpureæ duplo longioribus. Ovula 4.

Species nova *Th. proliferæ* Turcz. affinis, sed floribus sessilibus, bracteolis majoribus, tubo conspicue multicostato, petalis quam lobi calycini majoribus distincta est. A *Th. Johnsonii* foliis angustioribus, longioribus, petalis majoribus, ovulis 4 distat.

Moora (No. 1429; 25. Sept. 1915, Miss G. Davis).

Scholtzia oligandra F. v. Müll., in Benth., Fl. Austr. III (1866) 70.

Moora (No. 1428; 25. Sept. 1915, Miss G. Davis).

Bæckea pulchella D. C. Prodr. III (1828) 230; Benth. Fl. Austr. III (1866) 86.

Tammin (No. 597; 6. Oct. 1914).

The specimens agree with the specimens preserved in the Kew Herb. under the name of *B. pulchella* D. C. (note by C. H. O.).

?**Bæckea pachyphylla** Benth. Fl. Austr. III (1866) 85.

Tammin (No. 598; 6. Oct. 1914).

I refer some sterile specimens of a *Bæckea* with doubt to this little known species. The leaves agree well with the leaves of *B. pachyphylla* in the Kew Herb. (note by C. H. O.).

Agonis linearifolia Schauer, in Pl. Preiss. I (1844) 118; Benth. Fl. Austr. III (1866) 98.

Seems to vary rather much with regard to the hairiness of the shoots (note by C. H. O.).

Kunzea micrantha Schauer, in Pl. Preiss. I (1844) 125; Benth. Fl. Austr. III (1866) 112.

Armadale, damp soil (No. 599; 20. Sept. 1914).

Kunzea sericea Turcz., Bull. Mosc. (1847) 162; Benth. Fl. Austr. III (1866) 117.

Waddouring (No. 591; Oct. 1914, Mr. Drummond).

Melaleuca radula Lindl. Swan Riv. App. Bot. Reg. (1839) 8; Benth. Fl. Austr. III (1866) 141; Diels, in Engl. Bot. Jahrb. 35 (1904) 427.

Tammin, heath (No. 627; 6. Oct. 1914), "sed spicis sublateralibus a typo diversa" (Diels scrips.).

Melaleuca hamulosa Turcz., Bull. Mosc. (1847) 165; Benth. Fl. Austr. III (1866) 146; Diels, in Engl. Botan. Jahrb. 35 (1904) 428.

Tammin, heath (No. 1116; 6. Oct. 1914). The specimens are sterile and bear numerous globose galls of the size of a small pea (note by C. H. O.).

Melaleuca uncinata R. Br., in Ait. Hort. Kew. ed. 2, IV (1812) 414; Benth. Fl. Austr. III (1866) 150; Diels, in Engl. Bot. Jahrb. 35 (1904) 428.

Tammin (No. 586; 6. Oct. 1914).

Melaleuca depressa Diels, in Engl. Botan. Jahrb. 35 (1904) 428.

Geraldton, on the dunes (No. 613; 28. Oct. 1914).

Eucalyptus. The best authority on this difficult genus Mr. I. H. Maiden, F. R. S., has been kind enough to name my Eucalypts of which I sent him duplicate specimens. Some of my Nos. are referred to in the recently published parts of his large work on *Eucalyptus.* Only the rarer and more critical species are mentioned here.

Eucalyptus gracilis F. v. Müll., var. **yilgarnensis** (Diels) Maid. Crit. Revis. Eucalyptus vol. IV. 9 (XXXIX) (1919) 265; *E. calycogona* Turcz. var. *gracilis* Maid., ibid. III (1903) 81, pl. 12.

Tammin, a "Morrel Gum" (No. 511; 6. Oct. 1914, with ripe fruits and big flower buds).

Eucalyptus Le Souefii Maid., Crit. Revis. Eucalyptus XVI (1912) 187, pl. 69, figs. 5—7.

Kalgoorlie (No. 515; 7. Oct. 1914, with big flower buds).

This recently described species is only known from Kalgoorlie, Coolgardie and Kurrawang (Maiden, l. c.).

Eucalyptus megacarpa F. v. Müll. Fragm. Phytog. Austr. II (1860) 70; Benth. Fl. Austr. III (1866) 232; F. v. Müll., Eucalyptographia 6 (1880); Maiden, Crit. Revis. Eucalyptus XVIII (1913) 246, pl. 78 figs. 4—8.

Yallingup Cave, a tree with whitish bark (No. 508; 27. Sept. 1914, with old fruits).

Eucalyptus Oldfieldii F. v. Müll. Fragm. Phytogr. Austr. II (1860) 37; Benth. Fl. Austr. III (1866) 237; F. v. Müll., Eucalyptographia 7 (1880); Maiden, Crit. Revis. Eucalyptus XVII (1912) 223, pl. 73, fig. 11, pl. 74, figs. 1—11; vol. V. I (= XLI) (1920) 21.

Tammin, a "Mallee Gum" (No. 512; 6. Oct. 1914, with ripe fruits).

Eucalyptus transcontinentalis Maiden, in Journ. R. Soc. N. S. Wales, 53 (1919) 58; *E. oleosa* F. v. Müll. var. *glauca* Maiden, Journ. W. Austr. Nat. Hist. Soc. III (1911) 171; Crit. Revis. Eucalyptus XV (1912) 167, pl. 66, figs. 6—15.

Kalgoorlie (No. 514; 8. Oct. 1914, with ripe fruits; No. 521; 8. Oct. 1914, with yellow flowers).

Eucalyptus erythronema Turcz., in Bull. Phys. Math. Acad. Petersbourg, 10 (1852) 337; F. v. Müll., Eucalyptographia 8 (1882); Maiden, Crit. Revis. Eucalyptus XXII (1914) 23, pl. 93, figs. 1—3; *E. conoidea* Benth. Fl. Austr. III (1866) 227.

Tammin, a tall shrub (No. 517; 6. Oct. 1914, in full flower).

Eucalyptus cladocalyx F. v. Müll., in Linnæa 25 (1852) 388; Maiden, Crit. Revis. Eucalypt. vol. IV. 6 (= XXXVI) (1919) 161, pl. 151; *E. corynocalyx* F. v. Müll. Fragm. Phytogr. Austr. II (1860) 43; Benth. Fl. Austr. III (1866) 218.

Armadale, a tree with white and smooth bark; planted (No. 502; 20. Sept. 1914, with ripe fruits).

Eucalyptus rudis Endl., in Huegel, Enum. Pl. (1837) 49; Benth. Fl. Austr. III (1866); Maiden, Crit. Revis. Eucalypt. vol. IV, 3 (XXXIII) (1917) 75, pl. 138.

Bridgetown (No. 509; 1. Oct. 1914); Armadale (No. 505; 20. Sept. 1914).

Halorrhagaceæ.

Halorrhagis pithyroides (Nees) Benth. Fl. Austr. II (1864) 476; Schindler, in Engler, Das Pflanzenreich IV, 225 (1905) 37.

Bayswater, sandy heath (No. 641; 18. Oct. 1914).

Halorrhagis tenuifolia Benth. Fl. Austr. II (1864) 477; Schindler, l. c. 54.

Vicinity of Perth (No. 643; 25. Oct. 1914, E. Dorph-Petersen).

Umbelliferæ.

Hydrocotyle callicarpa Bunge, in Pl. Preiss. I. 2 (1844) 283; Benth. Fl. Austr. III (1866) 343; *H. tripartita* Hook. f., Icon. pl. tab. 312, non R. Br.

Bayswater, in a swamp (No. 809; 18. Oct. 1914); Yallingup Cave, open place in the forest (No. 810; 26. Sept. 1914).

The specimens collected differ from the description by the erect and hairy stems, but not otherwise.

Hydrocotyle hispidula Bunge, in Pl. Preiss. I. 2 (1844) 283; Benth. Fl. Austr. III (1866) 343.

Yallingup Cave, sandy and open places in the forest (No. 807; 27. Sept. 1914).

Seems to be a rather rare species. Kew has specimens from Cottesloe near Perth (Cecil Andrews; 10. 9. 1902).

Hydrocotyle diantha D. C. Prodr. IV (1830) 63; Benth. Fl. Austr. III (1866) 345.

Bayswater, damp places (No. 805; 18. Oct. 1914); Yallingup Cave, wet places along a rivulet (No. 806; 27. Sept. 1914).

Hydrocotyle blepharocarpa F. v. Müll., Wing's Science Record for July 1883, Sep. p. 1 (seen in the Kew Herb.);

Diels u. Pritzel, Bot. Jahrb. 35 (1904) 451; Domin, Beih. Bot. Centralbl. XXIII Abt. 2 (1908) 293.

Yallingup Cave (No. 808; 26. Sept. 1914).

This is a true *Hydrocotyle*, and Domin (l. c.) is right when he leaves it under this genus and does not transfer it to the genus *Neosciadium* Dom.

Homalosciadium verticillatum (Turcz.) Domin, in Beih. Botan. Centralbl. XXIII, Abt. 2 (1908) 294; *Hydrocotyle verticillata* Turcz. in Bull. Soc. Nat. Mosc. XXII (1849) II, 28; Benth. Fl. Austr. III (1866) 346; *H. homolocarpa* F. v. Müll. Fragm. Phyt. Austr. II (1861) 129.

Yallingup Cave (No. 802; 26. Sept. 1914); Albany (No. 803; 21. Oct. 1914), and Armadale (23. Sept. 1914).

This little plant seems to be fairly common in open places in the sandy forest of the coast region.

Didiscus pilosus (Sm.) Domin, in Sitz.ber. k. Böhm. Gesellsch. d. Wiss. Prag (1908) 31; *Trachymene pilosa* Sm., in Rees' Cyclop. Suppl. XXXIX (1819); Benth. Fl. Austr. III (1866) 348.

In the treatment of the genus *Didiscus* D. C. (*Trachymene* Rudge, ex parte) I have followed K. Domin's monograph quoted above.

This is a common species.

At Geraldton (No. 796; 28. Oct. 1914) I collected a low form of it, which seems to correspond well with var. **Preissii** (Bunge) Domin l. c. (*Dimetopia P.* Bunge, in Pl. Preiss. I (1844) 284).

Didiscus cyanopetalus (Benth.) F. v. Müll., Fragm. Phyt. Austr. IX (1875) 46; Domin, l. c. 33; *Trachymene c.* Benth. Fl. Austr. III (1866) 348.

Vicinity of Perth (No. 1353; Mrs. M. Davis, 1915).

The specimens agree with the description of var. *ciliatulus* Dom. (l. c. 34).

Didiscus ornatus (Endl.) Domin, l. c. 35; *Cesatia ornata* Endl. in Ann. Mus. Wien II (1838) 200; *Trachymene eriocarpa* Benth. Fl. Austr. III (1866) 348.

Vicinity of Perth (No. 1351; Mrs. Davis, 1915).

Didiscus Benthamii Domin l. c. 39; *D. pilosus* Benth., in Hueg. Enum. Pl. (1837) 54, in nota; *Trachymene australis* Benth. Fl. Austr. III (1866) 349, pro parte minori.

Northam (Febr. 1900, Hancock).

To this species I refer with some doubt some specimens collected at Northam and distributed by the Nat. Herb. of N. S. Wales as *D. glaucifolius* Sm.

Trachymene compressa (Labill.) Rudge, in Transact. Linn. Soc. X (1810) 300; Diels u. Pritzel, in Engler, Botan. Jahrb. 35 (1904) 453; *Siebera compressa* Benth. Fl. Austr. III (1866) 352, ex parte.

Albany, sandy soil (No. 818; 21. Oct. 1914).

Trachymene tenuissima (Benth.) F. v. Müll. Cens. (1882) 62; *Siebera tenuissima* Benth. Fl. Austr. III (1866) 354.

Jarnadup, south of Bridgetown (No. 817; 2. Oct. 1914).

Xanthosia tasmanica Domin, in Fedde, Repert. nov. spec. IV (1907) 298; *X. pusilla β*, Hook. fil. Fl. Tasman. I (1860) 156; *X. pusilla* Benth. Fl. Austr. III (1866) 361, ex parte minore.

Jarnadup, south of Bridgetown (No. 814; 2. Oct. 1914).

It is rather unexpected to find this Tasmanian species, recently described by Domin, in W. Australia, but my plant agrees exactly with the specimens in the Kew Herb. from Tasmania (Georgetown, 21. Oct. 1842, Gunn, and Circular Head, 1837, Gunn), upon which Domin has founded the new species.

As far as I am able to judge Domin is quite right in creating a separate species upon this plant. As it appears from his description and remarks (l. c.), *X. tasmanica* differs in many respects from its nearest ally *X. pusilla,* e. g. in the much broader and glabrescent leaflets and the shape and size of the fruit.

Xanthosia candida Steud., var. **subtrilobata** nov. var. (Pl. XI, fig. 1).

Differt a typo foliis (infimis supremisque exceptis) trilobatis lobis integris acuminatis ± divaricatis.

Yallingup Cave, in open forest (No. 812; 26. Sept. 1914).

This variety which is perhaps an independent species, differs distinctly from the typical *X. candida* Steud. in the much shorter and trilobate leaves with more or less diverging side-lobes.

Daucus glochidiatus (Labill.) Fisch., Mey. et Avé-Lall. Ind. Sem. Hort. Petr. IX Suppl. 11, ex Hayward and Druce, Advent. Fl. of Tweedside (1919) 78; *D. brachiatus* Sieb. in D. C. Prodr. IV (1830) 214; Benth. Fl. Austr. III (1866) 376; *Scandix gloch.* Labill. Pl. Nov. Holl. I (1804) 75, tab. 102; *Caucalis gloch.* Poir.; D. C. Prodr. l. c. 216.

The species is widely distributed all over Australia. As to W. Austr. I have seen it both in the arid interior, Kalgoorlie (No. 821; 7. Oct. 1914), and near the coast of the S. W. corner, Yallingup Cave (No. 820; 27. Sept. 1914).

Petroselinum sativum Hoffm. Gen. Umbell. I (1814) 177.

Yallingup Cave, in open forest on rather naked soil (No. 819; 26. Sept. 1914).

A curious looking little plant, which grew amongst many other annuals near the Yallingup Cave in a place rather distant from houses, has puzzled me much. But I cannot find that it agrees with other Umbellifers than with the common garden plant *P. sativum.* As is evident from the figure (Pl. XI, Fig. 2) it has a rather unusual habit, the umbels being more or less axillary or rather very few-rayed. All the specimens had the same abnormal aspect.

IV. Dicotyledones, Sympetalæ.

Epacridaceæ (determ. by C. Christensen and C. H. Ostenfeld).

Astroloma stomarrhena Sond., in Pl. Preiss. I (1844) 301; Benth. Fl. Austr. IV (1869) 152; Diels u. Pritzel, in Botan. Jahrb. 35 (1904) 463.

Of this large-flowered species which is said to be rather rare (Diels u. Pritzel, l. c.), I have two Nos. (939, 940) from the neighbourhood of Perth.

Leucopogon verticillatus R. Br. Prodr. Fl. Nov. Holl. (1810) 541; Benth. Fl. Austr. IV (1869) 184.

Manginup, south of Bridgetown (No. 932; 1. Oct. 1914), flowers pink.

Leucopogon polymorphus Sond., in Pl. Preiss. I (1844) 309; Benth. Fl. Austr. IV (1869) 202; Diels u. Pritzel, in Bot. Jahrb. 35 (1904) 475.

This species is common around Perth on the low-lying sandy heaths. It varies much with regard to hairiness.

some specimens being glabrous or nearly so (Nos. 919, 923), some hairy (f. *hirsutus*) (No. 920; 23. Aug. 1914; E. Dorph-Petersen).

Leucopogon australis R. Br. Prodr. Fl. Nov. Holl. (1810) 541; Benth. Fl. Austr. IV (1869) 187.

Palgarup, south of Bridgetown (No. 931; 2. Oct. 1914); Collie (No. 929; 18. Sept. 1914, Cecil Andrews).

Leucopogon amplectens Ostf. sp. nov. (Fig. 15, 1).

Fig. 15. *1. Leucopogon amplectens* Ostf. 2. *Leucopogon cucullatus* R. Br. (King George's Sound, leg. Harvey). (Nat. size).

Ex affinitate *L. cucullati* R. Br. et *L. sprengelioidis* Sond. Frutex erectus ramosissimus, ramulis glabris. Folia imbricata concavaque, adpressa, late suborbiculata, inferiora ca. 6 mm longa, 4—5 mm lata, superiora breviora 4—5 mm longa, 5—6 mm lata, brevissime subacuminata, carnosulo-coriacea, opaca, supra enervosa, subtus ± distincte nervosa, margine hyalino-cartilaginea, apice callosa. Spicæ in apicibus ramulorum plerumque simplices, paucifloræ; rachis puberula. Bracteæ late ovatæ, obtusæ, subecarinatæ, sepalis dimidio breviores, 1.2—2.4 mm longæ, brunnescentes. Sepala obtusa, margine ciliata, brunnescentia. Lobi corollæ ca. 1.5 mm longi, angusti, supra pilis albis dense hirsuti. Ceterum ut species affines.

Tammin, on sandy heath (No. 925; 6. Oct. 1914).

This new species differs from *L. cucullatus* (Fig. 15, 2) in the much broader, suborbiculate and subacute leaves and in smaller flowers, and from *L. sprengelioides* in much larger and broader leaves.

Lysinema ciliatum R. Br. var. **ericoides** Ostf. nov. var.

Differt a typo foliis brevissimis, ca. 3 mm longis, ca. 1 mm latis, adpressis, in ramulis brevioribus imbricatis, obtusis, oblongo-ovatis, dorso obtuse carinatis, supra concavis.

Tammin, on sandy heath (No. 937; 6. Oct. 1914).

This new variety is easily recognisable by its smaller leaves both on the main branches and on the shorter leafy sterile branches. It seems to take the place of the type when one comes somewhat farther in from the coastal region where the type is very common.

Besides the locality quoted above I have seen the variety in the Kew Herb. from the following places: Mount Churchman, R. Helms, 11. 1891 (Elder Explor. Exp.); Northam, Avon R., I. H. Gregory, 10. 2. 1900; Cowcowing, VIII, 1914. Max Koch, No. 1177; Interior S.W. Austr., I. S. Roe; S.W. Austr., Mr. Sarford, 1860.

Andersonia sprengelioides R. Br. Prodr. Fl. Nov. Holl. (1810) 554; Benth. Fl. Austr. IV (1869) 253; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 485.

I think it well worth keeping Sonder's species (in Plant. Preiss.) as varieties, as Pritzel (l. c.) has done. Both their differences in characters and their different area of occurrence point that way. I have var. *Lehmanniana* (Sond.) Pritzel (l. c.) from Darlington (No. 915; 28. Aug. 1914, C. Andrews) and from Kalamunda (29. July 1914, Gunnar

Andersson), and var. *patens* (Sond.) Pritzel (l. c.) from Albany, wet soil (No. 917; 20. Oct. 1914).

Dracophyllum gracile R. Br. Prodr. Fl. Nov. Holl. (1810) 556; Benth. Fl. Austr. IV (1869) 264.

Palgarup, south of Bridgetown (No. 911; 2. Oct. 1914).

Dracophyllum capitatum R. Br. Prodr. Fl. Nov. Holl. (1810) 556; Benth. Fl. Austr. IV (1869) 264.

Collie (No. 913; 18. Aug. 1914, leg. Cecil Andrews).

Dracophyllum parviflorum F. v. Müll. in Benth. Fl. Austr. IV (1869) 265.

Albany, in a turfy swamp (No. 912; 20. Oct. 1914).

The specimens agree well with the description and also with specimens of *D. parviflorum* in the Kew Herb. But perhaps the plants are only slender and small flowered *D. capitatum* (certainly not *D. gracile* as suggested by F. v. Müller).

Primulaceæ.

Anagallis arvensis L. sp. pl. (1753) 148; Benth. Fl. Austr. (1869) 270, ex parte.

This weed was not rare in several places, e. g. Yallingup Cave (Nos. 1021—1022; 27.—29. Sept. 1914).

Anagallis foemina Mill. Gard. Dict. VIII ed. (1768); *A. arvensis* var. *foemina* Schinz et Thellung, Bull. Herb. Boiss. 2. ser. (1907) 497; *A. coerulea* Schreb. Spicil. fl. Lips. (1771) 5; *A. arvensis* Benth. Fl. Austr. IV (1869) 270, ex parte.

Much more common than the foregoing and always well distinguished from it when the two grew together.

Perth, St. Omer Hospital, Garden weed (No. 1024; 10.

Sept. 1914); Yallingup Cave (No. 1023; 29. Sept. 1914, very common); York (No. 1388; 25. Nov. 1915, Mrs. M. Davis).

Samolus repens (Forst.) Pers. Syn. I (1805) 171; Benth. Fl. Austr. IV (1869) 271; *Sheffieldia repens* Forster, Char. Gen. (1776) 18; *Sheff. incana* Labill. Pl. Nov. Holl. I (1804) 40, tab. 54.

As Bentham (l. c.) says, this species is " exceedingly variable", and I am inclined to believe that several species are to be found under what is now considered *S. repens.*

Specimens which are very much like Labillardière's figure (l. c.) and which must be taken as true *S. repens*, although erect, were collected at Swan River near Bayswater (No. 1027; 18. Oct. 1914).

Very different from this form is: var. **floribundes** Benth. l. c. It has the leaves reduced nearly to scales and numerous flowers in panicles. A character which points to its independence as a species, is that the anthers bear pointed apical appendices (in *S. repens* and *S. junceus* this character does not occur or is very faintly developed). I have found this distinctive mark both in the specimens from Murchison River which Bentham (l. c.) quotes for his variety, and in specimens collected at Carnarvon in dune depressions (No. 1026; 31. Oct. 1914; Pl. XII, fig. 4). It seems to be a more northern xerophytic form than the true *S. repens.*

I have not had the opportunity to examine the whole group of *S. repens* and *S. junceus* thoroughly, therefore, provisionally, I leave var. *floribundus* under *S. repens*, but I think that closer examination will result in its separation as a distinct species.

S. junceus R. Br. Prodr. Fl. Nov. Holl. (1810) 429; Benth. Fl. Austr. IV (1869) 272.

Environs af Perth (No. 1025; 25. Oct. 1914, E. Dorph-Petersen).

Plumbaginaceæ.

Statice salicorniacea F. v. Müll., Fragm. Phytog. Austr. XI (1878) 7.

A very striking plant, common in wet dune depressions (pans) at Carnarvon (No. 1103; 31. Oct. 1914).

Loganiaceæ.

Logania vaginalis (Labill.) F. v. Müll. Fragm. VI (1868) 132; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 489; Diels, Pflanzenw. W. Austr. (1906) 192; *L. longifolia* R. Br. et *L. latifolia* R. Br. Prodr. Fl. Nov. Holl. (1810) 456, 455; Benth. Fl. Austr. IV (1869) 361.

I follow F. v. Müller and Diels in uniting *L. longifolia* and *L. latifolia* into one species.

Specimens with broadly lanceolate leaves (var. *longifolia* (R. Br.) Diels l. c., Fig. 49 B) were collected at Cottesloe near Fremantle (No. 996; 23. Aug. 1914, Cecil Andrews) and in a rich and damp valley near Yallingup Cave (No. 997; 28. Sept. 1914). This form seems to follow the southern part of the west coast.

Logania serpyllifolia R. Br. Prodr. Fl. Nov. Holl. (1810) 456; Benth. Fl. Austr. IV (1869) 366.

Yornup, south of Bridgetown (No. 999; 2. Oct. 1914) and Yallingup Cave, in the forest (No. 998; 26. Sept. 1914).

Flowers white and fragrant. Bentham's statement (l. c.) "Flowers usually 3—5 together" is incorrect, as the flowers are usually more numerous.

Logania flaviflora F. v. Müll., in Vict. Naturalist V (1889) 165; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 490.

This interesting species was found again at Tammin (No. 962; 6. Oct. 1914), where DIELS collected it in 1903.

Gentianaceæ.

Centaurium australe (R. Br.) comb. nov.; *Erythræa a.* R. Br. Prodr. Fl. Nov. Holl. (1810) 451; Benth. Fl. Austr. IV (1869) 371.

Vicinity of Perth (No. 945; 25. Oct. 1914, E. Dorph-Petersen).

Villarsia capitata Nees, in Pl. Preiss. 1 (1845) 365; Benth. Fl. Austr. IV (1869) 375; *V. involucrata* Hook. Icon. Pl. tab. 725.

Vicinity of Perth (No. 1118; 25. Oct. 1914; E. Dorph-Petersen).

Villarsia albiflora F. v. Müll. Fragm. Phytog. Austr. II (1860) 21; Benth. Fl. Austr. IV (1869) 377; *V. reniformis* Nees, in Pl. Preiss. I (1845) 364, non R. Br.

Perth, near Cannington (No. 946; 22. Sept. 1914, E. Dorph-Petersen).

Convolvulaceæ.

Dichondra repens Forster, Char. gen. (1776) 39, tab. 20; Benth. Fl. Austr, IV (1869) 438.

Specimens in flower of this ubiquitous tropical herb were collected near a rivulet at Yallingup Cave (No. 1131; 27. Sept. 1914).

Ipomæa Muelleri Benth., Fl. Austr. IV (1869) 423.

An *Ipomæa* answering well to the description of *I. Muelleri* by BENTHAM (l. c.) was found on the dunes near the railway jetty at Carnarvon (No. 1102; 31. Oct. 1914). The author gives it as a twiner, but the specimens seen by me were prostrate (but not rooting) for the simple reason that there were no shrubs present on the spot. The petioles and peduncles are somewhat pubescent; the pedicels short and thick, about as long as the calyx. Corolla pink; seed villous, grey-violet or brown, two in each cell of the two-celled globose capsule.

The species has not been found as far southward as Carnarvon; the nearest locality being Nichol Bay, near Cossacks (117° Long E.), from where it extends eastwards both along the coast and into the interior.

Cuscuta australis R. Br. Prodr. Fl. Nov. Holl. (1810) 491; Benth. Fl. Austr. IV (1869) 441.

Near Perth (No. 811; 15. Oct. 1914; leg. E. Dorph-Petersen), on *Eryngium rostratum* Cav.

Borraginaceæ.

Halgania rigida Sp. Moore, in Journ. Linn. Soc. XXXIV (1899) 204; Diels u. Pritzel, Botan, Jahrb. 35 (1904) 492.

Kalgoorlie, a very vernicose shrub with blue flowers (No. 1042; 8. Oct. 1914).

Myosotis australis R. Br. Prodr. Fl. Nov. Holl. (1810) 495; Benth. Fl. Austr. IV (1869) 405.

Yallingup Cave, in open forest; flowers white (No. 836; 29. Sept. 1914).

Eritrichium australasicum DC. Prodr. X (1846) 134; Benth. Fl. Austr. IV (1869) 406.

Kalgoorlie (No. 1117; 7. Oct. 1914).

Lappula concava F. v. Müll. Census Austr. Pl. (1882) 100; *Echinospermum c.* F. v. Müll. Fragm. Phytogr. Austr. II (1861) 139; Benth. Fl. Austr. IV (1869) 407.

Kalgoorlie (No. 837; 7. Oct. 1914).

Verbenaceæ.

Dicrastylis panifolia F. v. Müll. Fragm. Phytogr. Austr. II (1861) 160; Benth. Fl. Austr. V (1870) 43; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 499.

Tammin, heath (No. 1115; 6. Oct. 1914). Determ. by Dr. L. Diels.

Labiatæ.

Hemiandra pungens R. Br. Prodr. Fl. Nov. Holl. (1810) 502; Benth. Fl. Austr. V (1870) 109.

Bentham (l. c.) has enumerated the more marked forms of this very variable and common species, but he has created a good deal of new names instead of using already existing names. In following his delimitation of the forms I find the following combinations correct:

var. 1. **linearis** (Benth.); *H. linearis* Benth., in Huegel, Enum. pl. (1837) 79; *H. pungens, α, grandiflora* Benth. Fl. Austr. l. c.

Bayswater, sandy heath (No. 981; 18. Oct. 1914).

var. 2. **glabra** Benth., Fl. Austr. l. c.; *H. glabra* Benth., in Huegel, Enum. pl. (1837) 79.

Perth: near Cannington (No. 1034; 22. Sept. 1914, E. Dorph-Petersen).

var. 3. **brevifolia** (Benth.); *H. brevifolia* Benth., in Huegel, Enum. pl. (1837) 79; *H. pungens*, c, *diffusa* Benth. Fl. Austr. l. c.

var. 4. **rupestris** (Hueg.); *H. rupestris* Hueg. Bot. Arch. (1837) tab. 4; Benth., in Huegel, Enum. pl. (1837) 78; *H. pungens,* d, *hispida* Benth. Fl. Austr. l. c.

Cottesloe (No. 978; 11. Aug. 1914, Cecil Andrews); vicinity of Perth (No. 979; 18. Sept. 1914, E. Dorph-Petersen; No. 1382, 1915, Mrs. M. Davis).

var. 5. **incana** Benth. Fl. Austr. V (1870) 110.

Perth: King's Park (No. 980; 21. Oct. 1914).

Microcorys ericifolia Benth., in D. C. Prodr. XII (1848) 569; Fl. Austr. V (1870) 123.

Tammin, heath (No. 1113; 6. Oct. 1114).

Westringia rigida R. Br. Prodr. Fl. Nov. Holl. (1810) 501; Benth. Fl. Austr. V (1870) 129; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 530.

Fig. 16. *Westringia rigida* R. Br. *1*, var. *dolichophylla* Ostf., from Geraldton. *2*, var. *brachyphylla* Ostf., from Kalgoorlie. (Nat. size.)

DIELS (l. c.) has shown that in W. A. this species has two rather different forms, one occurring in the arid interior, the other in the calcareous coast-belt. I find that they differ so much from each other that they deserve at least varietal names:

var. **brachyphylla** nov. var. (Diels, l. c. forma 1). Folia brevia, 5—10 mm longa, apice spinosa plus minus recurvata. Fig. 16, 2.

Kalgoorlie (No. 982; 7. Oct. 1914).

var. **dolichophylla** nov. var. (Diels, l. c. forma 2).

Folia longiora, usque ad 30 mm longa, apice subespinosa, non recurvata. Fig. 16, 1.

Geraldton, on dunes (No. 977; 29. Oct. 1914).

Solanaceæ.

Lycium australe F. v. Müll., in Transact. Phil. Soc. Vict. I (1854) 20, ex Fragm. Phytogr. Austr. I (1858) 83; Benth.

Fl. Austr. IV (1869) 467; F. v. Müller and A. Morrison, in W. Austr. Yearbook for 1900—1901 (1902) 331.

Kalgoorlie (No. 1045; 7. Oct. 1914).

A low strongly spinescent shrub with divaricate branches. Berries orange-red, ovoid.

The same species is in the Kew Herb. from two other W. Australian localities, viz.: W. Austr., leg. Dr. W. H. Ince, and Boulder, W. D. Campbell, 28. July 1900. It seems to be distributed over the arid interior of Australia, but not very common.

Lycium ferocissimum Miers, in Ann. & Mag. Nat. Hist. XIV (1854) 187, and Ill. South Americ. Plants, tab. 70, fig. D; *L. campanulatum* E. Meyer, in Drege, Zwei Pflanzengeogr. Docum. 109 (nom. nud.); Wright, in Flora Cap. IV 2 (1904) 111, ex parte; J. M. Black, in Trans. R. Soc. S. Austr. XLII (1918) 54; *L. chinense* J. M. Black, in Naturalis. Fl. S. Austr. 114, fide J. M. Black in Herb. Kew.

Geraldton, on dunes (No. 1047; 28. Oct. 1914).

A rather low shrub with divaricate spinescent branches, campanulate calyx and large orange-red berries.

This species of *Lycium* is evidently an immigrant from South Africa as also recognized by Mr. J. M. Black who records it from South Australia (l. c.).

As to its name it must be called *L. ferocissimum* Miers, not *L. campanulatum* E. Meyer, and that for several reasons:

1. *L. campanulatum* E. Meyer is a *nomen nudum* until Wright's description in Fl. Cap.

2. Wright's *L. campanulatum* covers two different plants: (1) the same plant upon which *L. ferocissimum* Miers (l. c.) is based, and (2) another plant with much larger flowers and more erect-campanulate corolla. If *L. campanulatum*

is still to be used, it must be restricted to the latter plant.

My specimens (and those from S. Australia sent to Kew Herb. by Mr. J. M. Black) agree exactly with ZEYHER's No. 105 from Uitenhage, upon which number MIERS's description and figure is based.

The species has a good deal of resemblance to *L. chinense*, but is easily distinguished by its larger and more campanulate calyx and the large ovoid-globose berries (until 1.5 cm long and 1 cm broad).

Anthotroche pannosa Endl. Nov. Stirp. Dec. (1839); Benth. Fl. Austr. IV (1869) 467; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 533.

Meckering (No. 1119; Sept. 1914, O. H. Sargent).

Scrophulariaceæ.

Gratiola peruviana L. Sp. pl. (1753) 17; Benth. Fl. Austr. IV (1869) 493; *G. pubescens* R. Br. Prodr. Fl. Nov. Holl. (1810) 435.

Besides specimens from Albany (No. 1035; 20. Oct. 1914) which come under the main species, the var. **pumila** (F. v. Müll.) Benth., l. c., which has not been given as W. Australian before, was collected near Perth (No. 1036; 25. Oct. 1914, E. Dorph-Petersen).

Limosella aquatica L. Sp. pl. (1753) 631; Benth. Fl. Austr. IV (1869) 502.

Armadale, in dried-up ditches (No. 1030; 20. Sept. 1914).

Small specimens answering to var. *tenuifolia* (Wolf.) Nutt., with linear leaves.

Parentucellia latifolia (L.) Caruel, in Parlat. Fl. ital. VI (1885) 480; Diels u. Pritzel, in Bot. Jahrb. 35 (1904) 534;

Euphrasia l. L. Sp. pl. (1753) 604; *Eufragia l.* Griseb. spicil. Fl. rumel. II (1844) 14; *Bartschia l.* Sm. fl. graec. VI (1827) 69.

This introduced plant was recorded for W. A. by DIELS and PRITZEL (l. c.). I found it both at Perth, King's Park (No. 1031; 10. Sept. 1914) and at Busselton, grassy ground (No. 1032; 30. Sept. 1914).

Parentucellia viscosa (L.) Caruel, l. c.; *Bartschia viscosa* L. Sp. pl. (1753) 602.

This is another introduced plant which comes from the Mediterranean or West European countries. I found it in flower (fl. yellow) at Albany on damp grassy ground (No. 1033; 21. Oct. 1914).

Veronica calycina R. Br. Prodr. Fl. Nov. Holl. (1810) 435; Benth. Fl. Austr. IV (1869) 509; *V. stolonifera* Lehm. Ind. sem. Hort. Hamburg 1820, et in Pl. Preiss. I (1845) 342; *V. cygnorum* Miq., in Pl. Preiss. l. c.

Yallingup Cave, in the forest under shrubs (Nos. 1037 and 1038; 26. and 28. Sept. 1914, flow. and fruiting).

My specimens are very different from those collected by DRUMMOND and they represent a rather deviating form of this variable species. I should like to call them var. **stolonifera** (Lehm.) comb. nov., as they are like the plant described by LEHMANN under that species name. The variety differs from the true *V. calycina* in acute calyx lobes, shorter and curved hairs etc. Besides my specimens I have seen the same form in Kew Herb. from Swan River district, J. A. Brewer, 1874; and Claremount near Perth, Cecil Andrews, 1902, and Albany, Cecil Andrews, 1903.

Selaginaceæ.

Dischisma arenarium E. Mey., Comm. Pl. Afr. Austr. (1837) 251; Rolfe, in Flora Cap. vol. V, pt. I (1910?) 112.

Near Yallingup Cave House, on naked soil (No. 834, 26. Sept. 1914).

This little annual which is naturalized from S. Africa, was found in full flower and fruit. It has not been recorded before from W. A.

Dischisma capitatum (Thunb.) Choisy, Mém. Soc. Phys. Genève II. 2 (1823) 94; Benth. Fl. Austr. V (1870) 31; Rolfe, in Fl. Cap. vol. V, pt. 1 (1910?) 112.

Perth: King's Park, on naked sandy soil, small erect and unbranched specimens (No. 835; 11. Sept. 1914). The minute corolla is whitish.

This is also a South African species, but it has been found in the Swan River district already by Drummond (Bentham, l. c.)

Orobanchaceæ.

Orobanche cernua Loefl., var. **australiana** (F. v. Müll.) Beck, Monogr. Orobanche, Bibliotheca Botan. Heft 19 (1890) 144; *O. cernua* Benth. Fl. Austr. IV (1869) 533; *O. australiana* F. v. Müll., Cens. Austr. Pl. (1882) 98.

Near Perth (No. 1039; 13. Sept. 1914, in flower; E. Dorph-Petersen).

Lentibulariaceæ.

Utricularia simplex R. Br. Prodr. Fl. Nov. Holl. (1810) 431; Benth. Fl. Austr. IV (1869) 528.

Albany, on damp peat (No. 983; 20. Oct. 1914, flow. purple-violet).

Polypompholyx multifida (R. Br.) F. v. Müll. Fragm. Phytogr. Austr. VI (1868) 162; Benth. Fl. Austr. IV (1869) 532; Hooker, Icon. pl. tab. 3063 (1916).

Albany, in a swamp (No. 984; 20. Oct. 1914).

When I mention this beautiful plant which is well known from King George's Sound, the reason is that the text to the otherwise excellent plate in HOOKER's *Icones* says that the corolla is "purpureo-lilacina vel punicea", which shows that the description was drawn from herbarium material. In the living plant the corolla is pink (or rose), as also mentioned by BENTHAM (l. c.) and F. v. MÜLLER ("amoene rosea").

Myoporaceæ.

Myoporum acuminatum R. Br. Prodr. Fl. Nov. Holl. (1810) 515; Benth. Fl. Austr. V (1870) 3.

Carnarvon, at the shore (No. 1013; 31. Oct. 1914), with red fruits.

The specimens are narrow-leaved, answering to BENTHAM's var. *angustifolium*, which must be renamed var. **montanum** (R. Br. pro. sp.) comb. nov.

Myoporum deserti A. Cunn.; Benth. in Huegel, Enum. pl. (1837) 78; Fl. Austr. V (1870) 5.

Tammin, in open forest (No. 1014; 6. Oct. 1914).

Myoporum oppositifolium R. Br. Prodr. Fl. Nov. Holl. (1810) 516; Benth. Fl. Austr. V (1870) 7.

Yallingup Cave, at the shore (No. 1012; 26. Sept. 1914).

This record extends the area of this species somewhat farther to the north.

Eremophila R. Br.

In my treatment of this difficult genus I follow F. v. MÜLLER, Myoporinous Plants of Australia II (1886); SPENCER MOORE, in Journ. Linn. Soc. XXXIV (1899), and DIELS, in Botan. Jahrb. 35 (1904). MÜLLER and DIELS include *Pholidia* R. Br. in *Eremophila*, while R. WETTSTEIN (Natürl. Pflanzenfam., 1889) follows BAILLON in using the name

Pholidia with *Eremophila* as a synonym. Both names were published simultaneously by R. Brown (1810), and although *Pholidia* is found on p. 517 and *Eremophila* on p. 518, I find it more convenient to follow F. v. Müller who already in 1858 (Transact. R. Soc. Tasmania III) united them into *Eremophila*, than to transfer the numerous species published under *Eremophila* to *Pholidia*.

Eremophila Paisleyi F. v. Müll., Rep. Babbage Exp. (1858) 17, ex Benth. Fl. Austr. V (1870) 20; Diels, Botan. Jahrb. 35 (1904) 538.

Kalgoorlie (No. 1001; 7. Oct. 1914). Flowers pink or pale-lilac, a medium-sized shrub.

Eremophila Drummondii F. v. Müll., Fragm. Phytogr. Austr. VI (1868) 147; Benth. Fl. Austr. V (1870) 24; Diels, Botan. Jahrb. 35 (1904) 540.

Tammin, heath (No. 1010; 6. Oct. 1914), a very vernicose shrub.

Eremophila ionantha Diels, Botan. Jahrb. 35 (1904) 540, fig. 61, C, D.

Kalgoorlie (No. 1003; 7. Oct. 1914). Flowers pale-violet, a medium-sized shrub.

Eremophila interstans (Sp. Moore) Morrison, in W. Austr. Yearbook for 1900—1901, Perth (1902) 333; Diels, Botan. Jahrb. 35 (1904) 540; *Pholidia i.* Spencer Moore, Journ. Linn. Soc. XXXIV (1899) 210.

Kalgoorlie (No. 1009; 8. Oct. 1914). Flowers small and whitish.

Eremophila scoparia (R. Br.) F. v. Müll., in Proceed. R. Soc. Tasm. III (1858) 296; *Pholidia s.* R. Br. Prodr. Fl. Nov. Holl. (1810) 517; Benth. Fl. Austr. V (1870) 10.

Kalgoorlie (No. 1002; 7. Oct. 1914). Flowers pale-violet, a tall shrub.

Eremophila Weldii F. v. Müll., Fragm. Phytogr. Austr. VII (1870) 109; Diels, Botan. Jahrb. 35 (1904) 542.

Kalgoorlie (No. 1008; 8. Oct. 1914). Flowers violet; a low shrub.

Eremophila granitica Sp. Moore, Journ. Linn. Soc. XXXIV (1899) 214; Diels, Botan. Jahrb. 35 (1904) 545.

Kalgoorlie (No. 1004; 7. Oct. 1914). Flowers violet; a rather small shrub.

Eremophila glabra (R. Br.) comb. nov.; *Stenochilus glaber* R. Br. Prodr. Fl. Nov. Holl. (1810) 517; *Eremophila Brownii* F. v. Müll., Proc. R. Soc. Tasm. III (1858) 297; Benth. Fl. Austr. V (1870) 27; Diels, Botan. Jahrb. 35 (1904) 545.

Kalgoorlie (No. 1006; 8. Oct. 1914). Flowers red; a medium-sized shrub.

The change of the species name is necessary according to the international rules of nomenclature.

Eremophila angustifolia (Sp. Moore) comb. nov.; *E. Oldfieldii*, var. *angustifolia* Spencer Moore, Journ. Linn. Soc. XXXIV (1899) 215; Diels, Botan. Jahrb. 35 (1904) 546.

Ex aff. *E. Oldfieldii*. Differt: foliis anguste-linearibus, carnosulis (in sicco rugosis), acutissimis, et calycis lobis angustioribus lanceolatis, distincte acutis vel acuminatis. (Pl. XII, fig. 1).

Kalgoorlie (No. 1005; 7. Oct. 1914). Flowers orange-red; a tall shrub. 5 km south of Kalgoorlie (Gunnar Andersson, 2. Aug. 1914).

On comparing the typical specimens of *E. Oldfieldii* F.

v. Müll. from Murchison River and Shark's Bay — as seen in the Kew Herb. — with the plant which seems to be common in the interior of S. W. Australia (cfr. Sp. Moore and Diels), I find the latter quite distinct and do not doubt it being an independent species. The left habit figure on pl. XXXVII in F. v. Müller's Myopor. Pl. of Austr., represents the new species, while the right one is true *E. Oldfieldii.*

Eremophila decipiens nov. sp. Pl. XII, fig. 2.

Ex aff. *E. maculatæ.* Frutex non altus; rami adscendentes, juniores præcique apicem versus pilis stellatis minimis plus minus densis vestiti; folia oblongo-linearia, subacuta, 2—3 cm longa, 2—4 mm lata, juniora pilis stellatis minimis vestita. Flores solitarii, pedicelli graciles reflexi. Calycis parvi lobi imbricati, ovati, acuti, 4—5 mm longi, extus glabri, intus stellato-pilosi. Corolla coccinea, clavato- tubulosa, usque ad 2,5 cm longa, fundo extumescente, labium superius lobis 4 parvis angustis acutissimis, labium inferius a medio corollæ tubi reflexum, lineari-oblongum. Stamina exserta, glabra; stylus exsertus, parum hirsutus. Ovarium glabrum.

Kalgoorlie (No. 1007; 7. Oct. 1914).

This new species comes near to *E. maculata* (Ker.) F. v. Müll. and has been confounded with it. It differs in the quite different tomentum, which in *E. maculata* consists of rather short and recurved single hairs forming a dense clothing on the young branches (the leaves are quite glabrous), while in the new species both the young branches and the young leaves bear a minute stellate pubescence. Further differences are found in the smaller calyx-lobes (in *E. maculata* longer and acuminate) and in the glabrous innerside of the corolla (in *E. maculata* with some long hairs), etc.

The present species seems to be mostly a West Australian representative of *E. maculata* and is probably much distributed in the interior of the State, as far as I am able to judge from numerous specimens in the Kew Herb. The true *E. maculata* F. v. Müll. (*Stenochilus maculatus* Ker, in Bot. Regist. tab. 647, 1822) seems to be mostly Eastern, but I do not know if it also occurs in W. A.

To my species perhaps belongs *E. maculata* var. *brevifolia* Benth. (Fl. Austr. V, 1870, 29), but the few words of the diagnosis do not say anything about the different kind of hairiness.

Stenochilus racemosus Endl. (Nov. Stirp. dec. (1839) 50) is — as far as can be judged from DECANDOLLE's description (Prodr. XI, 715), as I have no access to the actual plant — quite another form, as it is said to have "ramuli glaberrimi".

S. curvipes Benth. in Mitch. Trop. Austr. 221 is unknown to me.

Eremophila alternifolia R. Br. Prodr. Fl. Nov. Holl. (1810) 518; Benth. Fl. Austr. V (1870) 30; Diels, Botan. Jahrb. 35 (1904) 546.

Kalgoorlie (No. 1000; 7. Oct. 1914). Flowers red, a medium-sized shrub.

Rubiaceæ.

Galium australe DC. Prodr. IV (1830) 608; Benth. Fl. Austr. III (1866) 446; F. v. Müller, Sec. Census (1889) 128; *G. parisiense* L. var. *australe* Ewart and White, in Proc. R. Soc. Victoria 21 (1908) 541.

Yallingup Cave, in a shadowy cleft (No. 1029; 28. Sept. 1914).

Lobeliaceæ (determ. by C. Christensen and C. H. Ostenfeld).

Wahlenbergia capensis (L.) A. DC., Monogr. Campan. (1830) 138, tab. 18.

Bayswater, in fruit (No. 989; 18. Oct. 1914); introduced and now subspontaneous.

Lobelia tenuior R. Br. Prodr. Fl. Nov. Holl. (1810) 564; Benth. Fl. Austr. IV (1869) 126.

Perth, King's Park, sparingly in the open forest (No. 986; 13. Oct. 1914, in flower).

Lobelia heterophylla Labill. Pl. Nov. Holl. I (1804) 52, tab. 74; Benth. Fl. Austr. IV (1869) 124.

Geraldton, on dunes (small specimen; No. 955, 28. Oct. 1914).

Monopsis debilis (L. fil.) Presl, Prodr. Monogr. Lobel. (1836) 11; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 550.

This is an introduced species which seems to spread widely in W. A., preferring damp, sandy places.

Diels and Pritzel have found it at Bayswater, where I have also collected it (No. 990; 18. Oct. 1914); and further I have it from Yallingup Cave (No. 991; 28. Sept. 1914) and from Albany (No. 992; 20. Oct. 1914); in all localities in flower.

Goodeniaceæ (determ. by C. Christensen and C. H. Ostenfeld).

Velleia pilosella (De Vriese) comb. nov.; *V. trinervis* var. *villosa* Benth. Fl. Austr. IV (1869) 47; K. Krause, Goodeniaceæ, in Das Pflanzenreich IV 277 (1912) 39; *V. trin.* var. *lanuginosa* Pritzel, in Botan. Jahrb. 35 (1904) 556; *Euthale pilosella* De Vriese in Pl. Preiss. I. 3 (1845) 414.

Palgarup (No. 955; 2. Oct. 1914) and Yornup, south of Bridgetown (No. 954; 2. Oct. 1914).

We think this hairy *Velleia* is sufficiently distinct from *V. trinervis* Labill. to be maintained as a proper species, as given by DE VRIESE (l. c.). It seems to be restricted to the most S. W. part of the State.

Goodenia calogynoides E. Pritzel, in Botan. Jahrb. 35 (1904) 560, Fig. 64 A—D; Krause, Goodeniaceæ, l. c. 81.

Kalgoorlie, a single specimen in fruit (No. 947; 7. Oct. 1914).

Goodenia coerulea R. Br. Prodr. Fl. Nov. Holl. (1810) 578; Benth. Fl. Austr. IV (1869) 67; Krause, Goodeniaceæ, l. c. 68.

Tammin, sandy places (No. 959; 6. Oct. 1914).

Goodenia coronopifolia R. Br. Prodr. Fl. Nov. Holl. (1810) 576; Benth. Fl. Austr. IV (1869) 75; Krause, Goodeniaceæ, l. c. 81.

With some doubt we refer a few small specimens of a *Goodenia* to this rare species which is known only from the northwestern coast at Cambridge Gulf (CUNNINGHAM) and from islands of the Gulf of Carpentaria (R. BROWN). The specimens are smaller and more slender than R. Brown's type specimens in the Kew Herb., besides they are somewhat more hairy. The indusium is undivided and shortly ciliate.

Armadale, on naked, clayey soil (No. 1121; 20. Sept. 1914).

Goodenia pulchella Benth., in Huegel, Enum. pl. (1837) 71; *G. filiformis* var. *pulchella* Benth. Fl. Austr. IV (1869) 77; Krause, Goodeniaceæ, l. c. (1912) 86; *Velleja lanceolata* Lindl. Swan Riv. App. Bot. Reg. (1839) 26.

Bayswater, near the Swan River (No. 952; 18. Oct. 1914).

After having examined the ample material in the Kew Herb. of *G. filiformis* and related forms, we feel convinced that the so-called var. *pulchella* is a distinct species. It differs from *G. filiformis* in the characters given by Bentham and Krause, further, as mentioned by Lindley, the leaves are distantly, but distinctly toothed.

Also the var. *minutiflora* F. v. Müll. (Fragm. Phytogr. Austr. VIII (1874) 245) is — from the specimens in Kew Herb. — a separate species (*G. micrantha* Hemsl. ined. in Kew Herb.).

Anthotium rubriflorum F. v. Müll., in Benth. Fl. Austr. IV (1869) 45; Krause, Goodeniaceæ, l. c. (1912) 111, Fig. 21 C—H.

Tammin, on sandy soil (No. 960; 6. Oct. 1914); in full flower; corolla red ("coccinea").

Scævola holosericea De Vriese, in Pl. Preiss. I (1845) 408; Benth. Fl. Austr. IV (1869) 95; Krause, Goodeniaceæ, l. c. (1912) 153.

Perth, King's Park, common (No. 971, 18. Sept. 1914; No. 969, 13. Oct. 1914).

The size of the corolla and of the floral leaves varies much in specimens growing at the same spot (male and female plants?).

Scævola auriculata Benth. Fl. Austr. IV (1869) 99; Krause, Goodeniaceæ, l. c. (1912) 158.

Jarnadup and Manginup, south of Bridgetown (Nos. 972 and 973; 1. Oct. 1914). Specimens less hairy than the type.

Scævola paludosa R. Br. var. **repens** (De Vriese) comb. nov.; *S. p.* var. *prostrata* Benth. Fl. Austr. IV (1869) 102; Krause, Goodeniaceæ, l. c. (1912) 163; *S. repens* De Vriese, in Pl. Preiss. I (1845) 406.

Perth, King's Park, a decumbent shrub with long prostrate stems, flowers whitish (No. 949; 18. Oct. 1914). Perhaps a distinct species.

Scævola Helmsii E. Pritzel, in Botan. Jahrb. 35 (1904) 572; Krause, Goodeniaceæ, l. c. (1912) 168, Fig. 29 A—F.

This very distinct species was collected in the same locality where DIELS and PRITZEL (l. c.) found it: Tammin (No. 964; 6. Oct. 1914, flowering).

Stylidiaceæ (determ. by C. Christensen and C. H. Ostenfeld).

Levenhookia pusilla R. Br. Prodr. Fl. Nov. Holl. (1810) 573; Benth. Fl. Austr. IV (1869) 34; Mildbraed, Stylidiaceæ, in Das Pflanzenreich IV 278 (1908) 28; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 598.

Yallingup Cave, sandy damp places (No. 1091; 26. Sept. 1914).

The flowering of this species is stated by DIELS and PRITZEL to occur in November and December, but my specimens taken at the end of September were in full flower.

Stylidium brachyphyllum Sond., in Pl. Preiss. I. 3 (1845) 386; Benth. Fl. Austr. IV (1869) 24; Mildbraed, Stylidiaceæ, l. c. 42.

Armadale, on naked, damp soil (No. 1080; 20. Sept. 1914).

Stylidium despectum R. Br. Prodr. Fl. Nov. Holl. (1810) 571; Benth. Fl. Austr. IV (1869) 22; Mildbraed, Stylidiaceæ, l. c. 42.

Besides from Albany from where this species is well known, I have it from Bayswater near Perth (No. 1078; 18. Oct. 1914).

S. despectum and *S. brachyphyllum* are very near each other, and *S. brachyphyllum* does not perhaps deserve to be maintained as a species.

Stylidium pulchellum Sond., in Pl. Preiss. I. 3 (1845) 381; Benth. Fl. Austr. IV (1869) 26; Diels u. Pritzel, in Botan. Jahrb. 35 (1904) 594; Mildbraed, Stylidiaceæ, l. c. 44.

Albany, on damp and sandy soil (No. 1069; 21. Oct. 1914); in full flower; corolla white with pink or purple stripes.

Stylidium emarginatum Sond., in Pl. Preiss I. 3 (1845) 383; Benth. Fl. Austr. IV (1869) 27; Mildbraed, Stylidiaceæ, l. c. 44.

Armadale, on naked, clayey soil (No. 1067; 20. Sept. 1914). In full flower; corolla cream-coloured.

Stylidium spathulatum R. Br. Prodr. Fl. Nov. Holl. (1810) 569; Benth. Fl. Austr. IV (1869) 17; Mildbraed, Stylidiaceæ, l. c. 57.

Albany, in a swamp (No. 1066; 20. Oct. 1914). In full flower; corolla cream-coloured.

var. **obovatum** Ostf., nov. var. Planta quam typo robustior altiorque (20—25 cm alta); folia longe petiolata, obovata. Pl. XII, fig. 3.

Wilgarup, south of Bridgetown (No. 1071; 1. Oct. 1914).

This variety is very different from typical *S. spathulatum* and ought perhaps be taken as a separate species. The flowers are cream-coloured.

Stylidium striatum Lindl. Swan Riv. App. Bot. Reg. (1839) 28; Benth. Fl. Austr. IV (1869) 18; Diel u. Pritzel, in Botan. Jahrb. 35 (1904) 593; Mildbraed, Stylidiaceæ, l. c. 62.

The typical form with rose-coloured flower was collected near Cannington, vicinity of Perth (No. 1060; 22. Sept. 1914, E. Dorph-Petersen).

A somewhat aberrant tall form with white flowers was found in the forest near Yallingup Cave (No. 1058; 29. Sept. 1914).

Stylidium diuroides Lindl. Swan Riv. App. Bot. Reg. (1839) 29; Benth. Fl. Austr. IV (1869) 20; Mildbraed, Stylidiaceæ, l. c. 66.

Armadale, in the forest on damp soil (Nos. 1053 and 1054; 20. and 23. Sept. 1914). Flowering has just begun, flowers cream-coloured (No. 1053) or white (No. 1054); seems to be a rather rare species.

Stylidium hispidum Lindl. Swan Riv. App. Bot. Reg. (1839) 29; Mildbraed, Stylidiaceæ, l. c. 70; *S. ciliatum* Benth. Fl. Austr. IV (1869) 13, ex parte minori.

Armadale, sandy soil in the forest (No. 1065; 23. Sept. 1914); flowers white. Gooseberry Hill (10. Oct. 1899, R. Helms, ex Nat. Herb. of N. S. Wales).

There seems to be some confusion as to the group of species around *S. piliferum*; I have followed the delimitation used by the monographer J. Mildbraed (l. c.).

Stylidium piliferum R. Br. Prodr. Fl. Nov. Holl. (1810) 569; Benth. Fl. Austr. IV (1869) 12; Mildbraed, Stylidiaceæ,

l. c. 70; *S. saxifragioides*, *S. bicolor* et *S. ciliatum* Lindl. Swan Riv. App. Bot. Reg. (1839).

This species is common on sandy places in the forest around Perth (Nos. 1062—1064; 1445). The flowers are white or somewhat cream-coloured.

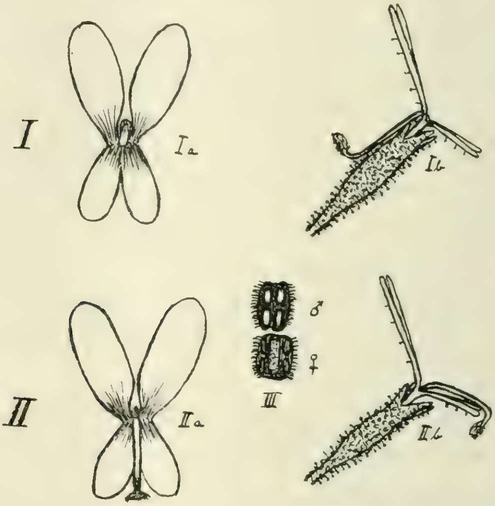

Fig. 17. *Stylidium piliferum* R. Br. Flower biology. Drawn from living plants.

Especially in this species I had the opportunity to study the well known movements of the gynostemium. They have been described by several observers. I need only mention George P. Burns[1] and Alex. G. Hamilton[2], the two latest contributors.

In *S. piliferum* the two larger petals between the base of which the minute labellum is placed, are turned up-

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[1] George P. Burns: Beitr. zur Kenntnis der Stylidiaceen. Flora, vol. 87 (1900) 313—354.

[2] Alex. G. Hamilton: On the Fertilization of Clerodendron tomentosum and Candollea (Stylidium) serrulata. Proc. Linn. Soc. N. South Wales, vol. 9 (1895) 18—24, pl. II.

wards and the gynostemium is — when untouched — bent backwards between them (Fig. 17, I a and b). The apical part of the gynostemium is curved so much as to form a blunt right angle with the lower part. If one touches the two smaller petals the gynostemium suddenly acts and springs into the position drawn in Fig. 17, II a and b; it now lies between the two smaller petals, which are united at their base, and its apical part is still curved. The irritability is only found in the basal part of the gynostemium. In the course of a quarter of an hour or half an hour the gynostemium has, slowly, wandered back into the first position, but it takes some time before it is sensitive again.

The flower is proterandrous. In the male stage the two double anther-sacks are seen on the head of the gynostemium surrounded by ciliate hairs on the outer side, while the stigma is hidden between them (Fig. 17, III ♂). In the female stage the anther-sacks have emptied their pollen and have shrunk, at the same time the stigma opens and takes the central place of the head of the gynostemium (Fig. 17, III ♀).

Hamilton (l. c.) says that insects are the fertilizers of *Stylidium serrulatum*. I have not succeeded in seeing any visitor in *S. piliferum*, but most probably the same is the case with this plant and with most species of the whole family.

Stylidium schoenoides D. C. Prodr. VII (1839) 782; Sonder, in Pl. Preiss. I, 3 (1845) 372; Diels u. Pritzel, in Botan. Jahrb. 35 (1904) 589; Mildbraed, Stylidiaceæ, l. c. 77, fig. 22 C—H; *S. reduplicatum* Benth. Fl. Austr. IV (1869) 7, ex max. parte; non R. Br.

Common around Perth (Nos 1081, 1083—1085, 1087, 1088); Yornup, south of Bridgetown (No. 1086; 2. Oct. 1914); Albany, damp places (No. 1082; 20. Oct. 1914).

PRITZEL (l. c.) has shown that the true *S. reduplicatum* of R. BROWN is a species restricted to the eastern part of the south coast of W. A. What has passed for *S. reduplicatum* is another species which is well described by SONDER (l. c.). It seems to be fairly widely distributed between Swan River and King George's Sound.

Stylidium divaricatum Sond., in Pl. Preiss. I, 3 (1845) 385; Mildbraed, Stylidiaceæ, l. c. 84, fig. 23 A, D, F; *S. streptocarpum* var. *tenellum* Benth. Fl. Austr. IV (1869) 28; Diels u. Pritzel in Botan. Jahrb. 35 (1904) 594; *S. gypsophiloides* Spencer Moore, Journ. Bot. XL (1902) 27.

A single plant of this species was found near Perth (No. 1055; 13. Sept. 1914, E. Dorph-Petersen). The flowers had a slight pink tint.

Stylidium leptophyllum D. C. Prodr. VII (1839) 783; Benth. Fl. Austr. IV (1869) 30; Mildbraed, Stylidiaceæ, l. c. 91; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 595.

Tammin, sandy soil (No. 1070; 6. Oct. 1914), flowers pink.

Compositæ.

Minuria Cunninghamii (D. C.) Benth. Fl. Austr. III (1866) 498.

Kalgoorlie (Nos. 856 and 857; 7. Oct. 1914).

Calotis multicaulis (Turcz.) comb. nov.; *C. plumulifera* F. v. Müll., Trans. Philos. Inst. Victoria III (1859) 57; Benth. Fl. Austr. III (1866) 505; *Goniopogon multicaule* Turcz. in Bull. de Moscou XXIV (1851) 174, tab. 2.

Kalgoorlie (No. 908; 7. Oct. 1914).

Calotis hispidula F. v. Müll. Trans. Victor. Inst. (1855) 130 ex Benth. Fl. Austr. III (1866) 506.

Kalgoorlie (No. 903; 7. Oct. 1914).

Pteronia australiensis, Hutchinson, sp. nov.

Frutex dense ramosissimus; rami cortice rupto brunneo obtecti; ramuli ultimi subgraciles, dense foliati, molliter lanato-tomentosi. Folia alterna, sessilia, spathulato-oblanceolata, obtusa, 5—8 mm longa, 2—3,5 mm lata, crasse coriacea, supra plana, infra carinata, utrinque dense molliter albido-tomentosa. Capitula discoidea, terminalia, solitaria, sessilia, elongato-cylindrica, leviter curvata, circiter 1,2 cm longa, 2,25 mm diametro. Involucri bracteæ circiter 5-seriatæ, plus minusve oblongo-ovatæ, minute mucronatæ, subcarnosæ, extra tenuiter pubescentes. Flores plerumque 5; corollæ tubus 7,5 mm longus, superne sensim latior, glaber, lobis 5 lineari-lanceolatis subacutis. Antheræ 5 mm longæ, longe apiculatæ, basi minute sagittatæ; pollinis granulæ globosæ, muricatæ. Achænia (matura non visa) linearia, glabra, basi callosa; Pappi setæ copiosæ, inæquales, basi in annulum brevissimum connatæ, corolla paulo breviores, subplumosæ.

Kalgoorlie (No. 858; 7. Oct. 1914).

Mr. J. Hutchinson has kindly examined this plant which I could not identify. He adds the following remarks to his description:

"When Dr. Ostenfeld first showed me this remarkable Composite I said at once that it was a *Pteronia*, a South African genus with which I am very well acquainted, having published a revision (with E. P. Phillips) in the Annals of the South African Museum, vol. ix, pt. v, pp. 277—329 (1917). Subsequent investigation has confirmed this surmise, and I have no hesitation in describing the plant as a new species of *Pteronia,* a natural and well defined genus of about 60 species hitherto known only from South Africa.

The finding of *Pteronia* in Western Australia by Dr. Ostenfeld is therefore of very great phytogeographical interest, and is a striking example indicative of a probable former land connection between these two regions, so well illustrated in the case of the natural family *Proteaceae.* Excluding the few large genera such as *Senecio, Helichrysum, Cotula,* etc., there are very few genera of *Compositæ* common to Australia and South Africa. The only natural genus common to the two areas is *Athrixia,* which occurs also in Tropical Africa and Madagascar. It is true the same may be said of *Helipterum,* but then *Helipterum* is in my opinion nothing more than an artificial genus developed separately in the two areas from the closely allied cosmopolitan *Helichrysum.* In the case of *Compositæ* especially, great caution should be observed in arriving at theoretical conclusions regarding distribution, as in most "natural" families many of the genera are probably polyphyletic".

Brachycome pachyptera Turcz., in Bull. de Moscou XXIV (1851) 175; Benth. Fl. Austr. III (1866) 512.

Kalgoorlie (No. 901; 7. Oct. 1914).

Brachycome trachycarpa F. v. Müll., in Linnæa XXV (1852) 337; Benth. Fl. Austr. III (1866) 515.

Kalgoorlie (No. 906; 7. Oct. 1914).

This species is not before recorded from W.A. My specimens agree well with the Kew specimens of it.

Brachycome ciliaris (Labill.) Less., Synops. Compos. (1832) 172; Benth. Fl. Austr. III (1866) 518.

I think that there are several species under what is called „*B. ciliaris*", and several of BENTHAM's varieties (l. c. 519) deserve to be more closely examined and separated from the main species.

I have what I consider the real *B. ciliaris* from Kalgoorlie (Nos. 862 and 905; 8. and 7. Oct. 1914), and further a much smaller glandular-pubescent plant from the same area: Kalgoorlie (No 907; 7. Oct. 1914); I have named it var. *glandulosa* Benth. (l. c.).

Brachycome latisquamea F. v. Müll., Fragm. Phytogr. Austr. XI (1878) 16; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 606.

Carnarvon, on dunes (No. 840; 31. Oct. 1914).

I agree with DIELS and PRITZEL (l. c.) in considering this species a suffrutex, not a herb as said by F. v. MÜLLER. My specimens are from the same locality as those collected by DIELS and PRITZEL. The species is hitherto only known from the northern part of the west coast of W. A.

Cotula coronopifolia L. Sp. pl. (1753) 892; Benth. Fl. Austr. III (1866) 549.

Perth (No. 885; 13. Sept. 1914, E. Dorph-Petersen).

Cotula bipinnata Thunb. Fl. Cap. (1823) 696; Harvey and Sonder, Fl. Cap. III (1864—65) 179; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 606; *C. oxyodonta* D. C. Prodr. VI (1836) 78.

York (No. 1393; 25. Nov. 1915; Mrs. Davis).

My specimens agree well with the specimens so named from Cape, collected by DREGE and present in the Kew Herbarium. HARVEY says (l. c.) that they are identical with THUNBERG's specimens, only smaller. If not, they should bear the name *C. oxyodonta* D. C., which name was based upon DREGE's plant.

This Cape plant has only once before been recorded from W. Australia, as far as I am aware, namely by Diels and Pritzel (l. c.).

Cotula gymnogyne F. Müll., ex Benth. Fl. Austr. III (1866) 549; *Gymnogyne cotuloides* Steetz, in Pl. Preiss. I (1845) 432.

Busselton, in dune depressions (No. 887; 30. Sept. 1914).

Cotula australis (Less.) Hook. f., Fl. Nov. Zel. I (1853) 128; Benth. Fl. Austr. III (1866) 550.

Perth, a common weed in the garden of St. Omer Hospital (No. 872; 10. Sept. 1914).

Isoëtopsis graminifolia Turcz., in Bull. de Moscou (1851) 175, tab. 3; Benth. Fl. Austr. III (1866) 556.

Kalgoorlie (No. 895; 7. Oct. 1914).

Myriocephalus gracilis (A. Gray) Benth. Fl. Austr. III (1866) 559; *Antheidosorus gr.* A. Gray, in Hook. Kew Journ. III (1851) 173; *Gilbertia tenuifolia* Turcz., in Bull. de Moscou (1851) 193.

Vicinity of Perth (No. 1379; 1915, Mrs. M. Davis).

Siloxerus humifusus Labill. Pl. Nov. Holl. II (1806) 58; *Angianthus h.* Benth. Fl. Austr. III (1866) 563 (excl. var. *minor*).

Vicinity of Perth (No. 848; 25. Oct. 1914, E. Dorph-Petersen); Albany (No. 852; 21. Oct. 1914); Yallingup Cave, sandy damp soil (No. 891; 28. Sept. 1914). Fig. 18 d—f.

As already pointed out by Bentham (l. c. p. 561) Labillardière's name *Siloxerus* is earlier than Wendland's *Angianthus* (1809) and I cannot see any reason for rejecting it, as Bentham's objection ("being at complete variance with the etymology given by the author") does not count nowadays.

More difficult to decide is the question whether the genus as taken by Bentham is a natural one, or whether it would be better to take up again some of the many, mostly monotypic genera which Bentham united into his *Angianthus*. For the present I think it more convenient to follow Bentham in the delimitation of the genus, but not in the name.

Fig. 18. *a, Siloxerus filifolius* (Benth.) Ostf., from Wooroloo (leg. Max Koch). *b—c,* The same, from Bayswater. *d, S. humifusus* Labill., from Albany. *e—f,* The same, from Perth. ($^3/_2$ nat. size).

Bentham (l. c. 563) has a var. *minor* based upon specimens from Kalgan River collected by Oldfield. These specimens I have seen at Kew and some of them represent a distinct species which differs from *S. humifusus* in several respects (see below). A single specimen of the same plant, collected by Oldfield at Murray River, is the type of *Gnaphalodes filifolium* Benth. (Fl. Austr. III, 1866, p. 578), which is no *Gnaphalodes*. In Kew Herb. I have examined the only specimen known. To this species belong also some more specimens which are named "*Angianthus humifusus*" in the collections at the British Museum and Kew.

If we use the species name in BENTHAM'S *Gnaphalodes filifolium* for the plant in question we get the following synonymy:

Siloxerus filifolius (Benth.) comb. nov.; *Gnaphalodes filifolium* Benth. Fl. Austr. III (1866) 578; *Angianthus humifusus*, var. *minor* Benth., l. c. 563, ex parte; (?) *A. h.* var *grandiflorus* Ewart, in Proc. R. Soc. Victoria, 20 (N. S.), pt. I (1907) 74.

It (Fig. 18 b—c) has great likeness to *S. humifusus*, but is generally a still smaller plant. The compound heads are globular, surrounded by a few linear leafy bracts, which exceed the head, at least when young. The involucral leaves of the partial heads are membraneous, obovate, whitish-transparent, often plicate or undulate above, about as long as the flowers or a little longer. Pappus of 5—6 much jagged-fringed scales, nearly as long as the flower, achenes smooth (or with very small palillæ). See Fig. 19, b.

Fig. 19. *a*, *Siloxerus humifusus* Labill. *b*, *S. filifolius* (Benth.) Ostf. Flowers and involucral bracts (about $^{5}/_{1}$ nat. size).

In *S. humifusus* the involucral leaves are much larger and considerably longer than the flowers (see Fig. 19, a.) The pappus scales on the other hand are hardly more than half as long as the corolla and they are not so much fringed as in *S. filifolius*. The whole flower is larger, mainly because of the longer tubular corolla.

The achenes are covered with transparent, protruding papillæ, already figured by LABILLARDIÈRE.

I have seen *S. filifolius* from the following W. A. localities: Murray R., Oldfield (type in Kew Herb.); Kalgan R., Oldfield (mixed with *S. humifusus*), Kew Herb.; W. Austr., Drummond (mixed with *S. humifusus*), Brit. Mus.; Bayswater (No. 854; 18. Oct. 1914, Ostenfeld), in a swamp,; Wooroolo, No. 1823, 1907, Max Koch (*"var. grandiflorus"*), Kew Herb. (this is perhaps a separate species as the achenes are finely papillose, the involucral leaves crispate, and the plant more robust, see Fig. 18 a).

In Kew Herb. there are further some very young specimens marked "Australia, Müller. Hort. Kew. Aug. 9th 1878". They seem to belong to the present species.

Siloxerus strictus (Steetz) comb. nov.; *Pogonolepis stricta* Steetz, in Pl. Preiss. I (1845) 440; *Angianthus strictus* Benth. Fl. Austr. III (1866) 568.

Kalgoorlie (No. 902; 7. Oct. 1914); Perth, near Cannington (No. 1126; 22. Sept. 1914, E. Dorph-Petersen).

The single specimen from the first mentioned locality has some resemblance to *Angianthus lanigerus* Ewart and White (Proc. R. Soc. Victoria, 23, (N. S.), 1911, 288), which I only know from the description and drawing.

Siloxerus tenellus (F. v. Müll.) comb. nov.; *Chrysocoryne t.* F. v. Müll., Trans. Vict. Inst. (1855) 130; *Angianthus tenellus* Benth. Fl. Austr. III (1866) 564.

Geraldton, amongst the dunes (No. 838; 29. Oct. 1914).

Siloxerus tomentosus (Wendl.) comb. nov.; *Angianthus t.* Wendl. Coll. II (1809) 31, tab. 48; Benth. Fl. Austr. III (1866) 562.

Kalgoorlie (No. 893; 7. Oct. 1914).

Gnephosis arachnoidea Turcz., in Bull. de Moscou (1851) 189; Benth. Fl. Austr. III (1866) 571.

Kalgoorlie (No. 892; 7. Oct. 1914).

Calocephalus Drummondii (A. Gray) Benth., Fl. Austr. III (1866) 574.

Mundaring Weir, Darling Range, on somewhat damp clayey soil (No. 868; 13. Sept. 1914).

Cephalipterum Drummondii A. Gray, in Hook. Kew Journ. IV (1852) 272; Benth. Fl. Austr. III (1866) 577.

Moora (Nos. 1422 and 1423; 25. Sept. 1915, Miss G. Davis), fl. yellow and fl. white. Both nos. belong to "*forma major*" by Diels (Bot. Jahrb. 35 (1904) 615).

Rutidosis argyrolepis (Schlecht.) F. v. Müll., ex Diels u. Pritzel, Bot. Jahrb. 35 (1904) 616; *R. pumilo* Benth., Fl. Austr. III (1866) 595.

Armadale, open and clayey damp soil (No. 851; 20. Sept. 1914); Cannington near Perth, damp soil (No. 875; 4. Sept. 1914).

Quinetia Urvillei Cass., in Diction. sc. nat. LX (1830) 579; Benth. Fl. Austr. III (1866) 595.

Yallingup Cave, on sandy soil (No. 877; 26. Sept. 1914).

Millotia tenuifolia Cass., in Ann. Sc. nat. XVII (1829) 416; Benth. Fl. Austr. III (1866) 596.

Busselton, in dune depressions (No. 889; 30. Sept. 1914); Mundaring Weir, Darling Range (No. 870; 13. Sept. 1914).

Podolepis rosea Steetz, in Pl. Preiss. I (1845) 463; Diels, in Botan. Jahrb. 35 (1904) 621.

Perth, common in King's Park, in sandy open places (Nos. 842 and 873; 10. Sept. and 13. Oct. 1914).

As to the species of *Podolepsis* I follow the treatment of L. Diels (l. c.)

Podolepis aristata Benth., in Huegel, Enum. pl. (1837) 64; Fl. Austr. III (1866) 605.

Tammin, on sandy soil (No. 860; 6. Oct. 1914).

Podolepis capillaris (Steetz) Diels, in Botan. Jahrb. 35 (1904) 621; *P. siemssenia* F. v. Müll., in Benth. Fl. Austr. (1866) 607; *Siemssenia capillaris* Steetz, in Pl. Preiss. I (1845) 467.

Kalgoorlie, common (No. 896; 8. Oct. 1914).

Schoenia Cassiniana (Gaudich.) Steetz, in Pl. Preiss. I (1845) 481; Benth. Fl. Austr. III (1866) 611.

Moora (No. 1426; 25. Sept. 1915, Miss G. Davis).

Waitzia acuminata Steetz, in Pl. Preiss. I (1845) 453; Diels u. Pritzel, in Bot. Jahrb. 35 (1904) 625; *W. corymbosa* Benth. Fl. Austr. III (1866) 635; non Wendland.

Tammin (No. 859; 6. Oct. 1914).

According to Diels and Pritzel (l. c.) F. v. Müller (in Oesterr. Apoteker-Ver. Zeitschr. 1896) has shown that Bentham (l. c.) was wrong when he used the name "*W. corymbosa* Wendl." for this species. Already Steetz (in Pl. Preiss.) has correctly used Wendland's name for the following species and has given the present one a new name. This species belongs to the eremæan part of W. A. and does not occur in the coastal belt.

Waitzia corymbosa Wendl. Coll. Pl. II (1809) 13, tab. 42; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 626; *W. nivea* Benth. Fl. Austr. III (1866) 636.

Perth, King's Park, sandy soil (No. 844; 13. Oct. 1914).

Waitzia podolepis (Gaudich.) Steetz, in Pl. Preiss. I (1845) 450; Benth. Fl. Austr. III (1866) 637; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 626.

Geraldton (No. 839; 29. Oct. 1914).

My specimens of this rare species agree well with specimens distributed by E. Pritzel (No. 621) and with the description given by Diels and Pritzel (l. c.). This species seems to be restricted to the coastal area of the middle part of W. A.

Waitzia Steetziana Lehm., in Pl. Preiss. I (1845) 454; Benth. Fl. Austr. III (1866) 636.

Yallingup Cave, in open places of the forest, both with whitish and with yellow involucres (Nos. 879 and 890; 26. and 29. Sept. 1914).

Helipterum roseum (Hook.) Benth. var. **nigropapposum** nov. var.

Differt a typo habitu graciliore, capitulis minoribus et præcipue apicibus plumosis pappi radiorum nigrescentibus.

Perth, King's Park, in open sandy places (No. 874; 10. Sept. 1914).

This plant, which seems to be one of the many forms of *H. roseum*, differs from the typical species in its slender and smaller size and in the black terminal tufts of hairs of the pappus bristles. The specimens are erect, one-headed, ab. 20 cm high; the inner involucral leaves are pink to white.

Helipterum rubellum (A. Gray) Benth. Fl. Austr. III (1866) 641.

Kalgoorlie (No. 861; 8. Oct. 1914).

Helipterum Fitzgibbonii F. v. Müll., Vict. Natur. VII (1890) 38; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 629; Sp. Moore, Journ. Linn. Soc. 34 (1899) 200.

Boulder (Ex herb. Mus. Perth; leg. W. D. C., 1900).

Helipterum chlorocephalum (Turcz.) Benth. Fl. Austr. III (1866) 641; *Schoenia chlorocephala* Turcz., in Bull. Mosc. (1851) 193; *Acroclinium multicaule* A. Gray, in Hook. Kew Journ. IV (1852) 271.

Moora (No. 1416; 25. Sept. 1915, Miss G. Davis).

Besides Drummond's type specimens of this plant which have the metallic green inner involucral leaves, there are in the Kew Herb. several specimens of the same species. All the characters are identical, only they have white involucral leaves; undoubtedly Drummond's specimens acquired their peculiar colour when they were dried and therefore the species name is very inappropriate.

The specimens present at Kew came mostly from places in the interior of Australia where the species seems to be widely distributed. They were named differently, some as *H. chlorocephalum*, others as *H. cotula* var., others again as *H. roseum* var.

Helipterum variabile (Sond.) comb. nov.; *H. hyalospermum* F. v. Müll., in Benth. Fl. Austr. III (1866) 644; *H. glutinosum* Druce, in Rep. Brit. Exch. Club, Suppl. 627 (1916) 1917; *Hyalosperma strictum* et *H. glutinosum* Steetz, in Pl. Preiss. I (1845) 477; *Hyalosp. variabile* Sond., in Linnæa 25 (1852) 519.

Vicinity of Perth (No. 1378; Mrs. Davis, 1915).

Steetz's names are the earlier, but as we have *Helipt. strictum* (Lindl.) Benth. and a *Helichrysum glutinosum* Benth. (described as *Helipt. glutinosum* Hook.), none of them are valid, which Druce (l. c.) seems to have overlooked. Hence we must use Sonder's species name as being prior to F. v. Müller's.

Helipterum Haigii F. v. Müll., Fragm. Phytogr. Austr. X (1877) 107; Sp. Moore, Journ. Linn. Soc. 24 (1899) 200.

Kalgoorlie (No. 899; 7. Oct. 1914).

Helipterum tenellum Turcz, in Bull. de Moscou (1851) 198; Benth. Fl. Austr. III (1866) 646; Diels u. Pritzel, Botan. Jahrb. 35 (1904) 630.

Kalgoorlie (No. 900; 7. Oct. 1914).

Helipterum pygmæum (D. C.) Benth. var. **Drummondii** (A. Gray) comb. nov.; *H. pygmæum*, var. *occidentale* Benth. Fl. Austr. III (1866) 647; *Pteropogon Drummondii* A. Gray, in Hook. Kew Journ. IV (1852) 267.

Kalgoorlie (No. 898; 7. Oct. 1914).

It would perhaps be preferable to regard the western form of *H. pygmæum* as a separate species which must then bear the name *H. Drummondii* (A. Gray, sub *Pteropogone*).

Helipterum polycephalum (A. Gray) Benth. Fl. Austr. III (1866) 649; *Pteropogon polycephalus* A. Gray, in Hook. Kew Journ. IV (1852) 268.

Yallingup Cave, open soil in the forest (No. 878; 26. Sept. 1914).

Helipterum australe (A. Gray) comb. nov.; *H. dimorpholepis* Benth. Fl. Austr. III (1866) 650; *H. pygmæum* Druce, in Hayward and Druce, Advent. Fl. Tweedside (1919) 103; *Dimorpholepis australis* A. Gray, in Hook. Kew Journ. IV (1852) 227; Hook. Ic. Pl. tab. 856; *Triptilodiscus pygmæus* Turcz. in Bull. de Moscou (1851) 66.

Kalgoorlie (No. 894; 7. Oct. 1914).

According to the rules of nomenclature it is neccessary to alter the species name of *H. dimorpholepis* Benth., and as we have already a *H. pygmæum*, A. Gray's name must be used, not Turczaninow's, as Druce (l c.) has done.

Gnaphalium collinum Labill. Pl. Nov. Holl. II (1806) 44, tab. 189; Benth. Fl. Austr. III (1866) 654.

Albany, damp soil (No. 855; 21. Oct. 1914).

The specimens agree very well with the specimens of this plant from Tasmania and S. E. Australia; they are perennial with rosulate leafy shoots, ascending flowering shoots and supraterranean runners.

It has not been reported from W. Austr. before, but has perhaps been included under *G. japonicum*.

Senecio brachyglossus F. v. Müll., in Linnæa 25 (1852) 525; Benth. Fl. Austr. III (1866) 669.

Kalgoorlie (No. 904; 7. Oct. 1914).

Perhaps Sp. Moore (Journ. Linn. Soc. 24, 1899, 201) meant this species, when he says that *S. vulgaris* is common round Coolgardie.

Ursinia anthemoides (R. Br.) Gärtn. fruct. II (1791) 463, in observ.; *Sphenogyne anthemoides* R. Br.

A common weed around Perth (western suburbs) on sandy poor soil (No. 843; 13. Oct. 1914, and No. 1374; 1915, Mrs. Davis).

Specimens of this South-African plant were sent to Kew some years ago by Dr. F. Stoward, from the same area. In 1887 N. E. Brown (Gard. Chron., vol. 1, 670) created a new species *U. pulchra* N. E. Brown upon *Sphenogyne speciosa* Knowles and Westcott, Floral Cabinet (1838) II, 131, pl. 77; Paxton's Magaz. of Bot. (1839) VI, 77 with plate; and the Perth plant was at Kew identified with this species which was said to be a common Garden plant, but not known in the wild state. I have compared N. E. Brown's type specimen with the numerous specimens of *U. anthemoides* present in Kew and fail to find any difference marked enough to maintain the new species which, therefore, I consider a synonym only to *H. anthemoides.*

Arnoseris minima (L.) Schweigg. et Koerte, Fl. Erlangen II (1811) 72; *A. pusilla* Gärtn.; Benth. Fl. Austr. III (1866), 680.

Mundaring Weir, a weed (No. 867; 13. Sept. 1914).

Sonchus oleraceus L. Sp. pl. (1753) 794.

Seems to be rapidly spreading. It was common in Perth (No. 1341; 26. Oct. 1914) and was also present at Yallingup Cave (No. 1342; 29. Sept. 1914). Both nos. belong to the typical form: *α, triangularis* Wallr.

Forelagt paa Mødet d. 17. Decbr. 1920.
Færdig fra Trykkeriet d. 30. April 1921.

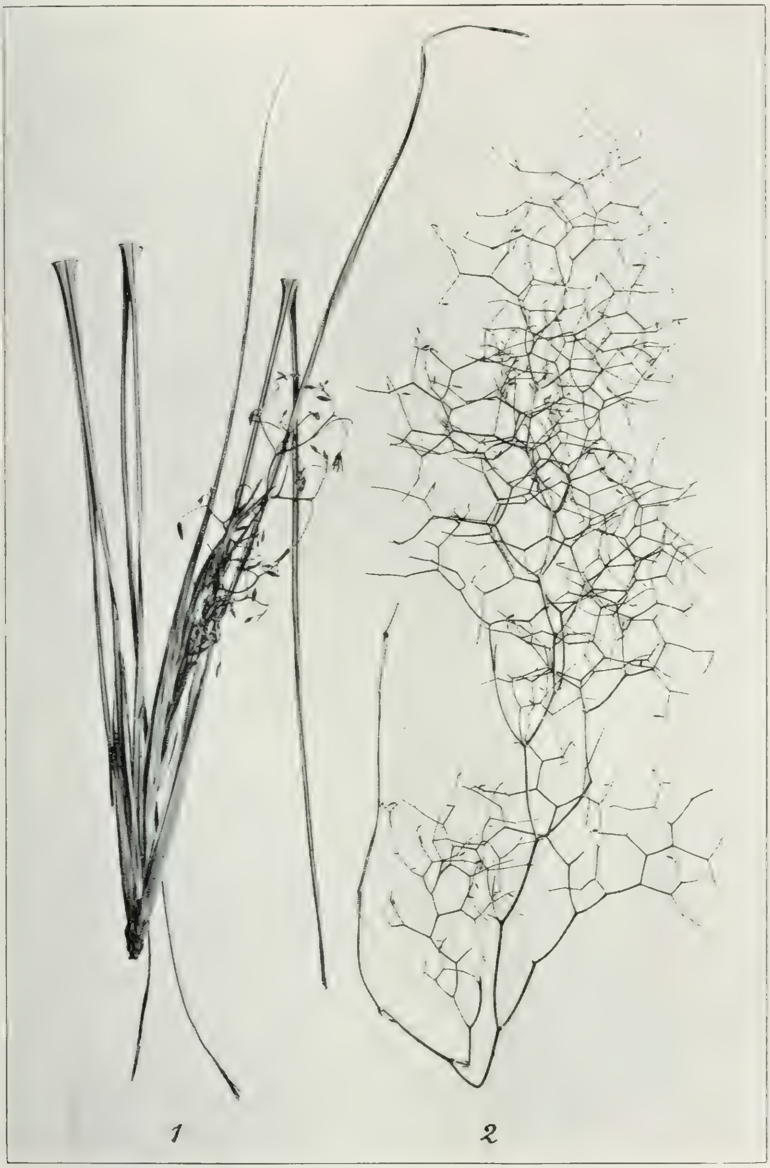

Fig. 1. Dianella revoluta R. Br., var. brevicaulis Ostf.
Fig. 2. Corynotheca micrantha (Lindl.) Macbride. (3/8 nat. size).

Fig. 1. Caladenia macrostylis Fitzg. Fig. 2. Bartlingia paleacea (F. Müll.) Ostf. Fig. 3. Patersonia pygmæa Lindl. Fig. 4. Patersonia longiscapa Sweet. Fig. 5. Juncus planifolius R. Br., var. humilis Ostf. Fig. 6. Borya nitida Labill., coarse form from Tamin. (1/2 nat. size).

1 2

Fig. 1 Casuarina decussata Benth., branch with ripe cone and branchelets with male inflorescences.
Fig. 2. Casuarina lepidophloia F. v. Müll., with young cones.
($^5/_9$ nat. size).

Casuarina acutivalvis F. v. Müll., male branch to the left, female branch with cones to the right. ($^3/_8$ nat. size).

Fig. 1. Adenanthos barbigera Lindl. Fig. 2. Adenanthos intermedius Ostf. Fig. 3. Adenanthos obovatus Labill., narrow-leaved form. Fig. 4. Adenanthos obovatus Labill., typical. (7/12 nat. size).

Fig. 1. Simsia latifolia R. Br., var. gracilis Ostf. from Perth, King's Park. Fig. 2 Simsia latifolia B. Br. typical, from the same place (taken about a month earlier). ($^2/_5$ nat size).

Tetragonia eremæa Ostf., a large branched specimen and a small unbranched one; wholly and partly ripe isolated fruits, seen from above and from the side. (nat. size).

Fig. 1. Marianthus erubescens Putterl.
Fig. 2. Marianthus gracilis Ostf. (7/12 nat. size).

a. Hibbertia pulchra Ostf. b. Hibbertia teretifolia Turcz.
c. Hibbertia inconspicua Ostf. (nat. size).

Fig. 1. Xanthosia candida Steud., var. subtrilobata Ostf.
Fig. 2. Petroselinum sativum Hoffm., abnormal form from Yallingup Cave. ($^7/_{12}$ nat. size).

Fig. 1. Eremophila angustifolia (Sp. Moore) Ostf. Fig. 2. Eremophila decipiens Ostf. Fig. 3. Stylidium spathulatum R. Br., var. obovatum Ostf. Fig. 4. Samolus repens (Forst.) Pers., var. floribundus Benth. (1/2 nat. size.)

Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **III,** 3.

FORTSATTE STUDIER OVER KAPILLÆRERNES FYSIOLOGI

AF

AUGUST KROGH

1742

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
1921

I mit tidligere Arbejde om Vævenes Forsyning med Ilt og Kapillærkredsløbets Regulering[1] har jeg fremført en Række Iagttagelser og Forsøg hvoraf det fremgaar, at Kapillærerne i hvert Fald i Muskler maa være selvstændig kontraktile, at der med andre Ord maa findes en særligt kapillariomotorisk Mekanisme, hvorved Kapillærernes Vidde reguleres. Dette Resultat stemmer med, hvad enkelte tidligere Forskere har fundet,[2] og er blevet bekræftet ved samtidige Undersøgelser af Dale[2] og hans Medarbejdere, der viser, at Histamin har specifik Virkning paa Kapillærer hos forskellige Dyr og bringer dem til Afslappelse.

Konstateringen af Kapillærernes Kontraktilitet rejser imidlertid en Række nye Spørgsmaal: Om de Maader, paa hvilke de kan paavirkes, om de Midler, ved hvilke deres Vidde reguleres i Organismen, om Betydningen af Regulationsmekanismen i bestemte Tilfælde, om den histologiske Paavisning af de kontraktile Elementer[3] o. s. v. Med disse Spørgsmaal har jeg været beskæftiget i de sidste Aar, og

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[1] Videnskabernes Selskab. Biologiske Meddelelser I. 6.

[2] Rouget: C. R. **88**, 1879. Roy and Graham Brown: Journ. of Physiol. **2**, 323, 1880. Steinach und Kahn: Pfl. Arch. **97**, 1903. Mayer: Anat. Anz. **21**, 1902. Heubner: Arch. f. exp. Path. u. Pharm. **56**, 1907. Jacoby: Ibid. **66**, 1911. Ebbecke: Pfl. Arch. **169**, 1917. Dale and Richards Journ. of Physiol. **52**, 1918. Dale and Laidlaw Ibid.

[3] Med en nærmere histologisk Undersøgelse af Kapillærerne er min Medarbejder Dr. B. Vimtrup beskæftiget. Han bekræfter Existensen af grenede Celler, der omfatter Kapillærerne, saaledes som allerede Rouget har beskrevet, men Beviset for, at disse er kontraktile, er endnu ikke ført.

skønt Undersøgelserne er langt fra at være afsluttede, anser jeg det for heldigt nu at give en kortfattet Oversigt over, hvad der er naaet. Mere udførlige og dokumenterede Fremstillinger vil efterhaanden fremkomme i Journal of Physiology, hvor Arbejder om Luftarters Diffusion gennem dyriske Væv, om Antallet af Kapillærer i Muskler, om Iltforsyningen og Kapillærkredsløbet er publiceret i Vol. 52 og om de lokale Reaktioner og Innervation af Karrene i Frøtungen i Vol. 53.

Metodiken ved de Undersøgelser der hidtil er gennemført, har været meget simpel, idet den i Hovedsagen har bestaaet i mikroskopisk Iagttagelse af Blodkarrene i gennemsigtige Væv, navnlig Tunge og Svømmehud, af uretanbedøvede Frøer, samtidig med at de blev paavirkede paa forskellig Maade.

Til mekanisk Irritation under Mikroskopet har jeg anvendt fine Glasnaale, med hvilke Overfladen blev kradset, spidse Kaktusbørster, med hvilke enkelte Blodkar kan prikkes og Haar af forskellig Stivhed anbragt paa passende Haandtag. Ved Hjælp af saadanne Haar er det muligt at udøve et lokalt Tryk af nogenlunde kendt Størrelse fra 1 mg opefter. Til lokal Paavirkning med Kemikalier er anvendt Glasnaale med en lille Kugle i Spidsen. Naar en saadan Kugle dyppes i en Vædske og derefter berører en fugtig Overflade, vil den afsætte en Draabe, hvis Størrelse er nogenlunde bestemt af Kuglens Størrelse. Med en Kugle paa 0,2 mm kan man anbringe en Draabe paa ca 0,001 mm^3 hvorsomhelst i Mikroskopets Synsfelt og opnaa en skarpt lokaliseret Virkning. Til langvarig Behandling med flydende Reagenser har jeg anvendt Reagensskaale: smaa parafinerede Messingringe, der lagdes ned paa Vævet og fyldtes med den paagældende Vædske.

Kapillærviddens Uafhængighed af Blodtrykket.

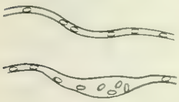

Fig. 1.

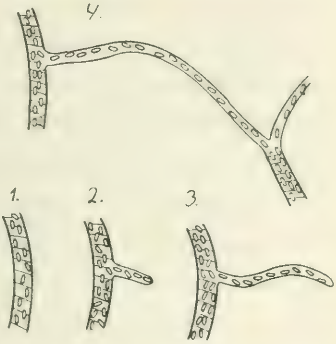

Fig. 2.

Den første Opgave, som maatte løses, var en direkte Paavisning af, at Kapillærforandringer er uafhængige af det arterielle Blodtryk. Dette lod sig meget let vise paa Frøtungen, der, naar den udspiles over en Glasplade med Undersiden opad, er et særlig gunstigt Objekt, idet der findes en glat Slimhinde med et meget vidmasket Kapillærnet, hvor de enkelte Kapillærer er let tilgængelige for Paavirkning, og hvor saavel de smaa Arterier som Vener direkte kan iagttages. Saa længe Tungen ikke paavirkes, er det langt overvejende Antal af disse Kapillærer lukkede og Tungen yderst bleg og blodfattig. Irriterer man et Parti af Tungen mekanisk, kan man yderst let fremkalde en betydelig Karudvidelse, og ved at irritere et enkelt Sted ganske svagt kan man bringe et enkelt Kapillær eller Del af et Kapillær til Udvidelse. Den skematiske Fig. 1 viser saaledes et Kapillær, dels i upaavirket Tilstand, dels efter at der er kradset lidt paa Midten af det. Fig. 2 viser, hvorledes det er muligt at finde et fuldstændig lukket Kapillær ved at kradse forsigtigt langs en lille Venegren (1). Blod løber ind fra Venen og fylder et Stykke af Kapillæret, men kommer ikke i Strømning. Ved at kradse videre kan man faa Kapillæret fyldt Stykke for Stykke (2, 3), indtil der opnaas Forbindelse med et aabent Kapillær eller Arterie (4), hvorefter der pludselig kommer Strøm. Dette Forsøg viser, at det ganske lave Venetryk er tilstrækkeligt til at fylde Kapillærer, hvis Vægge er slappede, medens det høje Arterietryk ikke kan tiltvinge sig Adgang til et kontraheret Kapillær.

Ved Paadrypning af en svag Opløsning af Acetylcholin kan alle de smaa Arterier bringes til at udvide sig stærkt. Dette forøger i høj Grad Blodstrømmen gennem Kapillærerne, men frembringer ikke nogen tydelig Udvidelse af dem og bringer kun undtagelsesvis Strøm i Kapillærer, der i Forvejen var strømløse.

Tilsvarende Iagttagelser til de nu beskrevne kan gøres paa Svømmehuden og andre Væv, og man kan i Almindelighed slutte, at naar en nogenlunde betydelig Kapillærudvidelse kommer istand, saa kan det ikke skyldes en simpel Stigning af det arterielle Blodtryk, men maa bero paa en Forandring i Kapillærvæggenes Tilstand — en Afslappelse af deres kontraktile Elementer, en Formindskelse af deres Tonus. Et Organs mere eller mindre røde Farve afhænger, som tidligere paavist, i første Linie af Kapillærernes Blodfylde, og man har altsaa Lov til at slutte, at i alle saadanne Tilfælde, hvor der er udpræget Rødme, har vi med udvidede Kapillærer at gøre, men hvorvidt Arterierne samtidig er udvidede og Trykket i Kapillærerne altsaa højt, det kan kun en nærmere Undersøgelse i hvert enkelt Tilfælde give Oplysning om.

Lokale kapillariomotoriske og arteriomotoriske Reaktioner.

Som ovenfor beskrevet fremkalder en yderst svag mekanisk Irritation af et enkelt Punkt af Frøtungens Slimhinde en lokal Udvidelse paa et underliggende Kapillær, og tilsvarende lokal Udvidelse kan fremkaldes paa samme Maade paa Arterier. Irriterer man stærkere eller gentagne Gange samme Punkt, breder Virkningen sig til et større

Areal, og saavel Kapillærer som Arterier bringes til Udvidelse. Det paavirkede Areal afhænger af Irritationens Styrke, men Virkningen paa Kapillærerne breder sig dog aldrig ud over en Afstand af et Par mm. Stikkes f. Ex. en Naal gennem Tungen bliver den omgivet af en Zone med indtil 2 mm Radius, hvor Kapillærerne er udvidede, og den Arterie, der forsyner dette Areal, er tydelig udvidet et langt Stykke tilbage i Tungen.

I Frøtungen frembringer mekanisk Irritation altid Kapillærudvidelse, men ved tilsvarende Forsøg paa Svømmehuden faar man et helt andet Resultat. Svømmehudens Kapillærnet er, ligesom Hudens overhovedet, meget tæt. Kapillærerne er næsten altid aabne, men dog saa snævre, at Blodlegemerne kun kan passere enkeltvis og under betydelig Formforandring. Irriterer man Kapillærer i Svømmehuden ganske svagt, lykkes det ofte at fremkalde lokal Udvidelse, men irriterer man stærkere, trækker det paagældende Kapillær sig sammen. Virkningen breder sig aldrig udover et Par Tiendedele Millimeter. Svag Irritation af en snæver Arterie bevirker i Reglen efter nogle Sekunder en Udvidelse, der kan strække sig over flere mm, men en stærk Irritation bevirker efter en lignende Latenstid en kraftig Kontraktion over en lang Strækning.[1] Ar-

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[1] Naar en enkelt Gren af en større Arterie bringes til at kontrahere sig betydeligt uden dog at lukke sig helt, kan man ofte gøre en højst ejendommelig Iagttagelse. Man ser Blodlegemerne forsvinde mere eller mindre fuldstændig fra det af Arterien forsynede Areal og kan let fristes til at tro, at Kapillærerne har kontraheret sig. Naar nogle Blodlegemer lejlighedsvis passerer, konstaterer man imidlertid, at dette ikke er Tilfældet og at der gaar en mere eller mindre livlig Strøm af yderst blodlegemefattigt Plasma igennem. Fænomenet beror paa det velkendte Forhold, at der i lidt større Kar altid findes en Randzone af Plasma og en central Søjle, hvori Blodlegemerne bevæger sig. Igennem en forsnævret Sidegren »skummes« Plasmaet af. I enkelte Tilfælde kan man se et Billede som den stærkt skematiserede Fig. 3 gengiver: at der ved hvert

terierne holder sig ofte fuldstændig lukket indtil et Kvarter.[2]

En Række kemiske Stoffer kan trænge igennem Slimhinden og paavirke Karrene i Frøens Tunge, idet de da altid foraarsager Udvidelse. Anbringer man en Draabe 1⁰/₀ Eddikesyre paa Tungen, vil Kapillærerne under og omkring Draaben udvide sig og ligeledes Arterierne, der forsyner dem, saa at der bliver et meget livligt Kredsløb.

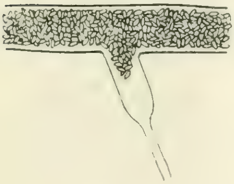
Fig. 3.

Udsættes et Parti af Tungen for Paavirkning af ren Kulsyre, opstaar der en tydelig Hyperæmi, men en Blanding af 10 ⁰/₀ CO_2 i atmosfærisk Luft har næppe kendelig Virkning, skønt den maa frembringe en Reaktion, der er væsentlig surere end Vævets normale. En systematisk Undersøgelse af Brintionkoncentrationens Betydning for Kapillærernes Kontraktionstilstand vil senere blive foretaget.

En Række andre Stoffer har lignende Virkning paa Karrene i Frøtungen som Syre, men enkelte, som Jod, virker tydeligt stærkere paa Kapillærer end paa Arterier, og det er lykkedes mig at finde et enkelt, Uretan, der praktisk talt udelukkende virker paa Kapillærer. Anbringes en Draabe 25⁰/₀ Uretan over et Kapillær, indtræder fuldstændig Af-

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Pulsslag trænger en »Tap« af Blodlegemer over i Sidegrenen, men at den i Reglen gaar tilbage uden at miste et Blodlegeme. Denne Iagttagelse er af en vis Betydning for at forklare de i den senere Tid ret hyppig iagttagne Tilfælde af Forskelle i Blodets Indhold af Blodlegemer mellem forskellige Kargebeter. Blod fra Gebeter, hvis Arterioler er noget forsnævrede, vil let blive mere eller mindre anæmisk, medens Blod fra andre Steder samtidig vil vise en vis Polyglobuli.

[2] Den biologiske Betydning af denne Reaktion er meget tydelig. Prikker man f. Ex. Hul paa en Arteri, bløder den kun et Øjeblik, før den lukker sig, og naar den igen aabner sig, er det udtraadte Blod koaguleret og forhindrer videre Blødning.

slappelse af Væggens Tonus. Man kan undertiden se et saadant Kapillær fyldes ganske gradvis fra en Arterie, der er saa snæver, at Blodlegemerne presses igennem et for et, medens Kapillæret efterhaanden naar en Diameter af indtil 50 μ. I et saadant Kapillær udvikler der sig i Løbet af nogle Minutter fuldstændig Stase, idet Kapillæret fyldes med tæt sammenpakkede Blodlegemer som vist paa Fig. 4.[1]

Medens som nævnte Kapillærerne i Frøens Tunge bringes til stærk Udvidelse ved en Række forskellige kemiske Stoffer,

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[1] Denne Stases nærmere Mekanisme frembyder betydelig Interesse. Den umiddelbare Iagttagelse giver det Indtryk, at den fremkommer ved, at Kapillærvæggen bliver permeabel for Blodvædsken, medens Blodlegemerne holdes tilbage. Under normale Forhold er Kapillærvæggen efter den almindelige Opfattelse, som støttes af talrige Forsøg og Iagttagelser, permeabel for Vand og Krystalloider, men impermeabel for Kolloider. Den Forestilling, man føres til at danne sig ved at se Uretanstasen komme istand, er, at Kapilærvæggen ved den hurtige Udvidelse bliver porøs, saa at de store Kolloidmolekuler kan passere igennem. For at prøve denne Forestilling og faa et Slags Maal for Porernes Størrelse har min Medarbejder Dr. A. Harrop og jeg anstillet følgende Forsøgsrække: Paa en Frø, hvis Tunge var udspilet, injiceredes i en Vene i et Forsøg en Opslemning af Tusch, hvis Partikler, der er meget ensartede, ligger paa Grænsen af det mikroskopisk synlige ɔ: har en Størrelse af nogle Tiendedele μ. Efter at det tuschblandede Blod var kommet til Syne i Tungens Kar bragtes nogle Kapillærer til maximal Udvidelse ved Uretantilsætning. Det viste sig, at Tuschpartiklerne ikke trængte igennem de udvidede Kapillærers Vægge, undtagen paa et enkelt begrænset Sted. Forsøget gentoges paa en anden Frø med det kolloidale Farvestof Vitalrødt istedetfor Tusch. Vitalrødt trænger ikke igennem normale Kapillærers Vægge, men langs de Kapillærer, der blev behandlede med Uretan, viste der sig umiddelbart efter en fin rød Stribe, der efterhaanden blev bredere og mere diffus. Et tredje Forsøg med »opløst« Stivelse viste, at ogsaa dette Stofs store Molekuler gik let igennem udvidede Kapillærers Vægge.

Der kunde mod disse Forsøg rejses den Indvending, at den forøgede Permeabilitet og Udvidelsen af Kapillærerne vel skyldtes Uretanen, men var uafhængige af hinanden. Dette modbevises ved Forsøg, hvor en hurtig Udvidelse tilvejebragtes ad nervøs Vej og ligeledes førte til, at Vitalrødt passerede ud gennem Kapillærvæggen. Disse Forsøg over Permeabilitetens Ændringer som Følge af Kapillærudvidelser vil senere blive fortsat med Kolloider af forskellig veldefineret Dispersitetsgrad.

er andre Kapillærer i Organismen og specielt Hudens og Svømmehudens langt mere modstandsdygtige og udvider sig kun lidt eller slet ikke. Dette har Betydning i teoretisk Henseende, idet det viser, at Kapillærernes fysiologiske Egenskaber varierer fra Organ til Organ, at man ikke har Lov at slutte fra deres Forhold i ét Organ eller blot i én Organisme til deres Forhold i Almindelighed. Herved kompliceres Studiet selvsagt betydeligt, men vinder samtidig i Interesse. Den biologiske Betydning af Tungekarrenes særlig udprægede Reaktion overfor alle Slags Paavirkninger mener jeg at finde deri, at Tungen hos Frøen jo er Fangstredskabet overfor Dyrenes levende Bytte. Den bliver herved udsat saavel for mekanisk Irritation som for de ætsende Vædsker, mange Insekter udsondrer, naar de gribes. Som en Beskyttelse herimod maa den forøgede Blodcirkulation og den ligeledes optrædende livlige Slimsekretion paa de angrebne Steder utvivlsomt opfattes.

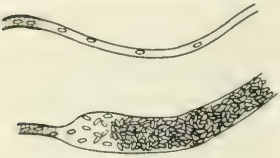

Fig. 4.

Kapillærernes og de smaa Arteriers Innervation.

Som omtalt ovenfor vil en strængt lokal Irritation af Tungens Slimhinde kunne paavirke Kapillærerne indenfor en Afstand af et Par mm og den tilførende Arterie endnu længere borte, ligesom en Irritation af et enkelt Punkt af en lille Arterie i Svømmehuden efter Omstændighederne kan medføre Kontraktion eller Dilatation af en Strækning paa flere mm af den paagældende Arterie. Disse Reaktioner indtræder efter en Latenstid paa ca. 10—15 Sekunder, men praktisk talt samtidig over hele det Parti, der reagerer. Man maa derfor antage, at de kontraktile Elementer paavirkes gennem Nervetraade. Hvis man antog, at der f. Ex. ved mekanisk Irritation dannedes et virksomt Stof paa det irriterede Sted, og at dette ved at diffundere ud til alle Sider frembragte Reaktionens Udbredelse, saa maatte den foregaa langsomt og gradvis og under meget stærk Afsvækkelse, jo mere man fjernede sig fra det irriterede Punkt. Antagelse af en Ledning gennem selve de kontraktile Elementer er heller ikke forenelig med Udbredningens Latenstid og navnlig ikke med, at der sker Overledning fra Kapillærer til Arterier, hvis kontraktile Elementer ialfald er ganske forskellige i anatomisk Henseende og ikke kan antages at være saaledes sammenvoksede, at Overledning af Irritamenter kan finde Sted. Paa de mindste Arteriegrene ligger iøvrigt Ringmuskeltraadene i ret betydelig indbyrdes Afstand og uden synlig indbyrdes Forbindelse.

Antagelsen af en Ledning af Irritationsprocessen gennem Nervetraade bestyrkes ved Resultaterne af Forsøg over Virkningen af Kokain paa de lokale vasomotoriske Reaktioner. Kokain har som bekendt elektiv Virkning paa sensible Nerveender. Naar et Areal af Tungens Slimhinde behandles med en 0,2—0,5 % Opløsning af Kokainklorid, nedsættes dets Modtagelighed for mekanisk Irritation efterhaanden, saaledes at Virkningen af temmelig stærk Irritation efter 20—30 Minutter bliver svag og strængt lokal og senere helt udebliver. Ved Behandling af den intakte Svømmehud med Kokain ophæves efter nogen Tids Forløb Arteriernes Evne til at reagere over en lang Strækning paa mekanisk Paavirkning, og dette gælder saavel Kontraktionsreaktionen efter stærk Irritation som Dilatationsreaktionen efter svag.

Det er altsaa klart, at mekaniske Irritamenter virker gennem Nervetraade paa fjernere liggende Kar, hvorimod Forsøg med Applikation af Kemikalier efter Kokainisering viser, at disse ialfald i stor Udstrækning virker direkte paa de kontraktile Elementer.

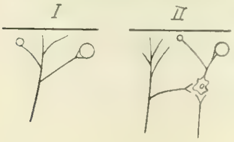

Fig. 5.

Den mest nærliggende Forklaring paa de vasomotoriske Reaktioners Udbredelse vilde være den, at vi her havde at gøre med en regulær Reflex: at Paavirkningen gennem sensible Nervetraade ledes til Centralnervesystemet og over motoriske Celler og Nervetraade naaede til Karrenes kontraktile Elementer. At denne Forklaring ikke kan være rigtig, fremgaar med Sikkerhed deraf, at Overskæring eller Blokering af Forbindelserne med Centralnervesystemet ikke i mindste Maade influerer paa Reaktionerne, hvilket er konstateret i talrige Forsøg baade med Tungenerver og med N. ischiadicus. Vi har altsaa at gøre med lokale Nerveprocesser af den Art, som kendes gennem Bruces og Bardys[1] Undersøgelser over experimentelle Betændelser i Conjunctiva, der hæmmes ved Kokainisering, men ikke paavirkes af Nerveoverskæring. I Overensstemmelse med Bayliss[1] Paavisning af, at Irritation af sensible Nervefibre medfører Karudvidelse, antager saavel Bruce som Bardy, at det første Led i disse Processer er en Irritation af sensible Nerveender, men medens Bruce ligesom Bayliss antager, at de enkelte sensible Traade sender Fibriller til de nærmest liggende Kar efter Skemaet Fig. 5, I, anfører Bardy Forsøg, der efter hans Mening maa tolkes derhen, at de sensible Traade sender Grene til lokale Ganglieceller, der igen innerverer Karrene (Fig. 5, II). For Frøtungens Vedkommende stemmer de experimentelle Resultater bedst med Bruce's Opfattelse. Hvis Irritamentet ledes til en autonom Gangliecelle, maatte man vente, at alle de Blodkar, der innerveredes fra denne, maatte blive ensartet paavirket, at

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[1] Bruce: Arch. f. exp. Bath. **63**, 424, 1010. Bardy: Skand. Arch. Physiol. **32**, 198, 1915. Bayliss Journ. of Physiol **26**, 173, 1901.

med andre Ord Reaktionens Udbredelse maatte være ret uafhængig af Irritationens Styrke, medens det tværtimod viser sig, at man kan frembringe alle Gradationer i Udbredelse ved at variere Irritamentets Styrke. Disse Gradationer forklares let og simpelt, naar man antager, at den enkelte sensible Nervetraad, der ledsager en lille Arterie, sender Grene dels til denne, dels til de Kapillærer, den forsyner, saaledes som skematisk fremstillet paa Fig. 6. Irriteres en at disse Grene, vil Irritamentet kunne brede sig til dem alle, men hver Gang det passerer en Forgrening, vil det blive svækket ved at fordeles til to Grene, og jo kraftigere den oprindelige Paavirkning er, desto større Areal vil Nerveprocessen kunne udbrede sig til, før den kommer under Tærskelværdien for Reaktionen. Naar Irritamenter af forskellig Styrke kan udløse modsatte Reaktioner, saaledes som det typisk er Tilfældet i Frøens Svømmehud, er det klart, at der maa være to forskellige Sæt af Nervetraade med antagonistiske Egenskaber, og det bliver nødvendigt at anstille særlige Forsøg for at udfinde, hvilke Slags Nervetraade de enkelte Reaktioner maa henføres til. Paa Forhaand er det efter Bayliss Resultater sandsynligt, at Dilatationsreaktionen skyldes Processer i sensible Nervetraade, og da Reaktionen indtræder efter yderst svag mekanisk Paavirkning, der ikke kan tænkes at medføre Smerte, ligger det nærmest at tænke paa Tryksansens Nerver. Med Hensyn til Kontraktionsreaktionerne er det derimod vanskeligt at danne sig nogen Forhaandsanskuelse. At Reaktionen ophæves ved Kokainisering, maatte efter sædvanlig Opfattelse tyde paa, at man havde med sensible Nervetraade at gøre, men paa den anden Side er det velbekendt,


Fig. 6.

at dorsalsympatiske Traade gaar til Arterierne og bevirker deres Kontraktion.

For at løse disse Spørgsmaal har mine Medarbejdere Dr. HARROP og Dr. LIEBERMANN, og jeg foretaget et Antal Nerveirritationer og Degenerationsforsøg.

Frøens Tunge innerveres gennem to Nerver N. glossopharyngeus og N. hypoglossus, af hvilke den sidste hovedsagelig forsyner Musklerne, medens den første er den vigtigste Kirtelnerve. Disse Nervers Rødder og de sympatiske Ganglier, hvorfra de forsynes med postganglionære Traade, er saa vanskelig tilgængelige, at man maa indskrænke sig til at udføre Irritationsforsøg paa selve Nervestammerne. Ved elektrisk Irritation varieret paa mange forskellige Maader er det aldrig lykkedes mig at opnaa nogen Virkning paa Karrene gennem N. hypoglossus, medens jeg i adskillige Tilfælde har set smaa Arterier kontrahere sig efter Irritation af N. glossopharyngeus. Derimod har mekanisk Irritation af begge Nerver, frembragt ved at klemme dem mod en Pincet, en meget tydelig dilaterende Virkning saavel paa Kapillærer som paa Arterier, saa at der efter en Latenstid paa 10—30 Sekunder opstaar en betydelig Hyperæmi med meget livlig Blodstrom. Forsøg med mekanisk Irritation af de enkelte Nerver viser, at N. glossopharyngeus fører dilaterende Traade til største Delen af Tungen, medens N. hypoglossus kun innerverer begrænsede Arealer. Det Forhold, at de vasodilatoriske Traade i Nerverne reagerer stærkt paa mekanisk Irritation, men ikke paa elektrisk, er analogt med det, som BAYLISS har fundet for de vasodilatoriske Traade i N. ischiadicus, hvis Identitet med de sensible han har konstateret, og taler altsaa stærkt for, at ogsaa Tungenervernes vasodilatoriske Traade er sensible.

For Svømmehudens Vedkommende er det muligt at komme Spørgsmaalet nærmere, idet Fibrene af forskellig Oprindelse kan isoleres fra hinanden og irriteres hver for sig. Naar Rødderne til N. ischiadicus opsøges i Rygmarvskanalen og irriteres elektrisk eller mekanisk, faar man ved isoleret Irritation af de bagerste sensible Rødder en meget udpræget Udvidelse af Svømmehudens Arterier, men ingen tydelig Virkning paa Kapillærerne.[1] Ved Irritation af de forreste Rødder faar man Kontraktion af Svømmehudens Arterier. Denne Reaktion fremkaldes ligeledes ved Irritation af de tilsvarende sympatiske Ganglier og udebliver, hvis disse exstirperes, før de forreste Rødder irriteres. Det er altsaa klart, at de konstriktoriske Nervefibre tilhører Dorsalsympathicus.[2]

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[1] I en nylig udkommet Afhandling af Yasukazu Doi (Journ. of Physiol **54**, 227, 1920) angives det, at mekanisk Irritation af de bagerste Rødder ogsaa frembringer Udvidelse af Svømmehudens Kapillærer. Jeg betvivler noget Rigtigheden af denne Angivelse, der vil blive underkastet fornyet nærmere Prøvelse.

[2] I denne Forbindelse bør omtales Arteriernes højst paafaldende Forhold overfor Adrenalin. I Tungen af *R. esculenta* paavirkes de større Arterier overhovedet ikke af Adrenalin, medens de smaa udvider sig ved Paadrypning af 0,1 °/₀ Adrenalin, der har en udpræget dilatatorisk Virkning paa Kapillærerne. I Tungen af *R. platyrrhina* er Virkningen af Adrenalin paa Kapillærene den samme, men mange Arterier bringes til Kontraktion. I Svømmehuden og Huden overhovedet (*R. platyrrh.* og *oxyrrhina*) virker Adrenalin konstriktorisk paa de større Arteriegrene, sædvanlig til en ganske bestemt og skarp Grænse paa hver enkelt Arterie, og udenfor denne Grænse kan Arterierne i de fleste Tilfælde overhovedet ikke paavirkes, ligesom Kapillærerne synes uimodtagelige. I andre undersøgte Væv, som Kroppens og Lemmernes Muskler, kontraherer Arterierne sig til de fineste Grene under Paavirkning af Adrenalin. I Almindelighed løber jo Adrenalinmodtageligheden fuldstændig parallelt med den sympathiske Innervation, og man skulde altsaa vente, at Svømmehudens Arterier ved Irritation gennem Sympathicus kun vilde kontrahere sig til Adrenalingrænsen. Dette er dog ikke Tilfældet, Sympathicus virker helt ud til Arteriernes yderste Ender, baade naar Irritationen sker fra Gangliecellerne i Grænsestrængen, og naar den er lokal, og vi har her

De Resultater, der er opnaaet ved Irritation af de enkelte Nerverødder, har vi faaet bekræftet ved Irritationsforsøg paa N. ischiadicus' Hovedstamme, efter at bestemte Sæt af Fibre var bragt til at degenerere ved Afskæring af Forbindelsen med deres Nerveceller. Saaledes fremkalder Ischiadicusirritation nogen Tid efter Exstirpation af de sympathiske Ganglier IX og X konstant Dilatation af Svømmehudens Arterier og efter Exstirpation af de tilsvarende sensible Spinalganglier Konstriktion, medens det kan paavises, at Traade forløbende gennem forreste Rødder uden at passere de sympathiske Ganglier ikke har nogen Virkning paa Svømmehudens Kar.

Virkningen af Nervefibrenes Degeneration paa de lokale Reaktioner er ikke fuldstændig opklaret. I et Forsøg, hvor Nerverne til højre Side af Tungen var overskaarne, var de lokale Reaktioner efter 8 Dages Forløb afsvækkede og bredte sig navnlig ikke til saa stort et Areal som paa venstre Side, og efter 18—26 Dage kunde der kun frembringes Udvidelser paa Kapillærer og Arterier, der var skarpt begrænsede til de irriterede Steder. I et andet Tilfælde var Virkningen paa Udbredelsen af den lokale Reaktion langt mindre udtalt efter 18 Dage, medens der efter 100 Dage kun fremkom Reaktion paa selve det irriterede Sted. Atter i andre Tilfælde fandtes nogen Udbredelse af Reaktionerne selv efter 3—5 Maaneders Forløb. Forsøgene med Degeneration af enkelte Fiberarter i Baglemmernes Nerver har givet endnu mindre klare Resultater. Efter Overskæring af Ischiadicus' Rødder, hvorefter kun de direkte motoriske Fibre degenerer, ses, som man kunde vente, ingen Virkning. Efter Exstirpation af de sympathiske Ganglier til Ischiadicus bliver

et Exempel paa, at Parallelismen mellem Sympathicus og Adrenalinvirkning ikke er absolut.

efter et Par Maaneders Forløb Kontraktionsreaktionen paa Arterierne meget vanskelig at fremkalde, og i adskillige Tilfælde har kun Kontraktion paa selve det irriterede Sted kunnet tilvejebringes, men efter 4—5 Maaneders Forløb synes det, som om Kontraktionsreaktionen igen kan fremkaldes paa normal Maade og med normal Udbredelse, skønt Irritationen af Ischiadicus giver Dilatation, og sympathiske Fibre altsaa ikke synes at være regenererede. Ganske lignende Forhold gælder for Dilatationsreaktionen efter Exstirpation af Spinalganglierne. Paa et vist Tidspunkt efter Operationen synes Dilatationsreaktionen paa lokal Irritation at være ophævet, samtidig med at Kontraktionsreaktionen yderst let fremkaldes, men senere findes Dilatationsreaktionen paany, skønt Regeneration af sensible Fibre ikke kan paavises og jo ogsaa vanskeligt kan finde Sted, naar de Celler, hvorfra Regenerationen skulde udgaa, er fjærnede.

Her foreligger altsaa det Forhold, at de Endeforgreninger af Nervetraadene, hvorpaa de lokale Reaktioners Udbredelse maa antages at bero, ikke synes at degenerere fuldstændigt efter Overskæring af Forbindelsen med deres Nerveceller, men endog efter en forbigaaende Nedsættelse i Funktionsevnen formaaer at genvinde denne. Dette er i Strid med de almindelige Antagelser, hvorefter det er en absolut Betingelse for en Nervetraads Funktionsevne og endog for dens anatomiske Existens, at Forbindelsen med den tilsvarende Nervecelle ikke er afbrudt. Om Forklaringen paa Anomalien skal søges i Existensen af perifere Nervenet med enkelte Celler, der kan overtage Ernæringsfunktionen, eller i andre Forhold, er det endnu for tidligt at udtale sig om. Indgaaende anatomiske Undersøgelser vil her sandsynligvis blive nødvendige.

Sammenfattes sluttelig de ved Undersøgelserne over Innervationen af Karrene hidtil vundne Resultater, kommer man til følgende almindelige Billede.

I Frøtungen *(R. esculenta)* kan der paavises konstriktorisk virkende Traade til Arterier, men ikke til Kapillærer, hvorimod der er et stærkt udviklet System af dilatatorisk virkende Traad, saavel til Arterier som til Kapillærer. Dette System maa, efter alt hvad der foreligger, antages for at være af sensibel Natur. De enkelte Nervetraade maa forgrene sig i en Mængde Fibriller, og paa Axonreflexer i disse Forgreninger beror de lokale Reaktioners Udbredelse.

I Frøens Svømmehud *(R. temporaria)* er Arterierne konstriktorisk innerverede gennem Dorsalsympathicus. De sympathiske Nervetraades Grene kan paavirkes ved stærk mekanisk Irritation, og gennem Axonreflexer kan lange Stykker af Arterierne bringes til Kontraktion ved Irritation af et enkelt Punkt. De samme Arterier er dilatatorisk innerverede gennem sensible Nervetraade, hvis Endeudbredning reagerer paa svag mekanisk Irritation og gennem Axonreflexer giver Dilatation af længere Strækninger af de paagældende Arterier.[1] Nogen Innervation af Svømmehudens Kapillærer har ikke kunnet paavises med Sikkerhed og maa ialfald være meget svagt udviklet.

Blodets Betydning for Karrenes Kontraktionstilstand.

Det er ovenfor omtalt, at der hverken i Tungen eller i Svømmehuden kan paavises Nerver, der frembringer Kontraktion af Kapillærer. Det er en Iagttagelse, der er gjort

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[1] Spørgsmaalet om Existensen af virkelig antidrom Innervation af Blodkarrene, ɔ: Ledning af Impulser, der fremkalder Dilatation, fra Centralnervesystemet gennem de bagerste Nerverødders sensible Traade, har jeg endnu ikke taget op til experimentel Undersøgelse. Adskillige Forhold tyder paa at saadan Innervation existerer og spiller en betydelig Rolle, og et nærmere Studium er planlagt.

Gang efter Gang, at naar Organerne lades i Ro under saa vidt muligt naturlige Forhold, vil udvidede Kapillærer og Arterier kontrahere sig, og det ligger da nær at antage, at Blodstrømmen paa en eller anden Maade bevirker denne Kontraktion. De første Forsøg herover foretoges paa Frøtungen ved at underbinde Arteriegrene. Det viste sig, at naar der efter nogle Timers Underbinding paany aabnedes for Blodstrømmen, kom der tydelig Hyperæmi med Udvidelse saavel af Arterier som særlig af Kapillærer. Til at fremkalde en maximal Hyperæmi krævedes mindst 12 Timers Standsning af Blodtilførslen. Hyperæmi som Følge af midlertidig standset Blodtilførsel er velbekendt fra mangfoldige tidligere Forsøg saavel paa Frøer som paa højere Dyr, og man har altid forklaret den som en Virkning af den afbrudte Iltforsyning, der fører til Dannelsen af abnorme Stofskifteprodukter, specielt organiske Syrer, der direkte kan gøres ansvarlige for Karrenes Udvidelse. I den udspilede Frøtunge kan denne Forklaring imidlertid ikke med Rette gøres gældende, idet en simpel Beregning viser, at Diffusionen af Ilt fra Atmosfæren er fuldt tilstrækkelig til at dække Vævets Iltkrav. For en Sikkerheds Skyld har jeg gjort Forsøg med Frøer, der opbevaredes i ren Ilt, saa længe Kredsløbet til en Del af Tungen var afspærret. Resultatet blev ganske det samme som i atmosfærisk Luft. I et særlig instruktivt 14 Timers Forsøg viste det sig, at den paagældende Arterie ikke var fuldstændig spærret, idet Blodet i de afspærrede større Arterier og Vener var i netop synlig Bevægelse, medens Bevægelsen i de mindre Kar var altfor langsom til at kunne iagttages. I dette Tilfælde kom der efter Arteriernes Aabning kun en ganske ringe Hyperæmi. En saa ringe Blodforsyning, at den slet ingen Rolle kan spille med Hensyn til Iltforsyningen, er altsaa tilstrækkelig til at opretholde Tungekapillærernes Tonus.

I tilsvarende Forsøg med Svømmehuden viste det sig, at saavel Arterier som Kapillærer her er langt mere følsomme for Spærring for Blodtilførslen, end Tilfældet er i Tungen, skønt Betingelserne for Ilttilførsel fra Atmosfæren er endnu bedre. Allerede efter 20 Minutters Spærring, og selv om den ikke er fuldstændig, kommer det til Hyperæmi med meget stærkt udvidede Kapillærer. Naar Blodstrømmen igen faar Adgang, begynder Kapillærerne hurtig at kontrahere sig, og allerede efter 10 Minutters Forløb kan deres Tonus paany være normal, forudsat at Udvidelsen ikke har været for stærk. Er dette Tilfældet bliver Kapillærvæggene permeable, og det kommer til Exsudation af Plasma og Stase af Blodlegemer.

Den Forklaring paa disse Resultater, som umiddelbart frembyder sig, er, at Blodet maa indeholde et Stof, som paavirker de kontraktile Elementer i Kapillærernes Vægge og stimulerer dem til tonisk Kontraktion.

Tilstedeværelsen af et saadant Stof i Blodet betinger en overordentlig fuldkommen Regulationsmekanisme, hvorved Blodet under den største Økonomi bliver ganske regelmæssig fordelt. Hvis et Kapillær har været spærret for Blod en vis Tid, vil dets Tonus slappes, og Blodet vil strømme igennem, til det paany kan lukke sig. De aabne Kapillærer i Tungen eller i en Muskel vil altsaa bestandig skifte Plads. Det Vævselement, der i et givet Øjeblik ligger langt fra et aabent Kapillær og saaledes bliver daarlig forsynet, vil noget senere faa Blodstrømmen forbi i umiddelbar Nærhed. Intet Parti af Vævet bliver forfordelt, og der økonomiseres til det yderste med Blodet.

I Forbindelse med Dr. Harrop er jeg begyndt at efter-søge dette hidtil ukendte Stof, som betinger Kapillærernes Tonus. Til dette Formaal lægger vi Kanule i den ene Arteria femoralis hos en Frø og arrangerer kunstig Gennemstrømning under et passende Tryk af det paagældende Bens Kar. Under Forberedelserne med Indlæggelse af Kanule o. s. v. er Kredsløbet spærret saalænge, at Kapillærerne i Svømmehuden bliver stærkt udvidede, og lader man nu en Væske strømme igennem, der indeholder det virksomme Stof, vil de paany kontrahere sig. Det viste sig, som man kunde vente, at de kunstige Erstatningsvædsker for Blod: Ringers Vædske og Ringers Vædske med Gummitilsætning er ganske uvirksomme. Derimod er defibrineret Okseblod fuldt virksomt til at restituere Kapillærernes Tonus. Serum fra dette Blod, vundet ved Centrifugering, er ligeledes virksomt.

Anbringes en Kollodiumssæk med Ringers Vædske i frisk defibrineret Okseblod, bliver Saltopløsningen efter nogle Timers Dialyse ligeledes virksom. Denne Vædske kan ophedes til Kogning uden at afsvækkes kendeligt. Det ubekendte Stof findes altsaa opløst i Blodvædsken; det er rimeligvis det samme hos alle Hvirveldyr, og dets Molekule er ikke større, end at det kan diffundere gennem Kollodium, der er absolut impermeabelt for Proteinstoffer. Disse Resultater, som er hvad vi hidtil har naaet, byder, som det vil ses, gode Betingelser for at komme videre og muligvis isolere og bestemme det virksomme Stof. Denne Opgave bliver da den første af den lange Række Problemer, Kapillærernes Fysiologi frembyder, som vi vil søge at bringe frem til Løsning.

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Biologiske Meddelelser. **III,** 4

EXPERIMENTAL PRODUCTION OF TAR CANCER IN WHITE MICE

BY

JOHANNES FIBIGER AND FRIDTJOF BANG

WITH SIX PLATES

1742

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
1921

It is a long recognised fact that the skin, when exposed for a longer period to the action of substances due to incomplete combustion of coal, or to distillation of coal, tar or allied compounds, may become the seat of dermatosis, papillomatous and carcinomatous growth.

As will be generally known, the first observation in this domain was "the chimney sweeps' cancer" (Percival Pott 1775), caused by the influence of the soot; already in the early half of the nineteenth century literature contained a considerable number of reports on this cancer.

Later observations (Volkmann[1], Tillmans[2], Schuchardt[3], a. o.) have shown that cutaneous diseases and cancer of quite a similar type may occur among workers engaged in the manufacture of tar and crude paraffin; and finally it has been reported (Legge[4], Lush[5], Ross and Cropper[6],

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[1] Berl. klin. Wochenschrift. 1874.

[2] Deutsche Zeitschrift f. Chirurgie. 1880, cit. by Schuchardt.

[3] Volkmann's Sammlung klin. Vorträge, No. 257, 1885.

[4] Home Office. Manufacture of Patent Fuel. Special Report on Ulceration of the Skin and Epitheliomatous Cancer in the Manufacture of Patent Fuel, and of Grease. London 1912.

[5] Report to His Majesty's Secretary of State for the Home Department on the Draft Regulations proposed to be made for the Manufacture of Patent Fuel (Briquettes) with addition of Pitch. Presented to Parliament by Command of His Majesty. London 1911. Second Report 1913. Annual Report of the Chief Inspector of Factories and Workshops for the Year 1918, presented to Parliament by Command of His Majesty. London 1919.

[6] The Problem of the Gasworks Pitch Industries and Cancer. London 1913. H. C. Ross: Occupational Cancer. The Journal of Cancer Research. Vol. III. 1918.

HERMAN[1], BAYET and SLOSSE[2], GLIBERT[3], a. o.) that also workers employed in the briquette factories are liable to suffer from similar affections, which are ascribed to the action of the pitch contained in this sort of fuel. Also among workers at petroleum wells a series of cutaneous carcinomata has been observed (ULLMANN[4], a. o.).

The skin affections of the chimney sweeps and those of the tar, paraffin and briquette workers present very great conformities in regard to localisation, development, symptoms and course of disease. In all these workers the affections will make their first appearance — most commonly and most strongly — on the skin of scrotum, and epitheliomatous growth will occur with relative frequency in this region too. The lesions, however, may affect other parts of the body (hands, neck, arms, face, lips).

Initial symptoms are: dermatitis, pigmentation, chronical thickening of the skin, keratosis and warty growths (sootwarts, pitchwarts), after which ulcers and carcinomata of the common malignant keratinising epitheliomatous type may develop.

The quite similar character of these cutaneous affections and their occurrence after the action of substances which may, to some extent, be ascribed to the same origin, most naturally has given rise to the opinion that in all these affections the same or closely allied chemical factors in the strongly composed substances: soot, tar, crude pa-

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[1] Prophylaxie de la maladie du brai. Bull. de l'Académie Royale de Médecine de Belgique. IV Série. Tome XXIX. 1919.

[2] L'intoxication houillère arsenicale. Ibidem.

[3] Contribution à l'étude du cancer professionel. Ibidem.

[4] Ueber das Wesen und die Verbreitung einiger bei der Erdölgewinnung und Paraffinfabrikation entstehender Berufsdermatosen. Das oesterreichische Sanitätswesen. No. 18. 1912.

raffin and pitch, might in reality be made responsible for the irritation of the skin and the development of cancer. Creosote and carbolic acid have been pointed out as dangerous agents, and arsenic, anthracene and aniline as well, but we do not yet possess any real knowledge of the nature of the active substances, and up till now there has been no practicable way whatever of solving this question by means of experimental investigations, because it has hitherto proved impossible to produce cutaneous cancer in animals on exposing their skin either to such composed products as are considered etiological factors, or to various of the chemical compounds contained therein.

It was thus reported by HANAU[1] (1889) that a greater series of experiments, in which for months rats had been painted on the skin of scrotum with pitch or tar (with or without paraffin admixed) has given negative results. CAZIN's[2] investigations (1894) in which for 5 months a dog was brushed with tar and soot on an inflamed area of the skin, did not prove successful either, no more did the experiments of BROSCH[3] (1900) in which the skin of guinea-pigs (after previous bruising) was rubbed with xylol-paraffin for 2—3 months every 3—4 day.

Nor did STAHR[4] (1907) succeed in producing cutaneous cancer by means of injuring and treating the skin of rabbits, mice and rats with xylol-paraffin, soot or tar, — and on rubbing the skin of rabbits' ears with crude paraffin oils (ULLMANN[5] 1912), soot (HAGA[6] 1913), anilinous

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[1] Fortschr. der Medizin. VII. 1889.

[2] Des origines et des modes de transmission du cancer, Paris 1894.

[3] Virchow's Archiv Bd. 162. 1900.

[4] Münch. med. Wochenschrift. 1907.

[5] l, c.

[6] Zeitschr. f. Krebsforschung. 1913. Vol. XII.

ointments (Haxthausen[1] 1916) only epithelial proliferation and no carcinomatous growth was produced. Also on the skin of rabbits' scrotum soot had no effect. (Haga)[2].

Finally a considerable number of investigations have been published most of which were impelled by the renowned experiments of Fischer[3] on the effect of injections with Scharlach R. oil. For subcutaneous injection on the rabbits' ears were used partly various crude paraffin oils (with or without admixture of soot), partly extracts of tobacco tar, coal tar, pitch and the like. Also in these experiments (Meyer[4], Benthin[5], Wacker and Schminke[6], Greischer[7], Ross and Cropper[8], Bayon[9]) the result — when most successful — was only proliferation and some downgrowth of the surface epithelium, but no development of carcinoma.

The first reports on experiments with positive results appeared from Japan in 1915, and were due to Yamagiwa and Ichikawa[10].

These investigations, commenced in 1913, were inspired (Yamagiwa and Ichikawa[10]) by the success of Fibiger's[11]

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[1] Dermatologische Zeitschr. Bd. XXIII. 1916.

[2] Zeitschr. f. Krebsforschung. 1913. Vol. XII.

[3] Münch. med. Wochenschrift. 1906.

[4] Ziegler's Beiträge Bd. 46. 1909.

[5] Zeitschrift f. Krebsforschung. Bd. 10. 1911.

[6] Münch. med. Wochenschrift. 1911.

[7] Zeitschr. f. Krebsforschung Bd. 11. 1912.

[8] l. c.

[9] The Problem of the Gasworks Pitch Industries and Cancer. London 1913.

[10] Experimentelle Studie über die Pathogenese der Epithelialgeschwülste I, II and III. Mittheil. der med. Fakultät der Kaiserlichen Universität zu Tokyo. Bd. XV. 1915. Bd. XVII. 1917. Bd. XIX. 1918. The Journal of Cancer Research. Vol. III. 1918.

[11] Zeitschrift für Krebsforschung. XIII. 1913.

experimental production of cancer on transmission of the *Spiroptera neoplastica (Gongylonema neoplasticum).*

As experimental animals Yamagiwa and Ichikawa used rabbits the ears of which were painted with coal tar every 2nd or 3rd day. The result of these experiments was published in a series of reports, the last of which appeared in 1918.

It will be seen from these reports that papillomatous new growth ("folliculoepitheliomata") may be produced on the rabbit's ear by application of coal tar for 30 to 100 days; that by the repeated application complete carcinoma was produced in 12 out of 196 rabbits, and furthermore that carcinoma was found in its earliest stage in 23[1] and in an early stage in 26 ears[1]. The carcinomatous change was discovered between the 55th and the 360th day, in most of the cases it was found after the 150th day.

The presence of metastasis was microscopically proved in the regional lymph nodes in three cases.

The hyperkeratotic papillomatous new growths continued to grow after the irritant had been discontinued and eventually developed into cutaneous horns. From such horns carcinoma developed in some cases.

Investigations of this kind have hitherto been published by no other author, whereas Bullock and Rohdenburg[2] in 1918 — without having tested the Japanese experiments — expressed their doubt as to Yamagiwa's and Ichikawa's success in producing real carcinoma.

In 1918 information was given by a third Japanese scientist Hidejirō Tsutsui[3], who by painting the skin of

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[1] The number of animals is not communicated.

[2] The Journal of Cancer Research. III. 1918.

[3] Ueber das künstlich erzeugte Cancroid bei der Maus. Gann. Japanische Zeitschrift für Krebsforschung. XII. 2. Juli. 1918.

mice repeatedly with tar had also succeeded in producing hyperkeratosis, papillomatous growth and carcinoma. Only an extremely brief report of these experiments is at hand, from which it appears that out of 67 mice which survived more than 100 days after the beginning of the painting, cutaneous carcinoma developed in 16, sarcoma in 1 mouse. Metastatic nodules were found in the lungs of 2 mice.

Also experiments of this kind are hitherto unpublished from other laboratories.

Finally YAMAGIWA and ICHIKAWA[1] in 1919 reported, that on repeated injection of mixtures of lanoline and tar, or extracts from tar in lanoline into the mammae of 47 rabbits initial stages of cancroids were produced in 3 cases, taking their rise from the large ducts. In a 4th rabbit cancroid developed as well, and in a 5th a myxofibrosarcoma mammae, which produced metastases and according to information in a letter from Prof. YAMAGIWA to FIBIGER proved transplantable.

In spite of BULLOCK and ROHDENBURG's criticism of YAMAGIWA's and ICHIKAWA's statements it has seemed to us to admit of no doubt whatever, that these latter authors have actually succeeded in producing experimentally tar carcinoma of the skin in rabbits, — and the examination of some microscopical preparations which were most kindly sent to FIBIGER by Prof. YAMAGIWA proved the successful result of the experiments.

It seems to us, however, that still more importance must be assigned to the investigations made by TSUTSUI on mice, and not only because, generally speaking, it is

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[1] Experimentelle Studie über die Pathogenese der Epithelialgeschwülste. Mitt. der med. Fakultät der kaiserlichen Universität zu Tokyo. Bd. XXII. 1919.

an essential advantage to use for experimental purposes such animals as mice, that are easily procured and less expensive to breed, but especially because the great majority of previous experimental investigations on cancer — and particularly the transplantation experiments — have been performed on mice, whose relation to cancer, on the whole, must be considered better known than that of any other animal.

In continuation of investigations carried on by Fibiger in the Anatomo-Pathological Institute of the University of Copenhagen with a view to the experimental production of cacinoma, we have then — on the base of the communications given by Tsutsui — entered upon a series of experiments, the preliminary result of which we shall state in the following pages.

Our investigations comprise 2 series of experiments, the first of which (*I*), commenced June 30th 1919, includes *15*, the second (*II*), commenced October 31st 1919, *10* white mice. Ten mice weighed 17—19 grammes, 15 20—27 grammes. 14 were males, 11 females. To this may be added a third series (*III*) made by one of us (F. Bang) and comprising *20* mice, which will be dealt with later on.

All mice were painted every 2—3 day. For painting was used coal tar from the same supply. Application of the tar was cautiously made on the same spot of the skin of the back (between the scapulae).

In order to facilitate the action of the tar upon the skin of the painted area, in the first series the hairs were epilated before the beginning of the paintings, but this procedure was not repeated later on, as it soon turned out that the hairs were removed by the mice themselves or fell off spontaneously.

The results of the two first experimental series will be accounted for together.

In *8* mice (which died 23—34 days after the beginning of the paintings) and in *1* mouse (which died 62 days after the first painting) the skin did not present any special pathological changes except losing of hairs and dubious or quite slight thickenings.

Nor did microscopical examination reveal any pronounced changes. In 4 of these mice (which died respectively 25, 29, 29 and 34 days after the beginning of the paintings) pathological changes could not be traced with any certainty. In 4 mice (which died respectively 23, 27, 33 and 62 days after the 1st painting) partly slight desquamation and thickening of epidermis, partly inflammatory processes were found in corium, which in 3 of these mice contained small foci of lymphocytes and leucocytes, in the 4th (which died 27 days after the 1st painting) small abscesses situated in the connective tissue and the hair follicles.

In the 9th mouse (which died 25 days after the beginning of the paintings) slight downgrowth of the surface epithelium was found. Pronounced or heterotopical proliferation had not developed either in this mouse or in any of the 8 others.

In *1* mouse (which died 89 days after the beginning of painting) similar slight changes were found, whereas in *2* mice (which survived the 1st painting for 121 and 123 days respectively) more advanced desquamation and inflammatory changes had developed. Pathological downgrowth of the epithelium was not, however, detected in any of these animals.

In the remaining 13 mice far more pronounced changes and development of growths — in some cases very violent — were produced. Out of these mice we shall first take 3 which survived the 1st painting for the shortest time (102, 105 and 184 days respectively) presenting less pronounced changes than did the remaining 10 longest lived mice. As the initial effect of the paintings in all mice were found slight changes of the above-mentioned type: losing of hairs, slight thickenings and roughness of the skin, in one of the mice (see below) combined with small fissures. These alterations continued, and after about 3 months (82—86 days) development of small warty or papillomatous nodules was found, in 2 mice (named I_2 and II_{18}) increasing uniformly until the death of the animals, while in the third mouse a nodule developed which fell off after about $4^1/_2$ months and was replaced by a new one about 40 days later. In order to illustrate the progress of the changes in these mice, the following particulars about the last-mentioned mouse are subjoined:

White male mouse named II_{24}, weight 25 grammes was painted from October 31st 1919. On November 18th 1919, 18 days after the 1st application of tar, small fissures were visible on the painted area; 14 days later, on December 1st, an extensive dermatitis with thickenings, fissures, covered all over by a crust had developed. On January 21st 1920, 82 days after the 1st painting, a strongly circumscribed nodule as large as the head of a pin was found on the painted spot in addition to the changes above. In the time following the nodule increased in size, and 28 days later had reached the height of 5 mm, its diameter being about 2 mm.

The growth again decreased in size. On March 15th (26 days later) is noted: The growth has nearly disappeared, but roughness is still to be felt in its place.

Then a new and papillomatous growth developed, the height and diameter of which on April 24th (40 days later on, 176 days after the 1st painting) measured about 2 mm. The mouse died on May 2nd 1920, 184 days after the 1st application of tar.

On microscopical examination the growth, cut in serial sections, was found to be a papilloma of typical structure. The surrounding skin was somewhat thickened, owing partly to hyperplasia of the covering epithelium, partly to proliferation of the elements of the connective tissue of corium, which in and under the papilloma—and in the neighbouring areas as well—contained a considerable number of lymphocytes, leucocytes and mastcells. Heterotopical or invasive downgrowth of the epithelium was not observed.

In this mouse which died 184 days after the beginning of the paintings, inflammatory processes were found in addition to a small papillomatous growth, the structure of which corresponded entirely to that of ordinary papillomata of the skin.

Also the 2 mice mentioned above (which survived the 1st painting for 102 and 105 days respectively) presented typical papillomata (see Plate II figs. 10 and 11) and inflammatory changes. Neither heterotopical downgrowth nor signs of carcinomatous growth were detected in any of these 3 mice.

Quite different changes, however, were found in the other *10* mice which survived the 1st painting for 243—333 days. Not only inflammatory processes and papillomatous growths of far more violent nature had developed in all of them, but besides, pronounced new growth of malignant type (carcinomata and carcino-sarcomata).

The following extract from the journals may demonstrate the development of the pathological processes in these 10 mice. (the letters b. o. p. will indicate: beginning of painting).

Mouse No. 1. (named II_{25}). White female mouse, weight 15 gr. was painted from October 31st 1919. On the 82th day some thickening of epidermis was found besides losing of hairs in the painted area, but 4 weeks later the skin was again smooth. During the following month, however, a small warty nodule developed, having on the 144th day gained nearly miliary size. 32 days later, all in all, 3 small nodules were visible, the largest of which measured about 2 mm in height and about 3 mm in basal diameter. These nodules kept unchanged until the 213th day after b.o.p. on May 31st 20, when infiltration was observed at the base of one of the papillomatous growths. 9 days later the infiltration was pronounced and painting was now discontinued. 243 days after the first painting (June 30th) a group of small papillomata had developed, and in the deeper layers an infiltration of the size of a pea was found. The mouse was then killed (weight 21 gr). The infiltration proved to be a whitish, partly solid, partly necrotic nodular mass containing horny tissue. Parts of the growth were used for transplantation (see below page 24). In the lymphatic glands and other organs no pathological changes.

On microscopical examination the non-transplanted remaining part of tumor was found to be a papillary, strongly keratinising carcinoma (type: *Epithelioma malignum*), infiltrating the connective tissue of corium and the underlying muscular layer (see Plate IV fig. 20). Axillary glands and lungs were cut in serial sections, presence of metastases not detectable.

Mouse No. 2. (named I_9). White male mouse, weight 25 gr painted from June 30th 1919. For the first 6 months the painted area did not present any special pathological changes except losing of hairs and roughness of the skin. Not until January 21st 1920, 205 days after b.o.p. a nodule was observed on the thickened skin, nearly as large as the head of a pin. The increase of the growth during the repeated paintings was very slight. On March 15th 20 a new, quite small papillomatous nodule of the same kind had developed. The mouse died on April 4th 20, 279 days after b.o.p., its weight being then 18 gr. Lymphatic glands and other organs normal.

Microscopical examination of the painted area showed besides proliferation of the fibrillar elements of the connective tissue, foci of lymphocytes and mast cells situated in corium, in the place of one of the tumors moreover, pronounced thickening with downgrowth of epidermis and keratinised retort—shaped cystic cavities,—whereas, corresponding to the other nodule, atypical downgrowth of the surface epithelium as irregular strands, containing epithelial pearls and horny globes, infiltrated the underlying connective tissue of corium (*Epithelioma malignum*, see Plate II fig. 12). The axillary lymphatic glands as well as the lungs were cut in serial sections. No metastases were found.

Mouse No. 3. (named II_{20}). White male mouse, weight 25 gr painted from October 31st 1919. As early as the 18th day after b. o. p.

not only losing of hairs, but also fissures were observed in the painted area of the skin. These fissures, however, soon disappeared, and about $2^3/_4$ months (82 days) after the 1st painting the skin appeared nearly normal and continued to be so for some time. On April 24th 1920 (176 days after b.o.p.) a papillomatous nodule of miliary size was found, which 5 weeks later had attained a height and diameter of about 4 mm. During the following month several small flat papillomatous nodules developed, which, however, again disappeared. 276 days after b.o.p. (August 2nd 20) an area of the skin measuring 8 mm by 9 mm was felt to be infiltrated, and on pressing this part a small amount of necrotic cellular masses could be squeezed out. The mouse died on August 7th 1920, 281 days after b.o.p. Post mortem examination showed the papillomatously changed surface of the skin to be covering a tumor-like thickening nearly as large as a pea and non-adherent to the muscles of the back. No metastases were found in the lymphatic glands nor in other organs.

On microscopical examination of the papillomatous growth its central part was found to be the seat of a strongly advanced necrosis, consisting of enormous layers of keratinising epithelial cells, the structure of which like that of the scarce elements of the connective tissue in most places was lost, owing to the very extensive necrosis. Also in the underlying part of corium necrosis had taken place in addition to strong inflammatory processes and purulent infiltration. On the margin of the papillomatous necrotic area the structure, however, was perfectly infact, and here a typical downgrowth of strands of flat-celled epithelium was seen, containing horny globes and epithelial pearls and invading the deeper layers of the connective tissue and the muscles *(Epithelioma malignum).* Axillary lymphatic glands and lungs were cut in serial sections but no metastases were found.

Mouse No. 4. (named II_{17}). White male mouse, weight 25 gr painted from October 31st 1919. After the usual initial changes a distinct crust was found on January 21st 1920 on the painted area. 192 days after the b.o.p., moreover, infiltration of the skin, and 3 weeks later a small papillomatous nodule was observed. Some few days later this nodule, however, fell off, leaving a small ulcer with thickened margins. This ulcer gradually increased in size, a necrotic mass could be squeezed from out its borders, and 264 days after the b.o.p. it had reached nearly the size of a pea, being on its surface covered by a crust of secretion and tar. From its margin an infiltration extended 2—3 mm into the surrounding tissue.

12 days later the ulcer measured 14 mm by 17 mm. The paintings were now discontinued. 16 days later the ul-

cer measured 15 mm by 17 mm and was covered by a high conical-shaped crust of tar and cellular masses as hard as bone (see Plate I fig. 3). This crust being on the point of loosening consequently was removed, and the underlying layer, covered with pus, was washed with a normal saline solution. The mouse died on August 28th 1920, 302 days after the b.o.p. Weight 20 gr. The ulcer then measured 21 mm by 21 mm. No metastasis formation in the lymphatic glands and other organs.

Microscopical examination showed the ulcer to be due to necrosis of the surface of a typical non-keratinising flat-celled carcinoma with invasive downgrowth into the muscles of the back.

Axillary lymphatic glands and lungs were cut in serial sections. Metastases were not found.

Mouse No. 5. (named I_5). White female mouse, weight 20 gr painted from June 30th 1919. After the usual initial symptoms a small nodular growth developed, which 191 days after b.o.p. (on January 7th 1920) had gained the size of the head of a pin, presenting a month later the aspect of a cutaneous horn, the height of which measured 7 mm, the diameter being 4,5 mm. The paintings were discontinued on February 9th 1920, 224 days after their beginning. (The size of the cutaneous horn is seen from Plate I fig. 4).

In spite of suspended painting the horn increased in size, and nine days later had gained the height of 8 mm, a quite similar, but somewhat smaller nodule having at the same time developed next to it. In the following period small quickly growing papillomata constantly arose. On April 3rd 1920, 278 days after b.o.p. infiltration was found at the base of the papillomata, increasing very conspicuously during the following time in depth and extension, while the papillomata broke off and the painted area was covered with irregular horny masses presenting the appearance of cutaneous horns (see photograph from April 14th Plate I fig. 5). On April 20th the infiltration had reached the dimensions of 5 mm by 10 mm. The mouse was killed on May 10th 1920, 315 days after b.o.p. weight 20 gr.

Metastases were not found in lymphatic glands nor in other organs which were all perfectly healthy. In the painted area of the skin infiltration was found measuring 8 mm by 10 mm.

Microscopical examination showed a strongly keratinising papillary carcinoma (of the type: *Epithelioma malignum* see Plate II fig. 14), extending invasively into corium and muscular layers. The axillary lymphatic glands and the lungs were cut in serial sections. No metastases were found.

Transplantation experiments gave negative results.

Mouse No. 6. (named I_{15}). White female mouse, weight 24 gr was painted from June 30th 1919. Not until January 21st 1920 205 days after b.o.p. was found a quite unquestionable thickening of the skin on the painted area, where 3 weeks later (February 10th) a nodule as large as the head of a pin had developed. During the following time this nodule gradually increased in size, and on February 23rd had gained the height of about 4 mm (see photograph from this day, see Plate I fig. 1). On March 5th 1920, 249 days after b.o.p. a papillomatous growth was observed measuring 5 mm in height, and separated from this, an ulcer the diameter of which was about 3 mm. The paintings were now discontinued. On March 15th an infiltration of the surrounding skin was seen to enclose the ulcer like an elevated margin, the diameter of which was 9 mm. The growth constantly increased in size. On March 18th necrotic cellular masses could be squeezed from its base. On April 24th an area of 9 mm by 14 mm was found to be partly ulcerated, partly covered with horny masses (see photograph from April 14th, see Plate I fig. 2).

The mouse died on May 15th 1920, 320 days after b.o.p., weight 19 grammes.

Besides the local changes no pathological processes were found. No metastasis formation.

Microscopical examination of the painted area showed a typical carcinoma with invasive downgrowth (of the type: *Epithelioma malignum* with strongly pronounced keratinisation) (see Plate III fig. 15). The axillary lymphatic glands and the lungs were cut in serial sections. An enlarged axillary gland was, to a great extent, destroyed by carcinomatous tissue of quite the same structure as the mother tumor (see Plate III fig. 16).

Mouse No. 7. (named 1_{12}). White male mouse, weight 20 grammes, painted from June 30th 1919. Beyond the usual initial processes no particular changes were met with until the 204th day after b.o.p., when thickening of the skin was found in the painted area. 41 days later, a nodule nearly as large as the head of a pin had, moreover, developed, but did not apparently increase in size during the following month. On April 8th 1920 was noted: the papilloma-like nodule is covered by a crust of tar, fissures are found at its base. On April 24th: No infiltration is to be detected at the base of the growth. On May 10th: several small new papillomatous growths and some infiltration (315 days after the first painting).

The mouse was killed on May 26th 1920, 331 days after

b. o. p. Weight 22 grammes. Besides local changes no pathological findings. The axillary glands normal.

Microscopical examination of the painted area showed tumor to be a papillomatous carcinoma with strong keratinisation and heterotopic invasive downgrowth of strands of flat-celled epithelium admixed with horny globes and epithelial pearls (type: epithelioma malignum).

The axillary lymphatic glands and the lungs were cut in serial sections. Metastases were not detected.

Transplantation experiments gave negative results.

Mouse No. 8. (named II_{23}). White male mouse. Weight 20 grammes, painted from October 31st 1919. 18 days later the skin of the painted area appeared slightly thickened and remained so for the following 2 months. On January 21st 1920 it was covered by a crust. These changes, however, healed up, and on February 18th 1920 the skin was again quite smooth. 176 days after b. o. p. a papillomatous growth had developed, measuring 2 mm by 2 mm. It increased in size and on the 213th day had attained a height of nearly 6 mm, a smaller new nodule having developed next to it.

14 days later, initial infiltration was found at the base of the papilloma. The paintings were now discontinued on the 231st day after their beginning (June 18th 1920). During the following 2 weeks the growths decreased in size and 241 days after b. o. p. only an ulcer was seen on the painted area covered by a crust of blood. From this ulcer a conical-shaped cutaneous horn now developed, measuring 15 mm in height and 17 mm in basal diameter 35 days later. At its base extensive infiltration was found.

The horn increased very quickly in size (see Plate I figs. 6—9).

August 18.	292	days	after	b.o.p.	its height was	24	mm.	its diameter	22	mm.
August 28.	302	—	—	—	—	29	-	—	21	-
Sept. 10.	315	—	—	—	—	33	-	—	23	-
Sept. 23.	328	—	—	—	—	36	-	—	23	-

The mouse fell off more and more, lost its hairs and died on September 28th 1920, 333 days after the first painting, its weight being then 21.7 grammes.

Post mortem examination showed the conical-shaped tumor to consist of firmly concreted necrotical masses, covered on their surface by a hard crust. On microscopical examination its base presented itself as a keratinising carcinoma (type: epithelioma malignum), growing invasively into the muscular layers of the back. Towards the surface, the tumor tissue passed into closely packed strands of horny cells with faintly staining nucleus, or into horny masses without nuclei. Everywhere leucocytes and lymphocytes were abundant.

The axillary lymphatic glands and the lungs were cut in serial sections. Metastases were not detected.

Mouse No. 9. (named I_{13}). White female mouse, weight 20 grammes, painted from June 30th 1919. 153 days after b. o. p. fissures of the skin were observed in addition to some thickening, and 38 days later a nodule somewhat larger than the head of a pin had developed, but after a fortnight it again disappeared, leaving in its place an excoriated area with slight marginal thickening. The paintings were now discontinued, 205 days after b. o. p. During the succeeding time a small ulcer with partly thickened elevated margin, resembling a rodent ulcer, was observed and constantly increased in size.

The mouse died on May 17th 1920, 322 days after b. o. p., weight 15 gr. The ulcer then measured 5 mm by 10 mm. Beyond the local changes no pathological findings were seen, an axillary gland was enlarged nearly to the size of half a pea.

Microscopical examination of the painted area showed the thickened wall-like border of the ulcer to consist partly of a strongly keratinising carcinoma of the type: epithelioma malignum, partly—on the limit of this carcinoma and distinctly separated from it—of a small nodule situated in corium and built up by strongly polymorphonucleated faintly staining sarcoma-like cells, several of which were plurinuclear, and small giant cells (see Plate III fig. 17 and 18). In this place it proved impossible to distinguish between the stroma and the real tumor parenchym. Unquestionable epithelial cells or keratinised cells were nowhere found, and the covering epidermis was normal. Foci of lymphocytes, leucocytes or inflammatory processes of other kinds were not detected. In preparations stained according to Mallory's method, a distinct fine fibrillar reticulum presented itself deep blue, but also in some of the neighbouring areas such fine fibrillæ could be found here and there. Typical spindle cell sarcoma was not detectable.

In the enlarged axillary lymphatic gland metastatic deposits of a typical strongly keratinising carcinoma were observed (see Plate III fig. 19). No signs of sarcoma. The lungs were cut in serial sections. No metastases.

Mouse No. 10. (named I_{14}). White female mouse, weight 19 gr painted from June 30th 1919. After losing of hairs and slighter thickening of the skin, a small papillomatous nodule had developed on the 114th day after the first painting. On December 1st, 40 days later, this had, however, again vanished, leaving in the painted area only a dermatitis with crust and fissures. On December 20th (173 days after b.o.p.) a small nodule had again developed and during the following time increased in size, being as big as a pea on January 21st 1920 (205 days after b.o.p.) and resembling a cutaneous horn. The paintings were now discontinued. On January 23rd was noted: tumor takes its rise exactly from the middle of the painted area, it is of the size of a pea and ulcerated at the base, its diameter being there 7 mm. Its height measures 5 mm (see Plate IV fig. 22). During the following time the growth increased very rapidly, and on February 4th 1920 measured 12 mm by 5 mm (see Plate IV fig. 23). The ulceration at the base was now more pronounced, rugged and rough on its surface. On February 18th most of the ulcerated area was found to be covered by horny masses, the primary cutaneous horn being now 13 mm in height (see Plate IV fig. 24). On March 5th extensive deep infiltration was noted; tumor measured now from side to side 14 mm in basal diameter, its height being 15 mm from the base to the point of the cutaneous horn (see Plate IV fig. 25). The mouse was killed on March 13th 20, 257 days after b. o. p. (see Plate IV fig. 26). Its weight on death was 19 gr.

Post mortem examination showed tumor to consist of a superficial horn-like part, built up by keratinising cells (cutaneous horn) and a whitish, softer basal part (see Plate IV fig. 27) reaching far down into the subcutaneous tissue and the upper muscular layers, but without growing invasively into the deep muscles of the back.

Parts of the basal region of tumor were used for transplantation (see below pag. 27). The remainders weighed 130 centigrammes.

There was no swelling of the regionary lymphatic glands. No metastatic deposits in the lungs, and no other pathological findings.

Microscopical examination showed tumor to consist partly of thick layers of all but necrotical strongly keratinising cells building up the superficial cutaneous horn, partly of invasive downgrowth of strands and nests of flat cells admixed with numerous strongly keratinising epithelial pearls (see Plate V fig. 28). The epithelial elements were situated in a stroma of connective tissue that in some places was only scarce, in others very rich in cells and built up by closely packed spindle cells (see Plate V fig. 29). In some areas these elements would be so predominant as to make the tumor tissue appear as a spindle cell sarcoma (see Plate V fig. 30 and Plate VI fig. 32), only here and there admixed with a few epithelial cells and strands of epithelium. In other places, in which the epithelial elements were more abundant, the structure presented a picture similar to that of a carcino-sarcoma (se Plate V fig. 31), and, in fact, the tumor tissue represented the pure epithelial type only in smaller limited areas, where the carcinoma partly belonged to the type: Epithelioma malignum.

The axillary and cervical lymphatic glands and the lungs were cut in serial sections. No metastases were found.

As will be seen from the above reports, the initial processes in these longest lived 10 mice, as well as in those mentioned before, consisted in losing of hairs, more or less pronounced thickening and roughness of the skin, in some cases accompanied by crust or fissure formation.

After this, in all the mice, more or less warty small growths developed, arising at different points of time and at the earlist to be seen about 4 months (mouse No. 10), at the latest about 8 months (mouse No. 7) after the first painting. These growths gradually assumed the form of process-like or warty papillomata, but, as a rule, after some time fell off, either leaving a bleeding slightly rough ulcer (see mouse No. 4 and No. 9), or being replaced by new, in some mice multiple growths of the same kind. The rate of growth of these papillomata was extremely rapid, they were covered by thick layers of keratinising epithelium, and on the surface of the ulcers deposits of secretion and necrotic horny cells were found. By these processes in several cases (especially in mouse No. 4, No. 8 and No. 10) conical-shaped cutaneous horns of such enormous dimensions developed, that their size nearly corresponded to one third or half of the total size of the mouse (see Plate I, figs. 3 and 8—9).

As later predominant phenomena, furthermore, in most cases an extensive, often wall-like thickening and infiltration could be seen at the base and margin of the large strongly keratinising papillomatous growths and cutaneous horns, and of the ulcers, due to the falling off of the papillomata. Such more or less pronounced infiltrations could at the earliest be demonstrated (on palpation or inspection) with certainty about 7 months after the first painting, and, as a rule, increased considerably until the death of the mice, in some cases then presenting the size of a pea or more.

In accordance with the statements of Yamagiwa, Ichikawa and Tsutsui it was proved in our experiments that the growth of such infiltrations, developed at later junctures, like the growth of the large papillomata and cutaneous horns, not only did not cease, but actually continued with unchanging energy until the death of the mice, even if the tar paintings were discontinued. The table below demonstrates this fact, as far as 6 of the mice are concerned. Noted in days passed since the first painting, the moment of suspension of the painting is contained in the 1st column, the day of death of the mice in the 2nd column, and finally, in the 3rd column the days passed between these two junctures, viz. the period in which the papillomata, cutaneous horns and ulcers have continued their growth with undiminished power.

Mouse No.	Painting suspended	Death of the mouse	The changes increased (until the death of the mouse) for:
4	276	302	26 days.
10	205	257	52 —
6	249	320	71
5	224	315	91
8	231	333	102 —
9	205	322	117

The accompanying photographs will further illustrate the enormous dimensions of the papillomata and cutaneous horns, and their great increase after suspension of the paintings (see Plate I, figs. 1—9, and Plate IV, figs. 22—26).

Microscopical examination of the changes met with in 8 of these mice (No. 1—8) showed the papillary growths and cutaneous horns —. especially in the upper parts most distant from their base — to consist, to a great extent, of deposits of horny and necrotical masses in which faintly staining epithelial cells and fine spurs of degenerating and decomposed connective tissue could indistinctly be traced here and there. In deeper layers the structure was more intact and often distinctly papillary, ramified spurs or septa of connective tissue being situated in enormous layers of keratinising epithelium of typical structure with admixture of lymphocytes, leucocytes and remainders of necrotical epithelium. In the deepest basal parts and infiltrated borders of the growths as well as in the thickened ground of the ulcers, typical flat celled carcinoma was found, representing in mouse 2 an early (see Plate II, fig. 12), in the others a more advanced stage. In mouse No. 4, in which, on death, the lesions presented the aspect of a rodent ulcer, the carcinoma disclosed but little tendency to keratinisation, whereas in the other 7 mice it contained numerous horny globes and epithelial pearls, and in most of the cases more or less perfectly corresponded to epithelioma malignum of typical structure. In 7 animals the invasive downgrowth reached down into the cutaneous muscular layers, penetrating it to some extent, while in the 8th case (mouse No. 2) it had only invaded the connective tissue of corium.

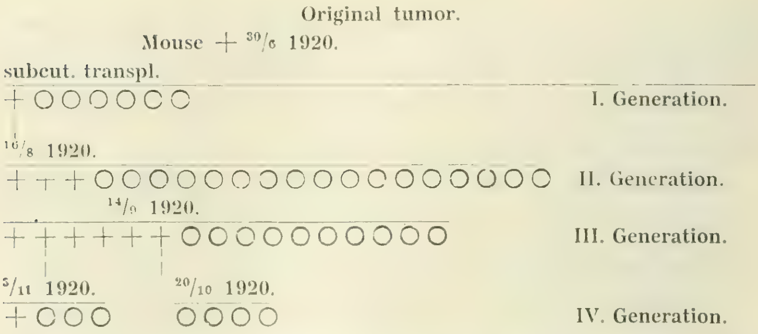
The adjacent part of the skin partly showed collateral hyperplasia of the epithelium, partly more or less pronounced inflammatory processes chiefly consisting of foci of lymphocytes, leucocytes and slighter proliferation of the elements of the connective tissue. Often the amount of mast cells was strongly increased.

In mouse No. 6 an axillary lymphatic gland was found to be the seat of extensive metastatic deposits of strongly keratinising carcinoma of the same structure as the primary tumor (see Plate III, figs. 15 and 16). Neither in lungs, lymphatic glands, nor in other organs of any other of these 8 mice were metastases detected.

Attempts were made in 3 cases to transplant the developed carcinomata (mouse No. 1, No. 5 and No. 7), but in 2 cases without success (mouse No. 5 and No. 7). It ought, however, to be noticed that for these transplantations only such a small number of mice was available that the negative result of the experiments, in reality, could not surprise, and the less so as transplantation of strongly keratinising tumors will frequently meet with great difficulties.

On the other hand, subcutaneous transplantation of the carcinoma of mouse No. 1 gave positive results. These experiments may be seen from the following schematic table (see page 24), in which the mice inoculated successfully are marked with +, the mice inoculated unsuccessfully with O.

As will be seen from the table, tumor could not by far be classed among the easily transplantable tumors, and its propagation in the mice inoculated only took place so slowly that subcutaneous nodules as large as hemp seeds or kernels of nuts did not develop till 4—6 weeks after transplantation. Nevertheless, it is justifiable to ascribe to this tumor a transplantability which must be regarded as



very remarkable, considering that the tumor was a carcinoma with strong tendency to keratinisation, (see Plate IV, figs. 20 and 21). That, as a rule, keratinising tumors will present far greater difficulties with regard to transplantability than did the carcinoma here recorded, is seen from the observations of Murray[1] and Haaland[1] mentioned in one of Fibiger's previous papers.[2]

All in all, the changes found in all these 8 mice must be characterised as combinations of strong development of keratosis with papillomatous growth, cutaneous horns and carcinomata.

According to the above observations regarding the development of the process in the live mouse, the supposition seems obvious that the carcinoma appeared as a secondary and final process, as a complication to primarily developed papillary growths. Nevertheless, we wish to emphasize distinctly that the microscopial examinations hitherto made by us do not as yet admit of any definite fixation of the consecutive order of the processes, nor of any decision as to whether or not the development of carcinoma be —

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[1] Third and Fourth Scientific Report of the Imperial Cancer Research Fund 1908 and 1911.

[2] Det Kgl. Danske Videnskabernes Selskabs Biologiske Meddelelser I_{14} 1919.

especially or at all — bound to the base of the papillomata, and neither do we — at the present stage of the investigations — see our way to form any judgment as to whether any special importance must be assigned to the epithelium of the hair follicles as an original starting point for the development of carcinoma, as it has been maintained by YAMAGIWA and ICHIKAWA[1] with regard to the tumors developed in tar painted rabbits.

For the solution of these questions investigations will be required which are not — like those of this paper — mainly confined to the advanced stage of the processes, and carried out with the chief aim of identifying their nature without a thorough study of the nicer details.

Besides carcinomatous changes as the above described, processes of a different kind were found in 2 mice (No. 9 and No. 10).

The presence of a typical keratinising carcinoma in mouse No. 9 was already ascertained beyond doubt by the microscopical examination (see page 18), and furthermore, was proved by a strongly developed carcinomatous metastasis in an axillary lymphatic gland (see Plate III, fig. 19).

But more consideration was required to determine the nature of the small tumor growth (see Plate III, figs. 17 and 18) adjacent to the carcinoma and situated in the corium, the structure of which tumor brought to mind that of certain types of polymorphous cell sarcomata, among others that of some sarcomata, found in rats (CLUNET[2] (X-ray sarcoma) BULLOCK and ROHDENBURG[3] (cysticercus-sarcoma).

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[1] l. c.

[2] Recherches expérimentales sur les tumeurs malignes. Paris 1910.

[3] Journal of Cancer Research. Vol. II. 1917.

HAALAND[1] who, while studying the secondary development of sarcoma from the stroma in transplanted originally pure carcinomata in mice, has described tumor structure of a similar kind, points out the difficulties one finds, at certain stages of the development of such sarcomata, in distinguishing between the elements of the latter and those of the carcinoma. After thorough examination, we must maintain our previously quoted[2] identification of the tumor in question as a polymorphous cell sarcoma and the total tumor growth as a carcino-sarcoma.

On the other hand, any discussion about the nature of the growth observed in mouse No. 10 is precluded. In this case we are placed before a mixed tumor built up in some places only of a keratinising squamous cell carcinoma, in others only of a typical spindle cell sarcoma, and finally, in certain areas of a mixture of both these components, as will be seen from the subjoined figures (Plate V, figs. 28—31, Plate VI, fig. 32).

As these demonstrate, the diagnosis: carcino-sarcoma must be considered conclusive solely on the base of the histological examination, but it is furthermore supported by the outcome of the transplantation experiments which are illustrated by the following table and by the figures (Plate VI, figs. 33—37).

These inoculations like those mentioned above were effected by means of a hollow needle like the one employed in the Imperial Cancer Research Fund's laboratories. Only 2 mice were inoculated intraperitoneally (with positive result), all the other mice subcutaneously.

It will be seen from the table that transplantation of tumor tissue from this mouse has been carried on—up till now—for 9 months and 11 generations[3]). In the first transplantation inocula-

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[1] l. c.

[2] Compt. rendus de la Société de Biologie. 1920.

[3] Further transplantations have been performed up till now (February 1921) with the same success in 2 generations.

	Transplantations made from: (number of mice)	Carcino sarcoma	Pure spindle cell sarcoma	○	Total
I. Generation (from)	1. ($^{13}/_{8}$ 1920	6	15	3	24
II. — a. —	2.	0	21	2	23
b. —	4.	0	7	6	13
b$_1$. —		0	10	6	16
b$_2$. —		(0)	(0)	(16)	(16)
III. — —	6.	0	22	6	28
IV. — —	5.	0	20	9	29
V. — —	2.	0	9	5	14
VI. — —	2.	0	10	4	14
VII. — —	3.	0	14	4	18
VIII. — —	4.	0	12	8	20
IX. — —	1.	0	4	4	8
X. — —	1.	0	5	1	6
XI. — —	2. ($^{15}/_{12}$ 1920)	0	8	2	10
		6	157	60+(16)	223+(16)

tion was made subcutaneously into 25 mice, one of which died already on the tenth day after transplantation. In 21 of the surviving 24 mice, tumors developed, being in 6 cases carcinosarcomata of the same type as the primary tumor (see Plate V fig. 29 and Plate VI fig. 36), whereas, in 15 mice, tumors were produced which on microscopical examination (most of them cut totally in serial sections) appeared as pure spindle cell sarcomata (see Plate VI fig. 37).

In 10 succeeding transplantations into, all in all, 199 mice, 142 of which gave positive result, only pure spindle cell sarcomata of the same homogeneous type developed.

The transplantations II b, II b$_1$ and II b$_2$ were all made with material from the same 4 mice, but the transplanted material used in transplantation II b$_1$ and in transplantation II b$_2$ had been conserved for respectively 7 and 14 days at a temperature of $\div$ 12—14° C. As will be seen from the table, conservation of the material for 7 days at this low temperature did not diminish the positive results of the transplantations, whereas transplantations with the same material having been exposed to the same low temperature for 14 days, gave only negative results. That these last negative results were not due to spontaneous immunity of the inoculated mice was shown by re-inoculations of 13 of these 16 mice with a fresh (not-frozen) material which in 12 mice gave positive results (3 of the 16 mice died too early after the 1st inoculation, and thus were not re-inoculated).

The tumor has thus been transplanted with positive results into 163 out of 223 mice (73 %).

The growth of the inoculated tumor pieces took place at an extraordinarily quick rate, so that in numerous mice, already after 2—3 weeks, tumors as large as dates or plums had developed (see Plate VI figs. 33—35), disclosing, however, at this juncture a tendency to necrosis and hemorrhage. Not unfrequently these tumors were the seat of extensive necrosis and ulceration after 4—6 weeks.

Thus, the carcino-sarcoma of this mouse (No. 10) proved to be easily transplantable, but only in a small number of the inoculated mice of the 1st generation did carcino-sarcoma develop, pure spindle cell sarcoma being produced in the majority of the mice of this generation and in all later generations.

With this case a new observation is added to the well-known examples already at hand, concerning the power of the sarcomatous tissue of overgrowing quickly and totally superseding the carcinomatous tissue on transplantation of mixed tumors in mice. Bashford[1] has reported 2 cases, in which spontaneous carcino-sarcoma in mice already on the 1st transplantation gav rise only to pure spindle cell sarcomata and continued to grow as such in all later generations; and the numerous renowned observations of secondary development of sarcoma in transplanted carcinomata in mice (Ehrlich, Apolant, Loeb, Bashford, Haaland, Russel, Clunet, a. o.) have also long ago proved the supremacy of the sarcomatous tissue which sets in sooner or later.

Apolant[2] has shown that the influence of cold (÷ 10° C.) for 15 days upon artificial mixtures of carcinoma and spindle cell sarcoma from mice may injure the sarcomatous

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[1] Fourth Scientific Report of the Imperial Cancer Research Fund. 1911. pag. 165—166.

[2] Zeitschrift für Krebsforschung Bd. VI. 1908.

tissue to such an extent as to make only carcino-sarcoma or pure carcinoma develop on transplantation of the tumor mixture, whereas, on transplantation of the tumor mixture which has not at all or only for a few days been exposed to the action of the cold, either pure sarcoma or sarcoma with minimal admixture of carcinoma will develop.

As will be seen from the explanation adjoining the table above, similar experiments were made with our tumor for the purpose of injuring the tumor tissue by exposing it to the action of cold, to such an extent as to give rise to a further development of carcinomatous elements possibly present. These experiments, however, gave only negative results.

The development of carcino-sarcoma has, as commonly known, been explained — especially on the base of the above-mentioned observations of sarcomatous growth in transplanted, originally pure carcinomatous tumors — as a result of an influence exercised by a primary carcinoma upon the stroma of connective tissue, and, no doubt, it cannot be precluded that also the carcino-sarcomata in our two cases (No. 9 and No. 10) may in their earliest stages originally have been pure carcinomata produced by the tar painting.

To this explanation, however, the objection may be raised that the majority both of carcinomatous and of sarcomatous elements in the examined parts of the tumor of mouse No. 10 were dispersed in mutually separated, only to some extent confluent areas, and that the same arrangement in a still more pronounced form was refound in the tumor from mouse No. 9, in which, in fact, the mixture of both components was so slightly pronounced that the tumor might also be explained as a growth composed of a carcinoma in contact with a quite adjacent neighbouring sarcoma (see Plate III, fig. 17). It must furthermore be taken into consideration that in a mouse painted with tar by TSUTSUI[1] a spindle cell sarcoma developed which, according to an adjoined illustration, seems to have contained no carcinomatous elements whatever. If the sarcomatous growth be due in this case to the action of a primary carcinoma, the latter must have disappeared completely by the time when the sarcomatous tumor had developed. It seems, however, just as likely, that the tar painting in this case may have caused primary development of sarcoma without any preceding carcinomatous growth, in analogy with the fact that influence of other kinds that generally produce development of carcinoma, may exceptionally give rise to sarcomatous growth, for which special peculiarities of the influenced elements of the connective tissue may possibly be made responsible.

J. CLUNET[2], MARIE, J. CLUNET and RAULOT LAPOINTE[3] have thus in 2 cases produced sarcoma in rats by means of X-rays in analogy with the cases of Roentgen sarcoma observed in man (PORTER and WOLBACH[4] a. o.) although the X-rays, as known, will generally only give rise to carcinoma. Also the reports on aniline tumors, which are, as a rule, carcinomatous, contain one observation of sarcoma (REHN[5]).

Thus, the production of carcino-sarcomata, according to our view, must not be ascribed only to a secondary development of sarcoma impelled by a primarily developed

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[1] l. c.

[2] l. c.

[3] Bull. de l'Association Française pour l'Étude du Cancer. 1912.

[4] Zeitschrift f. Krebsforschung Bd. XIII. 1913. pag. 559.

[5] Archiv f. klin. Chirurgie. 1895. Bd. 50.

carcinoma, but may also be due to the fact that the development of the carcinomatous components of the tumor tissue and the development of the sarcomatous components may both be co-ordinate effects of one and the same factor which has influenced epithelium and connective tissue coincidently. It seems to us that this explanation can hardly be precluded, neither in the cases here recorded where tar painting gave rise to the tumor growth, nor in cases of spontaneous primary carcino-sarcoma of unknown origin.

Hence, the total result of the above 2 series of experiments will, in the first place, generally speaking be that in agreement with the statements of Tsutsui it does not cause any difficulty to produce cutaneous carcinoma in mice experimentally on painting their skin with coal tar for a longer period every 2nd—3rd. day.

In all 10 mice which survived the 1st painting for at least 243 days, a malignant tumor developed, being in 8 cases a typical — more or less — keratinising carcinoma, in 2 mice, carcino-sarcoma. In 2 mice carcinomatous metastases were found in the lymphatic glands, in 2 cases (mouse No. 1 and mouse No. 10) tumor proved to be transplantable.

This outcome of the 2 series of experiments has now been confirmed by the result of a 3rd, made by one of us (Fridtjof Bang). This series was carried out as an introduction partly to a further study of the histological processes and their development, partly to a more definite fixation of the point of time, at which the cancer begins.

For this purpose, in the 3rd series the microscopical examination of the changes was not put off till the death of the mice, diagnostic excisions being performed in several cases (as done by YAMAGIWA and ICHIKAWA in their experiments on rabbits) as soon as the presence of deep downgrowing infiltration was proved by means of palpation or inspection.

For the rest, this series of experiments did not differ from those dealt with in the preceding pages. The mice were painted every 2nd—3rd day in the same way and with the same coal tar from the same supply as in previous experiments. The results were in perfect keeping with those above reported, the initial changes being also in these mice losing of hairs, thickening of the skin, slight inflammatory changes, small fissures or crust formation, succeeded by development of papillomatous growths and cutaneous horns, and as a final stage infiltration and ulcers.

The series of experiments comprises 20 white mice among which the 13 longest lived presented carcinomatous growths (proved solely by diagnostic excision in 2 animals, by diagnostic excision and post mortem examination in 3, and by post mortem examination in 8). Metastases were found in the axillary lymphatic glands of 4 mice and in the lung of 2.

A transplantation experiment was effected in one case and with positive result.

The tumor was a cornifying carcinoma with a great metastatic nodule in an axillary lymphatic gland. The implanted tissue—in 4 out of 6 mice inoculated with the primary tumor, in 2 out of 6 mice inoculated with the lymphatic gland—grew very quickly and in about 3 weeks developed into tumors of about the size of a pea or the kernel of a hazel nut, the histological structure of which tumors corresponded completely to the structure of the original tumor. Most unfortunately these tumors soon showed signs of infection, and transplantation, therefore, was not continued.

In all cases the tumors produced were more or less keratinising carcinomata, often of the type of epithelioma malignum. Unquestionable pure sarcoma or carcino-sarcoma was not found, although the possibility of an admixture of sarcomatous elements could not be precluded in one mouse.

It seems to us unnecessary to give a detailed report of the development of the changes in each animal of this series, partly because, in nearly all respects, it would be a repetition of previous statements, partly because a further account will appear when the material has been subjected to a more thorough histological study.

The table below (see page 34) is given in order to afford a general view of the total result of the whole 3 series of experiments. The 1st column contains the amount of days passed from the 1st painting until the time when the nature of the changes was proved, thus being in the case of 44 mice synonymous with the day of their death, while it indicates the day of diagnostic excision in the case of 1 mice of the 3rd series. These 2 animals both belong to the group of the longest lived mice of the 3rd series.

The skin affections are divided into 1) slight, 2) papillomatous and 3) development of carcinoma.

As seen from the table all 15 mice which survived the 1st painting only for at most 89 days presented but slight changes, whereas in 28 out of 30 mice which survived the 1st painting for 103—333 days papillomata and cutaneous horns had developed, being in no less than 24 individuals accompanied by development of carcinoma (in 22 individuals) or carcino-sarcoma (in 2 individuals). Thus, development of carcinoma (carcino-sarcoma) was found

Days passed after 1st painting	Number of mice	Slight changes	Papillomatous growth	Carcinoma (or carcinosarcoma.)
	I—II series of experiments:			
23—89	10	10	..	..
103—123	4	2	2	..
184	1	..	1	..
243—333	10	..	..	10
	III series of experiments:			
29—72	5	5	..	..
180—182	2	..	1	1
209—267	13	..	..	13
Total:	45	17	4	24
	All three series of experiments:			
180 days or longer	26	..	2	24

altogether in 24 out of 26 mice which survived the 1st painting for at least half a year (180 days).

Thus, in our investigations tar cancer has been produced with greater frequency than in the experiments made by Tsutsui.

Furthermore, our experiments have shown that, like the tar carcinomata in rabbits (Yamagiwa and Ichikawa) the artificially produced tar carcinoma may also in mice produce metastatic deposits in the lymphatic glands. Metastases in the lungs we have found in 2 of 13 mice, the lungs of 12 of which were cut completely in serial sections.

Finally, we have succeeded in giving the proof of the transplantability of the tar carcinomata produced artificially in mice.

The reason why development of malignant growths was found in a relatively greater number of mice in our experiments than was the case in Tsutsui's experiments, cannot be given, but it might perhaps be found in a difference between the tar used by TSUTSUI and that used by us, or in a difference as to susceptibility of the Japanese and the Danish mice.

As mentioned above, development of carcinoma was observed in our experiments at the earliest about half a year (182 days) after the beginning of painting, but examination of the carcinoma in this mouse, then dead, rendered it probable that development of cancer may take its rise at a still earlier juncture, and in some new investigations on this question made by one of us (BANG) and not yet finished, carcinomatous growth — up till now — has been found in several mice 5 months, or still earlier, after the 1st painting.

On the whole, the initial processes of carcinoma development in mice are in perfect keeping with those which precede the development of cutaneous carcinoma in workers who have been exposed to the action of soot, tar, crude paraffin and pitch.

Also in these workers the dermatitis will be characterized by keratosis, and development of papillomatous growth — as will be known — is a common finding, large cutaneous horns being also observed in chimney sweeps (CURLING[1], WADD[2], JOHNSON[3]) although of course of relatively far smaller dimensions than those found in mice and rabbits.

Furthermore, the histological structure of the growths presents conformities to that of the above professional

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[1] Treatise on Diseases of the testicle, cit. by LEBERT: Ueber Keratose. Breslau. 1864.

[2] Cases of diseased prepuce and scrotum. London 1817. cit. by STOEHR: Ueber den Schornsteinfegerkrebs der Engländer. Würzburg 1822.

[3] The Lancet. 1844. Vol. II.

carcinomata in man, these being also, as a rule, strongly keratinising types, belonging to the group of epithelioma malignum.

The successful results of the experiments made by YAMAGIWA, ICHIKAWA, TSUTSUI and by us renders it possible that continued investigation may solve the old question as to what chemical compounds or mixtures of compounds must be made responsible for the occurrence of this group of professional cancers.

In our experiments we have not yet entered upon this question which will probably require widely ranging investigations, but we might add a single item worthy of interest.

In consequence of the statements of BAYET and SLOSSE[1] in 1919 as to their having procured the definite proof that arsenic was the cause of tar cancer and the real cause too of cancer of chimney sweeps, briquette- and paraffin-workers, we have caused an analysis to be made of the tar employed in all our experiments. This analysis, kindly carried out by the Pharmacological Institute of the University of Copenhagen[2] gave as a result, that the tar in question contained arsenic in such small quantities that it could only be called traces (about 0,0003 per cent.).

That such a slight admixture of arsenic should actually be the active cancer-producing element in tar, seems rather dubious to our view, and let it further be added, that tests made in the laboratories of the Lister Institute have failed to detect any arsenic in pitch (H. C. Ross 1917).[3]

The question as to the special nature of the active sub-

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[1] l. c.

[2] Also in this place we wish to express our thanks to the Director of the Institute, Prof. Dr. J. BOCK.

[3] l. c.

stances, however, is not only of great interest to the hygiene of manufacture and to dermatology. The tracing out of such chemical compounds as might possess the power of giving rise to such excessive cell proliferations as those in question, presents the greatest interest also to biology and cancer research in general.

The continued and undiminished growth of the carcinomata after the suspension of the tar paintings corroborate previous clinical observations and does not lack analogies. Also other carcinomata (as f. inst. X-ray cancer, aniline cancer) will continue their growth even if the etiological factors, active at the earliest rise of the tumor, have disappeared, in the same way the Spiroptera cancer continues its growth even if the Spiropterae decrease in number or quite disappear (FIBIGER)[1], and it will be seen from the investigations of C. O. JENSEN[2] that neither does the plant cancer described by ERWIN SMITH cease its development, after *Bacterium tumefaciens* has died off in tumor.

These facts call our attention to a circumstance which augments the difficulties in exploring the causation of carcinomata, viz. that the etiological factors which were originally active, may have disappeared at the point of time when the carcinoma is observed, these factors being thus untraceable.

Thus, a further experimental investigation with the aim of ascertaining the shortest time necessary for the action of the tar to produce development of carcinoma, and how long after discontinuance of the irritant carcinoma may develop, — will be of the greatest interest.

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[1] Det Kgl. Danske Videnskabernes Selskabs Biologiske Meddelelser I, 11.

[2] Landbohøjskolens Aarsskrift 1918.

The production of carcinoma by so simple a method as tar painting, finally, represents an important step forward in experimental cancer research. Up till now, only one method has been known by which to produce carcinoma experimentally with certainty, namely the transmission of *Spiroptera neoplastica (Gongylonema neoplasticum)* which in 50—60 per cent of black and white rats (unfrequently in mice) gives rise to development of carcinoma of the stomach, and in a few cases furthermore of the tongue. On the transmission of spiropterae carcinoma has now been produced (Fibiger) in more than 100 experimental animals (rats and mice) at the Anatomo-Pathological Institute of the University of Copenhagen and, as previously stated, this method has rendered it possible to yield a contribution to the study of several of the problems of carcinoma.

This method, however, has this inconvenience, that development of carcinoma takes place in an organ, the stomach, that is not within easy reach of examination as long as the animal is alive, whereas tar carcinoma is produced on the skin, where the pathological processes and the propagation of the carcinoma may be followed from day to day in the live animal. Tar carcinoma also seems to be more frequently produced, in so far as it can hardly be due to an accident that tar carcinoma in these experiments occurred in no less than 24 out of 26 mice examined, at the earliest, half a year after the beginning of the paintings. That all sorts of tar should be equally active, is however, on the face of the matter, hardly probable.

But experimental tar carcinoma in mice, according to our experiments, furthermore, seems to possess a peculiarity which gives it a special place among the carcinomata hitherto found in mice, viz. its liability to metastasis formation in the lymphatic glands. It is a well-known fact that carcinoma in mice only very rarely will present metastatic deposits in these glands. As an example need only be mentioned that among 273 malignant tumors in mice examined by HAALAND[1], only 4 were found in which glandular metastasis could be observed with the naked eye, and microscopical examinations also have proved the rare occurrence of such metastases.

In distinction from this, we have found metastatic deposits in axillary lymphatic glands of no less than 6 out of our 24 tar painted carcinomatous mice. These carcinomatous lymphatic glands were all much enlarged and in several cases the carcinoma was visible already on naked eye examination.

Hence, the experimentally produced tar carcinoma in white mice may be said to present such great analogies to the carcinoma in man that among all known carcinomata in mice it may be considered the one which bears the closest resemblance to human carcinoma.

And experimental production of tar carcinoma will not only prove a control and an excellent supplement to the Spiroptera-method, but in some respects even exceeds the latter, and especially will render it less difficult, experimentally to examine and follow the effects of therapeutic methods, and to study the possibility of inducing immunity.

That it has now come within the reach of cancer research experimentally to produce with certainty carcinoma of quite homogeneous anatomical structure by means of two methods so different as the transmission of a nematode and repeated painting with an antiseptic substance

[1] l. c.

like tar, is a fact which yields a support to the modern view that the carcinomata cannot be due to one single identical cause, but that several or numerous factors of different origin and different nature may be active in inducing the epithelial cells to unlimited carcinomatous proliferation.

We desire to acknowledge our indebtedness to the Carlsberg Fund and the W. Bendix Legacy for their support of these investigations.

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PLATES

PLATE I.

Fig. 1. Mouse No. 6 Papillomatous growth, 238 days after the beginning of the tar painting. Natural size.

- 2. The same mouse. 289 days after b. o. p., 40 days after suspension of the tar painting. Natural size.

- 3. Mouse No. 4. Cutaneous horn, 292 days after the b. o. p. Natural size.

- 4. Mouse No. 5. Papillomatous growth (cutaneous horn) 224 days after b. o. p. The tar painting was now suspended. Natural size.

- 5. The same mouse. 65 days later. Natural size.

- 6. Mouse No. 8. Cutaneous horn, 290 days after b. o. p., 59 days after suspension of the tar painting. Natural size.

- 7. The same mouse, 68 days after suspension of the tar painting. Natural size.

- 8. The same mouse, 76 days after suspension of the tar painting. Natural size.

- 9. The same mouse, on death, 102 days after suspension of the tar painting. Natural size.

Fig. 1.

Fig. 2.

Fig. 3.

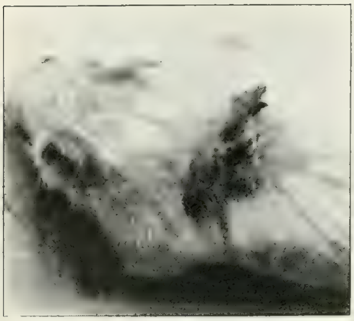


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

PLATE II.

Fig. 10. Papilloma in mouse, named II$_{18}$. $\times \frac{32}{1}$.

- 11. Papilloma in mouse, named I$_2$. $\times \frac{32}{1}$.

- 12. Carcinoma. Initial stage. Mouse No. 2, named I$_9$. $\times \frac{45}{1}$.

- 13. Carcinoma (type: Epithelioma malignum). Diagnostic excision. Mouse belonging to the 3rd series of experiments. $\times \frac{32}{1}$.

- 14. Carcinoma, representing very distinctly the type of Epithelioma malignum. Mouse No. 5. $\times \frac{45}{1}$.

Fig. 10.

Fig. 11.

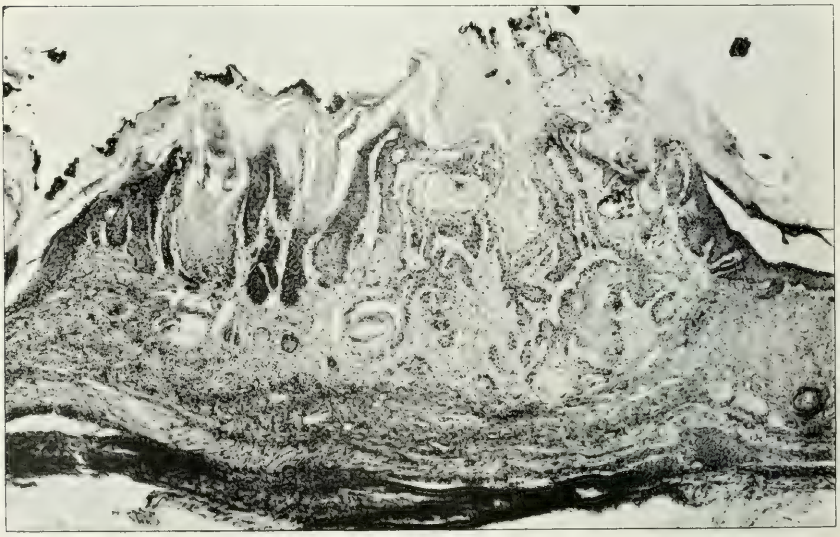


Fig. 12.

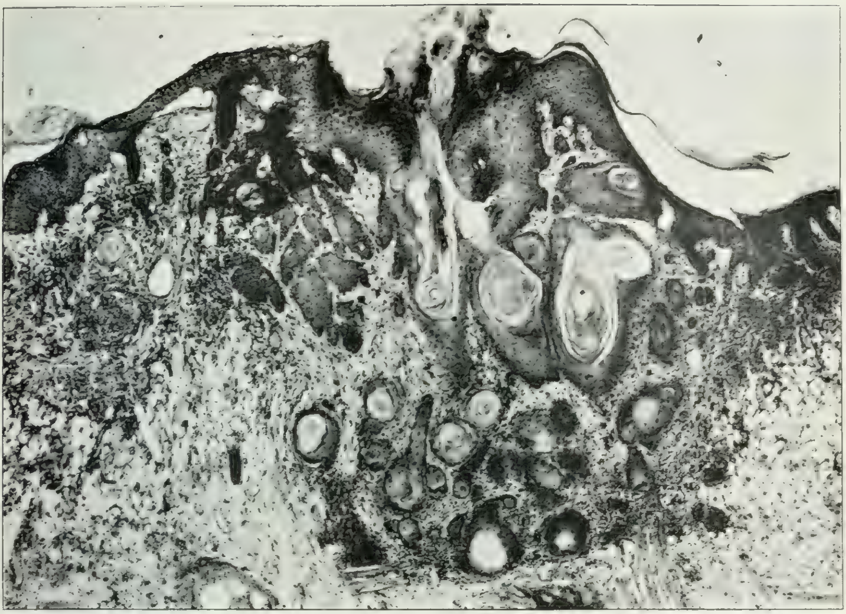


Fig. 13.

Fig. 14.

PLATE III.

Fig. 15. Keratinising carcinoma. Mouse No. 6. $\times \frac{45}{1}$.

- 16. Metastasis of the same tumor in an axillary lymphatic gland. $\times \frac{45}{1}$.

- 17. Carcino-sarcoma. Mouse No. 9. To the left carcinoma (type: Epithelioma malignum). To the right the polymorphous celled sarcomatous nodule. $\times \frac{45}{1}$.

- 18. The sarcomatous tissue from the tumor in mouse No. 9. $\times \frac{112}{1}$.

- 19. Carcinomatous, very strongly keratinising metastasis in an axillary lymphatic gland in the same mouse. (No. 9.) $\times \frac{45}{1}$.

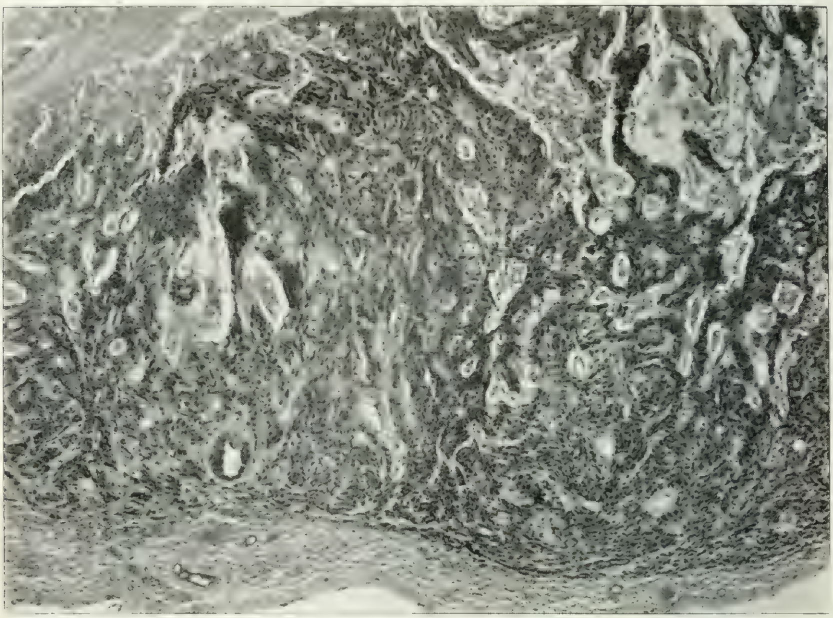


Fig. 15.

Fig. 16.

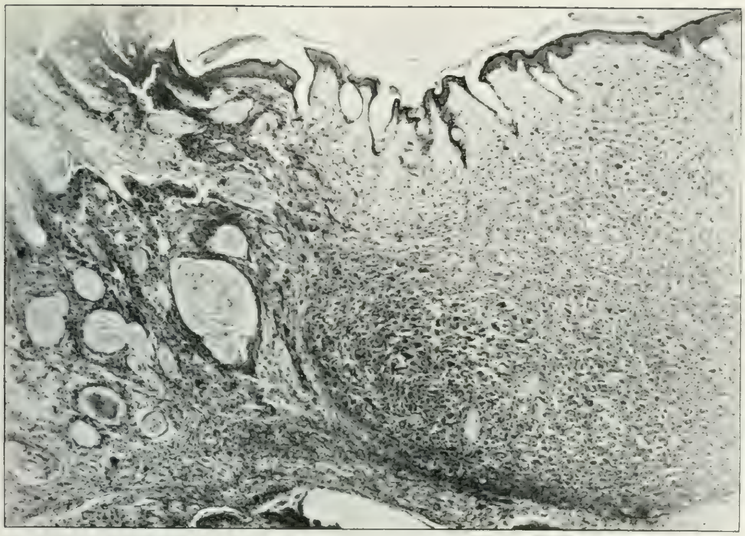


Fig. 17.

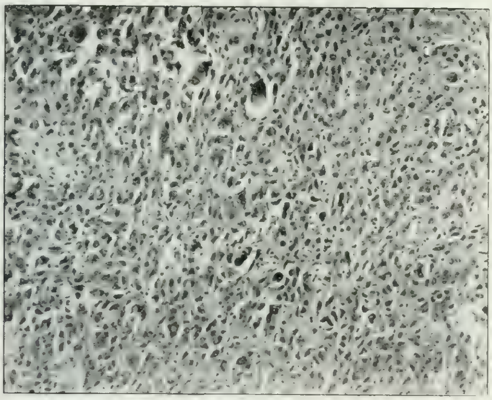


Fig. 18.

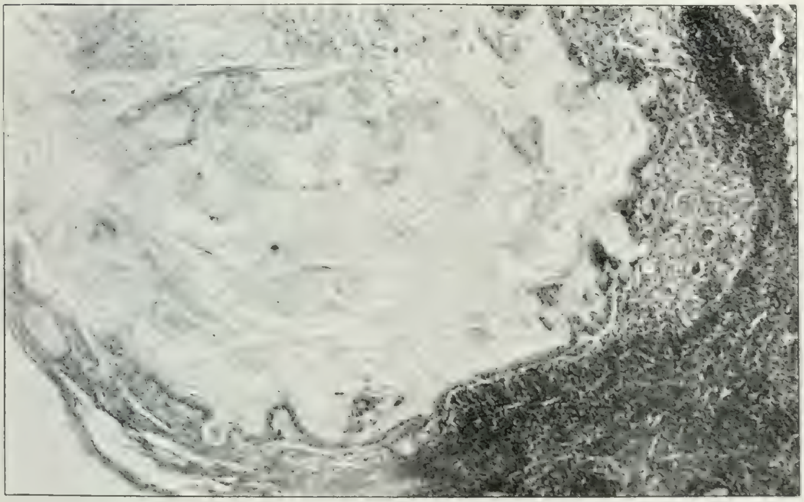


Fig. 19.

PLATE IV.

Fig. 20. Carcinoma (type: Epithelioma malignum) in mouse No. 1. $\times \frac{4.5}{1}$.

- 21. The same tumor transplanted. $\times \frac{4.5}{1}$.

- 22. Mouse No. 10. Cutaneous horn, 208 days after b. o. p. The paintings were suspended 3 days before. Natural size.

- 23. The same mouse, 14 days after suspension of the painting. Natural size.

- 24. The same mouse, 28 days after suspension of the tar painting. Natural size.

- 25. The same mouse, 44 days after suspension of the tar painting. Natural size.

- 26. The same mouse on death, 52 days after suspension of the tar painting. Natural size.

- 27. The same mouse. Cutaneous horn. The one half of the cutaneous horn and its carcinosarcomatous base, cut vertically. Natural size.

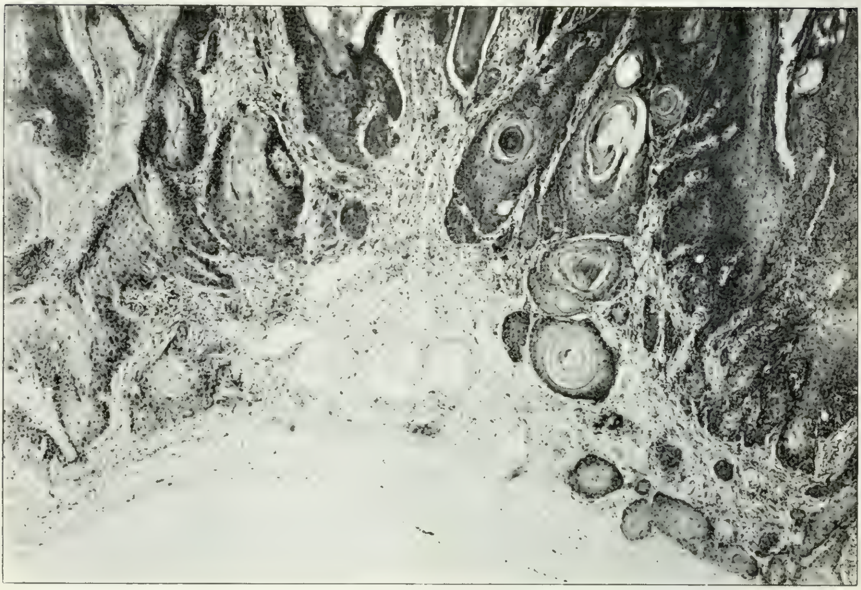


Fig. 20.

Fig. 21.

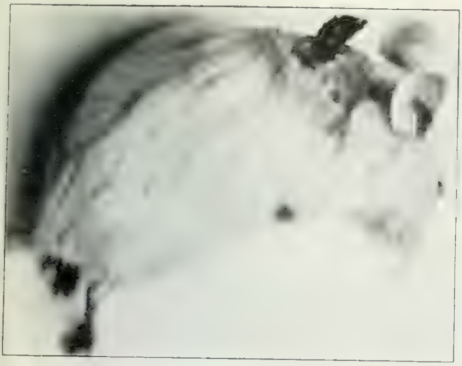


Fig. 22.

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 26.

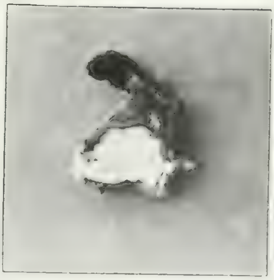


Fig. 27.

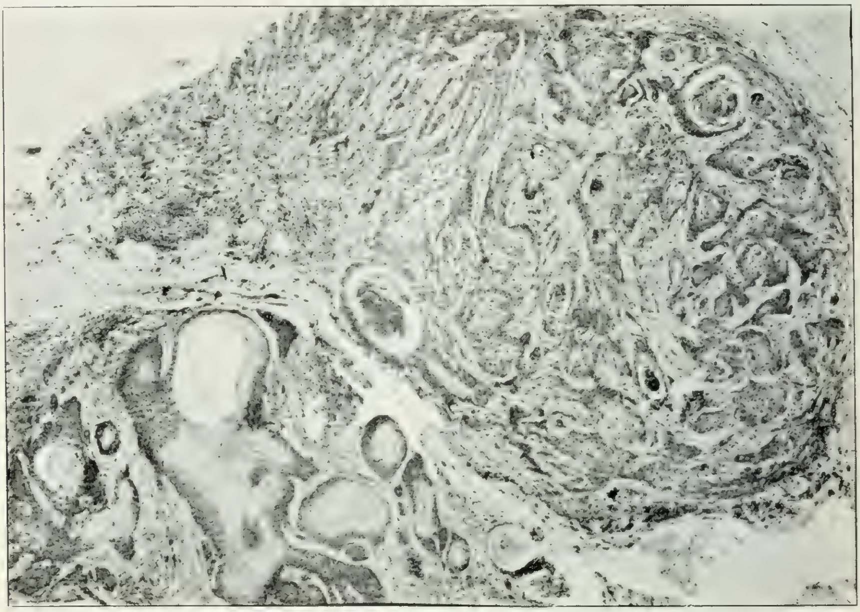
PLATE V.

Fig. 28. Mouse No. 10. The keratinising carcinomatous part of the tumor. $\times \frac{45}{1}$.

\- 29. The same mouse. Mixture of carcinomatous and sarcomatous components of the tumor. $\times \frac{40}{1}$.

\- 30. The same mouse. A spindle celled sarcomatous part of the tumor. $\times \frac{45}{1}$.

\- 31. The same mouse. Carcinomatous and sarcomatous areas adjacent to each other. $\times \frac{45}{1}$.



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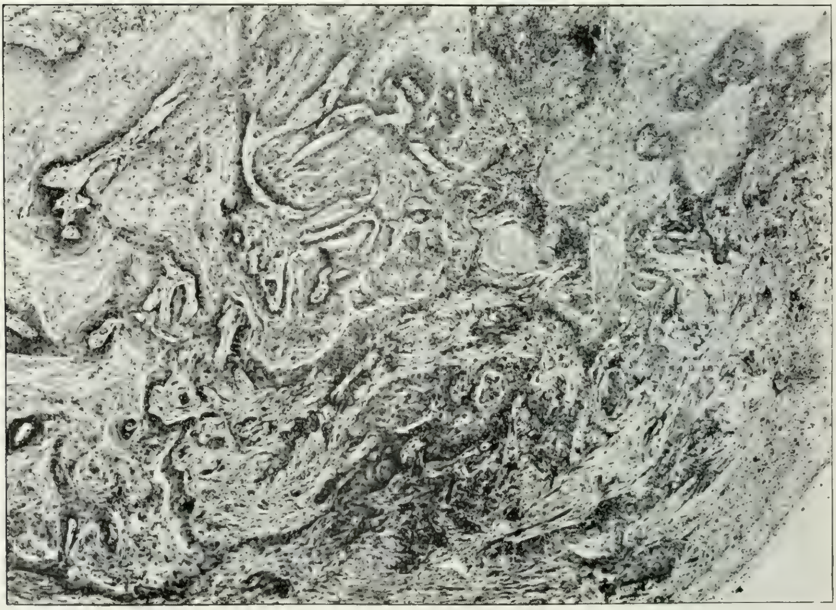

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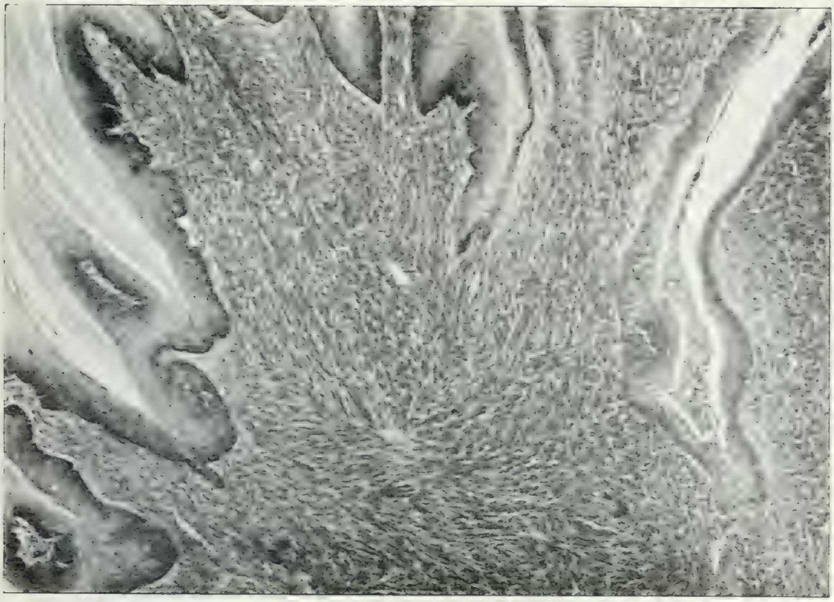

Fig. 30.

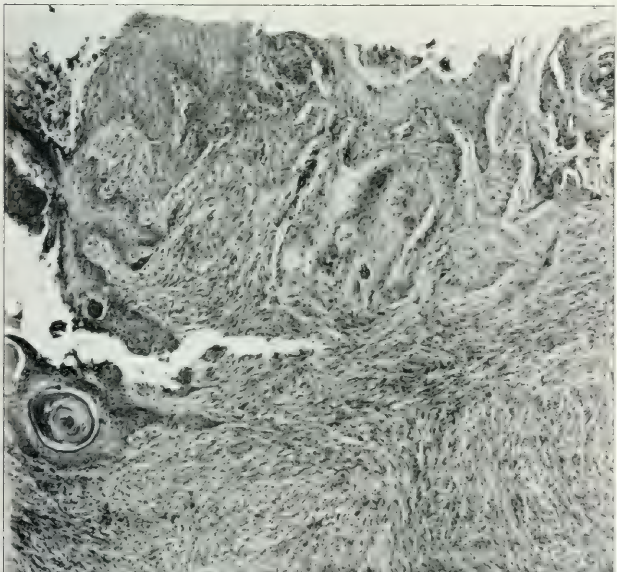

Fig. 31.

PLATE VI.

Fig. 32. Mouse No. 10. Spindle celled sarcomatous part of the tumor. $\times \frac{100}{1}$.

- 33. Mouse with subcutaneous tumor (pure spindle celled sarcoma), developed after transplantation of tumor tissue from mouse No. 10. Second generation. Natural size.

- 34 and 35. Mice with subcutaneous spindle celled sarcomatous tumors, developed on continued transplantation of tumor tissue from mouse No. 10. 8th generation. Natural size. The inoculations have been made at the root of the tail.

- 36 Subcutaneous carcino-sarcoma in a mouse, to which the carcino-sarcoma of mouse No. 10 has been transplanted. $\times \frac{45}{1}$.

- 37. Subcutaneous pure spindle celled sarcoma in another mouse, to which the carcino-sarcoma of mouse No. 10 has been transplanted. $\times \frac{100}{1}$.

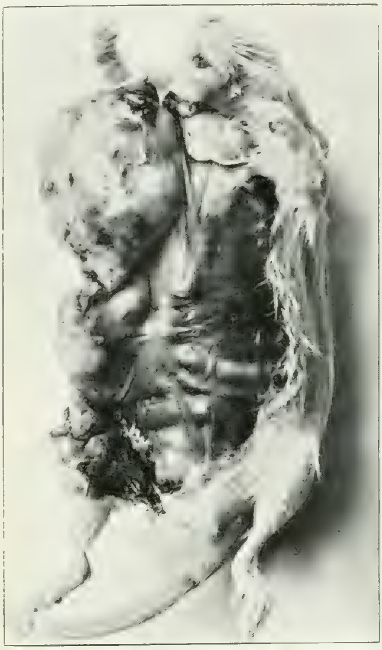

Fig. 33.

Fig. 34.

Fig. 36.

Fig. 35.

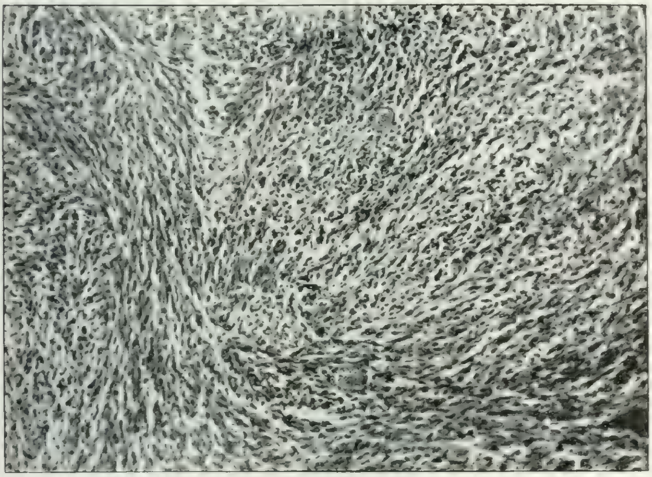

Fig. 32.

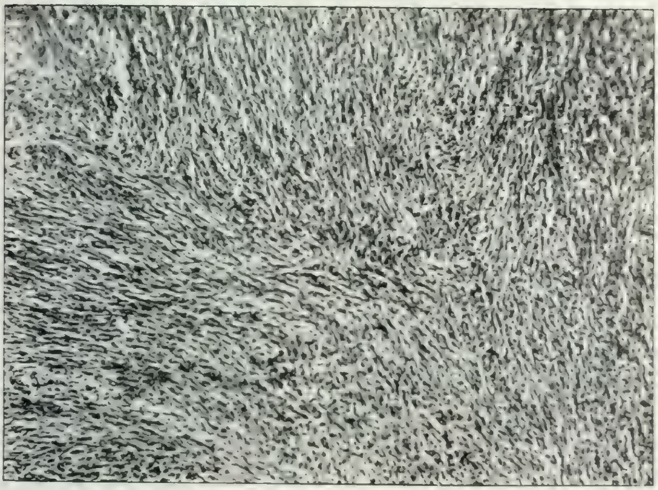

Fig. 37.

Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **III,** 5.

MESURAGE DES

ANGLES DES MITOSES

COMME MOYEN DE DISTINGUER ENTRE ELLES
LES DIVERSES CELLULES LYMPHOÏDES
DANS LA MOËLLE OSSEUSE

PAR

V. ELLERMANN

AVEC UNE PLANCHE

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
1921

Tandis que, depuis Neumann, c'est un fait bien établi que les globules rouges du sang sont formés dans la moëlle osseuse, on n'est point d'accord quand il s'agit de déterminer l'origine des globules blancs. La doctrine dualiste (Ehrlich) maintient que les leucocytes polynucléaires granulées sont formées dans la moëlle osseuse; les lymphocytes dans la rate, dans les ganglions lymphatiques et dans les autres tissus lymphatiques. D'après Ehrlich il s'agit de deux systèmes de tissu tout à fait indépendants, lesquels aussi dans des conditions pathologiques (dans les leucémies) prolifèrent indépendamment l'un de l'autre. Selon l'interprétation unitaire (Mollier, Weidenreich, e. pl.) qui s'appuie surtout sur l'embryologie et sur l'anatomie comparée, il n'y aurait aucune différence nette entre les lymphocytes et les leucocytes granulées. Ce serait essentiellement l'influence des conditions externes qui déterminerait l'évolution des cellules dans telle ou telle direction. Les leucocytes polynucléaires ne seraient pas développées exclusivement dans la moëlle osseuse, mais elles procéderaient aussi de lymphocytes provenant des organes lymphatiques. Ce qui a compliqué particulièrement la chose, c'est l'existence dans la moëlle osseuse, sous de différentes circonstances pathologiques, de cellules non-granulées, ressemblantes aux lymphocytes. Tandis que ces cellules sont considérées par les unitariens simplement comme des lymphocytes identiques à celles du tissu lymphatique proprement dit, elles ne sont pour les dualistes que des cellules »lymphoïdes«, c'est à dire des cellules ressemblant aux lymphocytes. Elles sont regardées tantôt comme des myéloblastes (Naegeli), tantôt comme des érythrogonies (Helly) ou bien comme les cellules-mères et des myélocytes et des érythroblastes (Klein). Plusieurs savants ont essayé de trouver des différences morphologiques entre les myéloblastes et les lymphoblastes, mais les différences sont petites et se ne laissent pas toujours indiquer avec sûreté. Naturellement il serait d'une grande valeur, si l'on pouvait réussir à trouver des traits qui rendraient possible de distinguer entre elles les différentes cellules lymphoïdes. Dans un travail précédent (comptes-rendus de la société de biologie, Février 1920) j'ai décrit une forme curieuse de mitose dans les cellules lymphoïdes de la moëlle osseuse dans des cas d'anémie pernicieuse. Le fuseau était extraordinairement longue et mince, l'angle du sommet très petit (20°). J'ai pu démontrer que les érythroblastes avaient une forme de mitose tout à fait semblable, tandis que les myélocytes présentaient un fuseau considérablement plus court et plus large, dont l'angle du sommet mesurait environ 70°. Par là j'ai conclu que dans l'anémie pernicieuse les cellules lymphoïdes étaient les préphases des érythroblastes (érythrogonies), et non pas des myéloblastes.

Le but du travail présent est donc, d'une part de vérifier à l'aide d'une meilleure méthode de mesurage les chiffres trouvés, d'autre part d'étendre le domaine de mes recherches à d'autres formes de cellules, notamment aux myéloblastes et aux lymphoblastes. On pourrait peut-être objecter à mes résultats antérieurs que les cellules lymphoïdes de moëlle, possédant une mitose à angle aigu, ressemblaient certainement aux mégaloblastes plus qu'aux myélocytes, mais elles pourraient néanmoins être ou des myéloblastes ou les cellules-mères des deux formes de cellules nommées. C'est pourquoi il était d'une grande importance de constater l'aspect des mitoses et de l'angle du sommet dans de véritables myéloblastes. De plus c'était une conséquence naturelle d'examiner, si les myéloblastes et les lymphoblastes étaient identiques ou si elles différaient quant à la forme de la mitose.

Dans mes recherches précédentes j'ai dessiné les mitoses et puis, sur le dessin, j'ai mesuré l'angle du sommet. Ce procédé étant assez difficile et donnant lieu à des inexactitudes, j'ai préféré dans le travail présent de mesurer directement les angles sous le microscope au moyen d'un oculaire goniométrique. On obtient par là une exactitude suffisante, comme démontre le calcul de la faute moyenne. Pour ce but deux angles de mitoses étaient mesurés, chacun dix fois.

	I		II
	64		60
	64		57
	68		54
	72		49
	66		51
	66		59
	60		56
	66		56
	66		56
	70		53
Moyenne...	66	Moyenne...	55
	$\mu = 3,3$		$\mu = 3,4$

La faute moyenne (qui était déterminée par la formule: $\mu = \sqrt{\frac{\Sigma d_n^2}{n-1}}$) n'est ainsi qu'environ 5%. Les mesurages pourront indiquer les différences entre les angles de deux mitoses, si la différence est plus grande que $3 \times 3{,}3 = 10^\circ$. En pratique on n'aura pas seulement à faire avec les défauts inhérents à la méthode, mais aussi avec des variations produites par d'autres raisons.

En calculant la faute moyenne d'une série de mitoses différentes appartenant à un seul et même type de cellules, p. ex. aux myélocytes, on y trouvera une plus grande faute moyenne (environ 11°). Ceci est en première ligne dû aux variations physiologiques de la grandeur de l'angle du sommet, mais aussi à d'autres choses: recourbement de l'axe longitudinal de la mitose, incertitude du jugement sur l'image microscopique etc. Dans le travail présent j'ai toujours mesuré au moins 40 angles de chaque sorte de mitose, et quelquefois le nombre double ou triple. Plus tard je discuterai combien de mesurages il faudra exécuter pour distinguer entre elles les cellules mentionnées ici.

Naturellement il faut que la matière de recherche soit aussi bien conservée que possible, et que la fixation et la coloration soient accomplies avec le plus grand soin. La méthode dont on se sert, doit être capable de colorer toutes les cellules différentes des tissus hématopoïétiques, de sorte qu'elles soient faciles à distinguer les unes des autres, et particulièrement il faut qu'elle donne une coloration nette des grains neutrophiles. Ces exigences sont satisfaites par la méthode décrite dans le travail cité ci-dessus.[1]

Mégaloblastes.

La matière était de la moëlle osseuse provenant d'un cas d'anémie pernicieuse. A. J., femme âgée de 45, reçue dans l'hôpital de Bispebjerg, service C, le 25 Sept. 1918, morte le 17 Janvier 1919. Autopsie légale N° 4/1919.

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[1] Voir aussi: Zeitschrift für wissenschaftliche Mikroskopie 1919.

Diagnostic de l'autopsie: Anæmia universalis. Hyperplasia chronica lienis levis. Hyperplasia rubra medullæ ossium. Pneumonia incipiens. Oedema pulmonum.

La microscopie de la moëlle osseuse montrait de nombreuses mégaloblastes et de grandes cellules lymphoïdes.

On trouvait les chiffres suivants:

14	20	7	31
16	20	7	28
20	13	30	21
17	34	9	19
15	20	20	17
18	13	12	10
23	10	14	33
5	26	25	13
11	22	19	9
17	20	23	18

Moyenne: 18°
$\sigma = 7,2$

Érythrogonies.

La matière était de la moëlle osseuse provenant d'un cas d'anémie pernicieuse. S. R., femme âgée de 37, reçue le 18 Août 1918 dans l'hôpital de Bispebjerg, service B, morte le 28 Août 1918.

Diagnostic de l'autopsie: Anæmia universalis. Hyperplasia griseo-rubra medullæ ossium. Oedema pulmonum. Hydropericardium. Sequelæ oophorectomiæ dextræ.

L'examen microscopique de la moëlle osseuse montrait de nombreuses cordes et amas de grandes cellules lymphoïdes.

Celles-ci étaient souvent en division mitotique, et on voyait fréquemment des formes de transition aux mégaloblastes. Le mesurage des angles des mitoses dans les cellules lymphoïdes (les érythrogonies) donnait le résultat suivant:

32
25
16
16
25
21
15
17
16
15
15
23
31
12
15
28
27
19
18
19
20
20
19
25
21
26
25
18
15
18
18
25
30
32
14
12
16
32
37
24

Moyenne: 21°
$\sigma = 6{,}3$

Lymphoblastes.

La matière provient d'un cas de leucémie lymphatique. I. S., femme âgée de 33. Reçue dans l'hôpital de Bispebjerg, service C, le 10 Janvier 1920, morte le 30 Janvier 1920. Autopsie N° 23.

Diagnostic de l'autopsie: Leucæmia lymphatica. Hyperplasia lymphoglandularum omnium levi gradu. Hyperplasia magna lienis. Infiltrationes leucæmicæ renum, glandularum suprarenalium. Lymphoma cordis. Lymphomata pleuræ dextræ.

Série I.

Celle-ci provient de la rate. La microscopie montra que les follicules, assez espacées, sont souvent considérablement aggrandies. Elles ne contiennent jamais de petites lymphocytes. mais seulement des lymphoblastes grandes ou moyennes.

Des mitoses se rencontrent fréquemment dans ces cellules.

Dans le tissu de la pulpe on trouve des cellules semblables et en outre quelques myélocytes et de rares mégaloblastes.

Le mesurage donnait les chiffres suivants:

32	35	46	43
31	51	35	36
35	53	27	44
39	53	44	47
34	41	31	39
37	32	35	45
60	40	44	36
64	52	33	38
53	44	43	40
59	40	27	58

Moyenne: 42°
$\sigma = 9{,}3$

Série II.

Celle-ci provient d'un ganglion lymphatique. Dans les follicules il n'y a aucune distinction entre la follicule primaire et secondaire. Elles ne contiennent que des cellules grandes et moyennes, lesquelles se trouvent souvent en mitose. Dans les cordes médullaires les cellules sont généralement plus petites. On trouvait les chiffres suivants:

43	42	58	35
46	38	71	41
30	41	30	35
24	40	37	35
22	40	39	35
24	34	48	42
50	23	56	30
38	46	44	35
23	30	52	41
25	32	38	37

Moyenne: 38°
$\sigma = 10{,}3$

Série III.

La matière (ganglions lymphatiques) provient de trois cas de leucémie lymphatique. Comme on ne s'était pas servi de la même fixation que dans le cas nommé ci-dessus, et comme par ce fait la coloration était moins bonne, le mesurage était difficile; c'est pourquoi je ne donnerai pas le détail des chiffres. En somme je mesurais 34 angles. La valeur la plus petite était 23°, la plus haute était 75°.

Moyenne: 44°

Série IV.

La matière était la rate et un ganglion lymphatique d'un enfant sain, mort par suite d'une contusion, et soumis à l'autopsie légale le 25 Janvier 1921.

L'examen microscopique de la rate montrait nombre de grandes follicules aux follicules secondaires qui fourmillaient de mitoses, tandis que celles-ci étaient très rares dans la partie extérieure des follicules. Dans le ganglion lymphatique on notait des phénomènes semblables.

Rate		Ganglion	
22	40	44	48
40	40	38	29
51	50	21	45
35	24	27	32
60	19	29	40
30	20	32	30
30	27	60	25
75	32	65	50
45	25	60	58
55	55	30	40

Moyenne: 39°

$\sigma = 11,3$

Myélocytes.

La matière était la moëlle osseuse provenant d'un cas de leucémie myéloïde chronique.

K. H., femme âgée de 54, reçue dans Rigshospitalet, service A, morte le 11 Juin 1919. Autopsie N° 153.

Diagnostic de l'autopsie: Splenomegalia (Leucæmia myelogenes). Struma. Bronchopneumonia hypostatica. Pleuritis fibrosa dextra. Anæmia organorum. Aplasia gl. suprarenalis dextræ.

L'examen microscopique de la moëlle osseuse montre des myélocytes neutrophiles nombreuses, les éosinophiles plus rares. Parmi les myélocytes on voit souvent des cellules non-granulées. Dans toutes les trois sortes de cellules se trouvent des mitoses. On trouvait les chiffres suivants:

Myélocytes neutrophiles.

62	62	58	60
64	48	77	56
80	61	60	69
82	68	65	62
66	83	58	67
59	72	61	64
59	63	56	73
73	75	56	76
48	81	66	68
66	84	60	73

Moyenne: 66°
$\sigma = 9{,}0$

Myélocytes éosinophiles.

66	81
82	73
74	91
78	58
71	73

Moyenne: 73°
$\sigma = 11{,}0$

Myéloblastes.

Ici je dispose de deux séries de mesurage.

Série I.

Celle-ci provient du cas ci-dessus mentionné de leucémie myéloïde chronique.

53	79	85	72
63	87	88	72
82	62	64	48
85	63	63	49
88	42	78	79
83	49	83	60
81	74	49	58
68	72	64	57
58	83	42	77
52	76	42	81

Moyenne: 68°
$\sigma = 14,3$

Série II.

La matière provient d'un cas de leucémie myéloblastique aiguë. E. S., garçon âgé de 11 ans, reçu le 15 Février 1920 dans l'hôpital de Bispebjerg, service C, et mort le 15 Mars 1920 à Kommunehospitalet, service 3. Autopsie N° 35.

Diagnostic de l'autopsie: Leucæmia. Infiltrationes leucæmicæ lienis, glandularum lymphaticarum, hili renis utriusque, telæ lymphaticæ pharyngis, medullæ ossium, intestini. Anæmia organorum. Degeneratio adiposa myocardii. Ecchymoses pericardii.

La microscopie des infiltrations existant dans la paroi du bassin rénal montre un réticulum, dans les mailles duquel se trouvent des cellules uniformes au protoplasme non-granulé assez abondant et présentant un noyau arrondi ou un peu lobé. Dans ces cellules-là se trouvent souvent des mitoses. Leur type est semblable à celui des myélocytes. Parmi les cellules non-granulées se trouvent de petits groupes de myélocytes neutrophiles typiques. La moëlle osseuse présente une image assez analogue.

57	63	67	83
88	81	67	74
69	81	57	52

64	79	74	56
57	86	71	64
55	81	67	84
65	73	62	65
68	69	69	59
59	80	73	56
67	74	79	57

Moyenne: 69°

$\sigma = 9,7$

En résumant les résultats, on verra que les chiffres trouvés peuvent être divisés en trois groupes, et que les différences au dedans de chaque groupe sont assez petites pour être dues au hasard.

1^er groupe.

Mégaloblastes:	18°	$\sigma = 7,2^\circ$
Érythrogonies:	21°	$\sigma = 6,3^\circ$

2^e groupe.

Lymphoblastes.	de leucémie	42°	$\sigma = 9,3^\circ$
	— —	38°	$\sigma = 10,3^\circ$
	d'organes norm.	39°	$\sigma = 14,0^\circ$

3^e groupe.

Myélocytes	neutrophiles	66°	$\sigma = 9,0^\circ$
	éosinophiles	73°	$\sigma = 11,0^\circ$
Myéloblastes	Leucémie chron.	68°	$\sigma = 14,3^\circ$
	— aiguë	69°	$\sigma = 9,7^\circ$

Tandis que les chiffres moyens de chaque groupe sont, on le voit, assez coïncidants et très différents de ceux des autres groupes, il va sans dire que les mitoses de chaque espèce de cellules varient sensiblement entre elles. Nous avons dressé ici le tableau des moyennes des différentes cellules lymphoïdes et leurs variations selon la loi de la faute moyenne.

	$\div 3\sigma$	$\div 2\sigma$	chiffre moyen	$+ 2\sigma$	$+ 3\sigma$
Érythrogonies...........	2°	8°	21° ($\sigma = 6{,}3$)	34°	40°
Lymphoblastes..........	6°	17°	40° ($\sigma = 11{,}3$)	63°	74°
Myéloblastes............	32°	45°	69° ($\sigma = 12{,}2$)	93°	106°

Les érythrogonies pourront ainsi avoir des valeurs situées entre 2° et 40°, les valeurs des lymphoblastes pourront varier entre 6° et 74° et les valeurs des myéloblastes entre 32° et 106°; remarquons pourtant qu' ordinairement les valeurs ne dépasseront guère 2σ.

Par le tableau on voit qu'on ne sera pas toujours capable de déterminer, à l'aide d'une mitose isolée, à quelle espèce appartient la cellule. En général les érythrogonies et les myéloblastes ne pourront pas être confondues; d'autre part il sera le plus souvent impossible de distinguer les lymphoblastes d'avec les deux autres formes de cellules, On y parviendra pourtant en mesurant, non pas une mitose isolée, mais toute une série, et il s'agit alors de savoir combien de mitoses il faut mesurer pour obtenir une exactitude suffisante.

Si, par exemple, on choisit de mesurer 16 angles, on aura une déviation moyenne: $\sigma' = \frac{\sigma}{\sqrt{16}} = \frac{\sigma}{4}$.

En calculant les limites 2σ et 3σ de la valeur trouvée, on aura les chiffres suivants:

	$\div 3\sigma$	$\div 2\sigma$	chiffre moyen	$+ 2\sigma$	$+ 3\sigma$
Érythrogonies	16°	18°	21° ($\sigma = 1{,}6$)	24°	26°
Lymphoblastes	32°	34°	40° ($\sigma = 2{,}8$)	46°	48°
Myéloblastes	60°	63°	69° ($\sigma = 3{,}1$)	75°	78°

Ainsi il se montre, qu'on n'a plus aucune fusion des groupes, mais qu'il sera toujours possible de déterminer l'espèce des cellules par le chiffre trouvé. Le chiffre des érythrogonies sera ordinairement situé entre 18° et 24°, tandis que seulement 5 % des observations dépasseront ces limites et seront situés entre 16° et 26°. De même les angles des lymphoblastes seront généralement situés entre 34° et 46°, et en tout cas elles ne dépasseront pas 32° et 48°; quant aux myéloblastes, les angles seront ordinairement compris entre 63° et 75° et ne dépasseront pas 60° et 78°.

Par ces recherches je crois avoir constaté, qu'il existe dans la moëlle osseuse deux espèces bien distinctes de cellules lymphoïdes, savoir les érythrogonies et les myéloblastes. Ces deux formes de cellules sont différentes des lymphoblastes du tissu lymphatique. Ces faits contredisent absolument la théorie unitaire sur les globules du sang. Tandis que la constatation des chiffres relatifs aux myéloblastes s'accorde bien avec les résultats obtenus dans les recherches antérieures sur les myélocytes, les chiffres relatifs aux mitoses des lymphoblastes m'ont causé quelque surprise. D'après Hansemann les lymphoblastes auraient en effet un fuseau tellement plat (conséquemment à angle obtus) qu'il serait même difficile à distinguer. Je crois qu'ici il y a une erreur. Le fait est, qu'on peut trouver en plein tissu lymphatique des vingtaines de mitoses à angle assez aigu, et remarquons-le, dans des cellules qui sont indubitablement des lymphoblastes.

Le mesurage des mitoses est une méthode qui exige certainement une technique soignée et quelque habitude, mais elle a sur l'observation simple le grand avantage d'exprimer par des chiffres les caractères distinctifs des cellules, tandis-que jusqu'à présent on n'avait que les détails inconstants et insaisisables de la morphologie des noyaux.

Peut-être cette méthode pourra-t-elle aussi s'appliquer à d'autres domaines de la cytologie.

Explication des figures.

Fig. 1—4.	Mégaloblastes.
Fig. 5—8.	Erythrogonies.
Fig. 9—12.	Lymphoblastes.
Fig. 13—16.	Myélocytes neutrophiles.
Fig. 17—20.	Myéloblastes.

Forelagt paa Mødet den 21. Januar 1921.
Færdig fra Trykkeriet den 21. Maj 1921.


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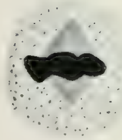
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Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **III,** 6.

MANGANOKLORIDS OG NOGLE ANDRE SALTES INDVIRKNING PAA ANTITOXINDANNELSEN

AF

L. E. WALBUM

WITH A RÉSUMÉ IN ENGLISH

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
1921

Forholdsvis tidligt lykkedes det i store Træk at antyde Lovene for Antitoxinets Dannelse i den aktivt immuniserede Organisme.

Brieger & Ehrlich (1) offentliggjorde i 1893 Immuniseringskurven for Geder, immuniserede mod Tetanusgift, og i 1897 og 1899 Salomonsen & Madsen (2, 3) de tilsvarende Kurver for diphtheri-immuniserede Heste. Senere er der publiceret et meget stort Antal Arbejder over Immunisering af forskellige Dyr med mange forskellige Antigener (bl. a. Madsen & Jørgensen (4): Typhus og Cholera) saavel af animalsk som af vegetabilsk Oprindelse, men alle disse Forsøg har — uden paa afgørende Punkter at have bragt noget egentlig nyt — bekræftet de først gjorte Iagttagelser og dermed vist, at Lovene for Dannelsen af de forskellige Antistoffer i store Linier synes at være de samme: umiddelbart efter Injektionen af Antigenet kommer undertiden et Fald i Blodets Antitoxinkoncentration (første negative Phase), derefter en stærk Stigning (den positive Phase) og dernæst atter et jævnt tiltagende Fald (anden negative Phase), en Kurve, der kan opfattes som Resultanten af de antitoxindannende og antitoxinnedbrydende Kræfter i Organismen (Th. Madsen 5).

Der er i Tidens Løb ofret et ikke ringe Arbejde paa mere indgaaende at studere disse Forhold; man har paa talrige Maader, som ved Svækkelse af Antigenet, ved

Ændring af Antigenets Dosering, ved Forandring af Injektionsmodus (subkutan, intravenøs, intramusculær etc.), af Tidspunkterne for Injektionerne, Kombination af aktiv og passiv Immunisering, ved Stimulering med forskellige Gifte, ved større eller mindre Aareladninger o. fl. a. søgt at ændre Immuniseringskurvens Form, væsentlig for ved Hjælp af de indvundne Iagttagelser at kaste nyt Lys over disse indviklede Forhold, men dog tillige for at forfølge det rent praktiske Formaal, at drive Blodets Antitoxinkoncentration saa højt op som muligt, hvilket bl. a. har Betydning for Fremstillingen af de antitoxiske Sera samt for Vaccineterapien.

Selv om disse Arbejder har bragt os noget nærmere henimod disse Maal, har de ikke i nogen væsentlig Grad forøget vort Kendskab til Immuniseringens og Antitoxindannelsens inderste Væsen.

I Immunitetsforskningens Begyndelse var det en ikke ualmindelig Antagelse, at Antitoxinet i Organismen opstod som Følge af en direkte Omdannelse af det injicerede Toxin. Det var SALOMONSEN & MADSEN, som først fremsatte den Tanke, at der hos et aktivt immuniseret Dyr stadig foregaar en Produktion og Destruktion af antitoxisk Substans, idet visse af Organismens Celler undergaar en varig Modifikation, hvorved de sættes i Stand til kontinuerligt at secernere Antitoxin. Denne Anskuelse har i Tidens Løb fæstnet sig og maa vel nu betragtes som almindelig anerkendt.

SALOMONSEN & MADSEN (6) viste ved deres Forsøg med Pilocarpin, at en almindelig forøget Sekretion betinger en — ganske vist kortvarig — Forøgelse af Antitoxinkoncentrationen i Blodet.

At een større Aareladning (ROUX & VAILLARD (7), SALOmonsen & Madsen (8), Friedberger & Dorner (9), Schroder (10) o. fl. a.) eller flere mindre Aareladninger (Pfeiffer (11), Reymann (12) o. fl.) virker stimulerende paa Antitoxindannelsen, har foranlediget flere (Pfeiffer & Marx, Wassermann & Takaki, Détre, Levaditi o. a.) til at fremsætte den Formodning, at der eksisterer en direkte Forbindelse mellem Bloddannelsen og Antitoxinproduktionen.

Madsen & Tallquist (13) har forfulgt denne Tanke og hos Forsøgsdyrene frembragt en Nydannelse af Blodlegemer ved Injektion af blodlegemeopløsende Gifte (Pyrodin og Pyrogallol), hvilket ligeledes havde Stigninger i Antitoxinkurven til Følge. Endvidere har Müller (14) ved sine Forsøg med Hetol vist en vis Sammenhæng mellem Virkningen af leukocytosefrembringende Stoffer og Antitoxindannelsen.

I den seneste Tid har Fürst (15) iagttaget, at Injektion af Methylenblaat foruden at nedsætte Leukocytantallet i Blodet tillige bevirker en ringe Stigning i Antistofdannelsen. Walker (16) er det lykkedes at stimulere Agglutinindannelsen hos Kaniner ved Injektion af Salvarsan. Hektoen & Corper (17) har undersøgt Thoriums Indvirkning paa Præcipitindannelsen og fundet, at denne hæmmes stærkt, saafremt Thorium injiceres paa et tidligt Stadium i Immuniseringsprocessen; er Produktionen af Antistoffet allerede i Gang, er Injektionen af Thorium derimod uden Virkning.

Det er ifølge Sagens Natur vanskeligt med vor nuværende Viden at drøfte Spørgsmaalet om Karakteren af de Processer, der foregaar under Antitoxinets Dannelse i Organismen, men af hvilken Art disse Processer end er (synthetiske Processer, Spaltninger, intramolekulære Omlejringer etc.), saa tør man vel nok formode, at Omsætninger af enzymatisk Natur ogsaa her — som ved al anden

Cellevirksomhed — spiller en mere eller mindre fremtrædende Rolle.

For at Enzymer skal kunne udfolde deres fulde Virkning, maa — som bekendt — visse Betingelser være tilstede, Betingelser om hvis Natur vi i de fleste Tilfælde kun ved meget lidt. Blandt talrige andre har man imidlertid gjort den Iagttagelse, at Tilstedeværelsen af visse Metalsalte kan have en meget betydelig og undertiden afgørende Indflydelse (flere Oxydaser) paa mange Enzymers Virkning (Katalysatorer — Ko-Enzymer), og dette har hos mig fremkaldt den Formodning, at visse Metalsalte maaske ogsaa kunde være af Betydning for de antitoxindannende Processer i den dyriske Organisme, samt — om dette viste sig at være Tilfældet — at saadanne Metalsaltes Art og Mængde i Organismen maaske kunde tænkes at være en af Aarsagerne til de ofte meget store individuelle Forskelligheder hos Dyrene i deres Evne til at producere Antitoxin. Man kunde saaledes formode, at ethvert Dyr, som overhovedet er i Stand til ved en Antitoxindannelse at reagere mod en Toxininjektion, er i Besiddelse af det eller de til en saadan Reaktion fornødne Enzymer (specifike?), hvilke saaledes bliver bestemmende for de kvalitative Forhold ved Antitoxinets Dannelse, samt at Arten og Mængden af de tilstedeværende Metalsalte (Katalysatorer?) mere eller mindre er bestemmende for de kvantitative Forhold ved disse Processer. Saafremt noget saadant var Tilfældet, maatte man med nogen Ret kunne vente, at Tilførsel til den under Immunisering værende Organisme af de paagældende Metalsalte i mange Tilfælde vilde forøge Omfanget af de antitoxindannende Processer, d. v. s. resultere i en Forøgelse af Antitoxinkoncentrationen i Blodet.

Ud fra disse Overvejelser har jeg udført en Del Forsøg med coli-immuniserede Geder og diphtheri-immuniserede Heste; til de først foretagne Forsøg har jeg valgt Manganoklorid $MnCl_2 \cdot 4H_2O$, da Mangan som bekendt er en i mange Tilfælde endog særlig kraftigt virkende Katalysator.

Ifølge Bertrand & Medigreceanu's (18) Undersøgelser er Mangan forøvrigt en vigtig Bestanddel i Organerne hos alle højere og de fleste lavere Dyr; det laveste Indhold af Mangan findes i Muskler, Nerver og Lunge (19), og den graa Hjærnesubstans indeholder en større Mængde end den hvide.

Forff. har analyseret Meneskeblod og Faareblod (20) og fundet, at det første indeholder 0,02 mg Mn og det sidste 0,06 mg Mn pr. Liter samt vist, at Manganet ikke findes i Blodlegemerne men udelukkende i Blodplasmaet.

Ved subkutan Injektion af Manganosulfat paa Kaniner (0,0025—0,02 g pr. Kilo Kanin) har B. & M. undersøgt Resorptions- og Fordelingsforholdet i Organismen og vist, at Saltet resorberes ualmindelig hurtigt og snart efter Injektionen findes i alle Væv. Det udskilles meget let og særlig med Galden, gennem Tarmslimhinden og Ventriklen, men en ringe Del udskilles ogsaa gennem Nyrerne.

Foruden med Manganoklorid har jeg tillige udført Forsøg med Nikkelklorid $NiCl_6 \cdot 6H_2O$, Koboltklorid $CoCl_2 \cdot 6H_2O$ og Zinkklorid $ZnCl_2$.

Forsøg med Geder.

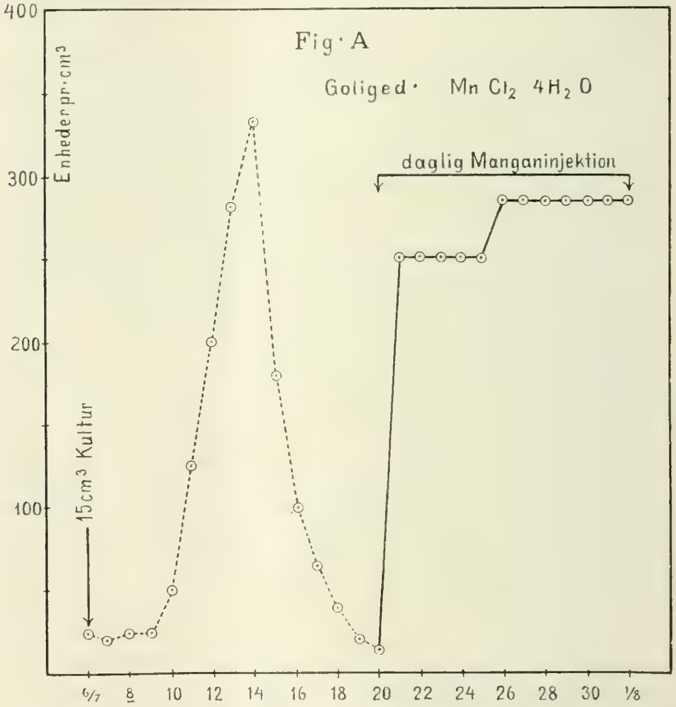
Da de individuelle Forskelligheder i Dyrenes Evne til at producere Antitoxin er saa store, og da man ikke iforvejen kan have nogen Mening om Antitoxinkurvens Højde, kan man vanskelig konstatere et Stofs eventuelle stimulerende Virkning ved at injicere dette ved Immuniseringens

Begyndelse samtidig med Antigenet; det er ved saadanne Undersøgelser nødvendigt at foretage Injektionen — eller Injektionerne — af det paagældende Stof paa et eller andet passende Tidspunkt i Antitoxinkurvens Fald.

Injektionerne af Saltoplosningerne er foretaget intravenøst.

Manganoklorid.

Etaarig Gedebuk (Nr. 1) — 25 kg. —, der tidligere havde været immuniseret med Colicultur. Den injicerede Colikultur opvarmedes først til 80° i 5 Minutter ligesom i de senere Forsøg. Blodprøve (10 cm^3) toges daglig, og det fraskilte Serum henstilledes i Iskælder til Forsøgets Afslutning, hvorefter Agglutininindholdet bestemtes paa sædvanlig Maade. Madsen & Jørgensen (4).



Forsøgets Resultater er sammenstillet i Tab. I, hvor de anførte Tal angiver Antallet af Agglutinineenheder i 1 cm³. Ved een Enhed forstaas den Agglutininmængde, der er i Stand til i 1 cm³ 24 Timers Kultur og i Løbet af 1 Time ved 37° at frembringe Agglutination af en bestemt Styrke.

$MnCl_2 \cdot 4H_2O$

Tab. I. Coli-Ged Nr. 1.

Dato	Injektion	Aggl.-Enheder	
6. Juli	15 cm³ Colikultur	25	
7. —		20	
8. —		25	
9. —		25	
10. —		50	
11. —		125	
12 —		200	
13. —		285	
14. —		335	
15. —		180	
16. —		100	
17. —		65	
18. —		40	
19. —		20	
20. —	25 cm³ $\frac{1}{100}$ molær $MnCl_2$	14	Rysten efter Injektion. 7^{00} Eft. T. 40,2°
21. —	—	250	Tp. normal
22. —	—	250	
23. —	—	250	
24. —	—	250	
25. —	—	250	
26. —	—	285	
27. —	—	285	
28. —	—	285	
29. —	—	285	
30. —	—	285	
31. —	—	285	
1. August	—	285	

Immuniseringsforløbet er grafisk gengivet i Fig. A.

I denne som ogsaa i de efterfølgende Kurver er de Svingninger i Agglutinationsstyrken, der er fremkaldt ved Injektion af et Metalsalt, trukket op med hele Linier, hvorimod de øvrige Svingninger er tegnede med stiplede Linier.

Det ses af dette Forsøg, at Dyret har reageret mod Kulturinjektionen paa normal Maade, først et ringe Fald, dernæst en stærk Stigning og derefter et hastigt Fald i Blodets Agglutininkoncentration. Den 20. Juli var Agglutininmængden lavere end før Immuniseringens Begyndelse, og paa denne Dag injiceredes 25 cm^3 af en 0,01 molær Opløsning af Manganoklorid; Dyret reagerede ret hæftigt overfor denne Injektion bl. a. ved Dyspnöe og ret stærk Rysten, og Kl. 7 Eftm. (Injektionen foretoges Kl. 11 Fmd.) var Tp. 40,2°. Næste Morgen var Dyret ganske frisk og reagerede ikke i mindste Maade paa de paafølgende daglige Injektioner af den samme Saltmængde. Ingen af de øvrige Geder reagerede synligt efter Metalsaltinjektionerne.

Af Fig. A fremgaar det, at den daglige Injektion af denne ringe Mængde Manganoklorid (c. 0,05 g) havde en meget betydelig Stigning i Agglutininkoncentrationen til Følge, samt at Stigningen foregik meget hurtigt; i Løbet af det første Døgn steg Agglutininmængden fra 14 til 250 Enheder; de følgende daglige Injektioner bragte Kurven til at stige yderligere, saaledes at det alene ved Manganbehandlingen lykkedes at bringe Agglutininkoncentrationen omtrent op til samme Styrke som den, der frembragtes af selve Antigenet.

Nikkelklorid.

Gedebuk (Nr. 5) (1½ Aar, 25 kg), der tidligere havde været immuniseret med Colikultur.

Forsøgets Resultater er opført paa Tab. II.

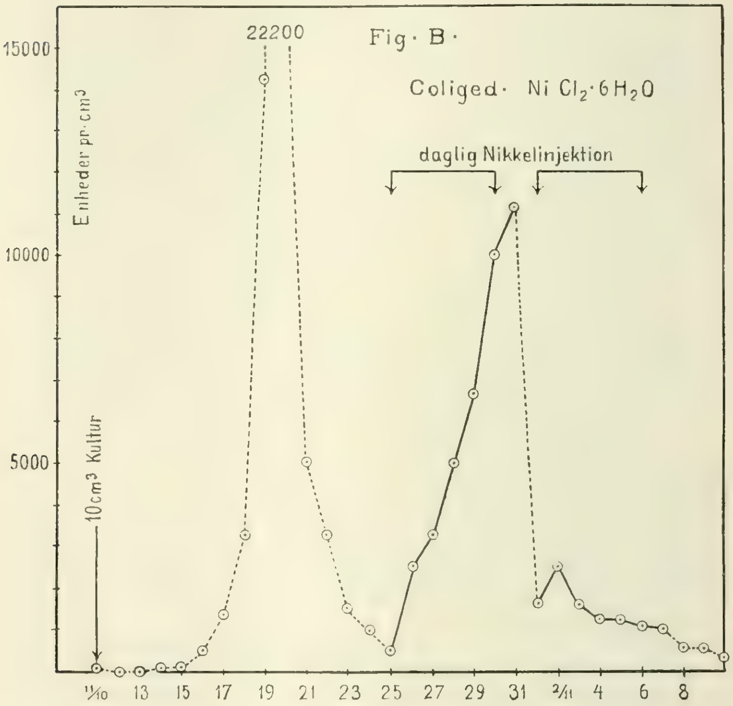
$NiCl_2 \cdot 6H_2O$

Tab. II. Coli-Ged Nr. 5.

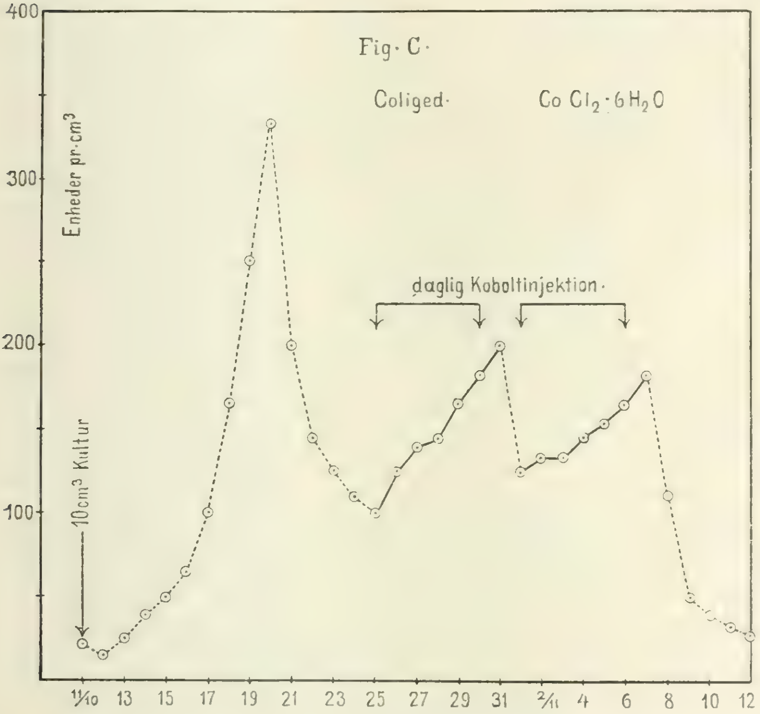
Dato	Injektion	Aggl.-Enheder	
11. Oktober ...	10 cm^3 Colikultur	100	
12. — ...		50	
13. — ...		50	
14. — ...		100	
15. — ...		125	
16. — ...		500	
17. — ...		1430	
18. — ...		3333	
19. — ...		14300	
20. — ...		22200	
21. — ...		5000	
22. — ...		3333	
23. — ...		1550	
24. — ...		1000	
25. — ...	25 cm^3 $\frac{1}{100}$ molær $NiCl_2$	500	Ingen Reaktion
26. — ...	—	2500	—
27. — ...	—	3333	—
28. — ...	—	5000	—
29. — ...	—	6670	—
30. — ...	—	10000	—
31. — ...	Ingen Injektion	11100	
1. November..	25 cm^3 $\frac{1}{100}$ molær $NiCl_2$	1670	—
2. — ..	—	2500	—
3. — ..	—	1670	—
4. — ..	—	1250	—
5. — ..	—	1250	—
6. — ..	—	1110	—
7. — ..	Ingen Injektion	1000	
8. — ..	—	500	
9. — ..	—	500	
10. — ..	—	333	
11. — ..	—	333	
12. — ..	—	250	

Immuniseringskurven er tegnet i Fig. B.

Ogsaa denne Ged reagerede med et lille Fald i umiddelbar Tilslutning til Injektionen af Kulturen; den paafølgende Stigning var meget betydelig, idet Agglutininstyrken naaede til 22200 Enheder i 1 cm^3. Paa den Dag, da Injektionen af Nikkelkloridet foretoges, var Agglutininmængden nede paa 500 Enheder; ogsaa dette Salt frembragte en betydelig Stigning, idet det lykkedes ved daglig Injektion i 6 Dage at bringe Agglutininkoncentrationen op til 11100 Enheder, d. v. s. til Halvdelen af Styrken i den første Kurve; det er muligt, at Agglutininmængden ved fortsat Injektion af Saltet vilde have tiltaget endnu mere, men ved en Fejltagelse fik Dyret (lige som de samtidig behandlede Geder Nr. 4 og 6) ingen Injektion af Nikkelklorid 31. Oktober (en Søndag), medens Injektionerne fortsattes om Mandagen og de følgende 6 Dage.



Under dette Forsøg gjorde man den Iagttagelse, at Agglutininmængden aftager med stor Hastighed saa snart som Tilførslen af Metalsaltet ophører. Samtidig synes Organismen i dette Tilfælde omtrent fuldstændig at have mistet Evnen til med Metalsalte som Stimulans at fortsætte Agglutininproduktionen, idet Agglutininkoncentrationen trods Injektion af Nikkelklorid jævnt og stadig aftager.



Koboltklorid.

Gedebuk Nr. 6 ($1^1/_2$ Aar, 25 kg); havde tidligere været coli-immuniseret.

Forsøgets Resultater findes paa Tab. III.

$CoCl_2 \cdot 6H_2O$

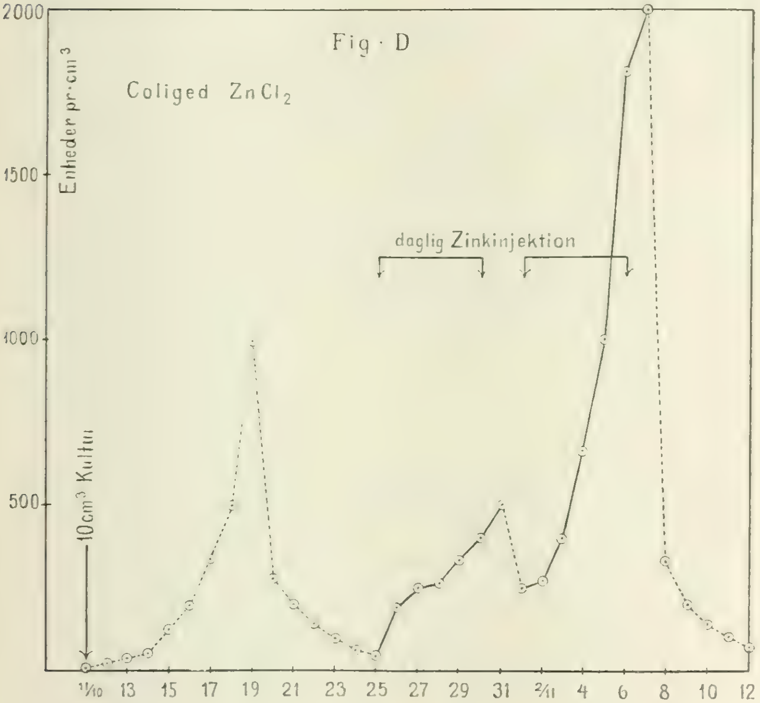
Tab. III. Coli-Ged Nr. 6.

Dato	Injektion	Aggl.-Enheder
11. Oktober ...	10 cm^3 Colikultur ...	20
12. — ...		15
13. — ...		25
14. — ...		40
15. — ...		50
16. — ...		66
17. — ...		100
18. — ...		165
19. — ...		250
20. — ...		333
21. — ...		200
22. — ...		145
23. — ...		125
24. — ...		110
25. — ...	25 cm^3 $\frac{1}{100}$ molær $CoCl_2$	100
26. — ...	—	125
27. — ...	—	133
28. — ...	—	145
29. — ...	—	165
30. — ...	—	182
31. — ...	Ingen Injektion	200
1. November..	25 cm^3 $\frac{1}{100}$ molær $CoCl_2$	125
2. — ..	—	133
3. — ..	—	133
4. — ..	—	145
5. — ..	—	154
6. — ..	—	165
7. — ..	Ingen Injektion	182
8. — ..	—	111
9. — ..	—	50
10. — ..	—	40
11. — ..	—	33
12. — ..	—	28

Immuniseringskurven er tegnet i Fig. C.

Man vil i dette Forsøg lægge Mærke til den forholdsvis lille Virkning i det første Døgn efter den første Saltinjektion sammenlignet med Virkningen af Mangan- og Nikkelklorid;

paa den anden Side er Faldet fra 31. Oktober til 1. November ikke særlig betydeligt; ved de fortsatte Saltinjektioner lykkes det atter at faa Agglutininmængden til at stige, men saa snart disse endelig ophører, falder Agglutininkoncentrationen meget stærkt.



Zinkklorid.

Gedebuk Nr. 4 (1$^1/_2$ Aar, 30 kg); har tidligere været immuniseret med Colikultur.

Forsøgsresultaterne er samlet i Tab. IV.

$ZnCl_2$

Tab. IV. Coli-Ged Nr. 4.

Dato	Injektion	Aggl.-Enheder
11. Oktober ...	10 cm^3 Colikultur	12,5
12. — ...		25
13. — ...		33,3
14. — ...		50
15. — ...		125
16. — ...		200
17. — ...		333
18. — ...		500
19. — ...		1000
20. — ...		286
21. — ...		200
22. — ...		133
23. — ...		100
24. — ...		66,7
25. — ...	25 cm^3 $\frac{1}{100}$ molær $ZnCl_2$	33,3
26. — ...	—	200
27. — ...	—	250
28. — ...	—	286
29. — ...	—	333
30. — ...	—	400
31. — ...	Ingen Injektion	500
1. November..	25 cm^3 $\frac{1}{100}$ molær $ZnCl_2$	250
2. — ..	—	286
3. — ..	—	400
4. — ..	—	667
5. — ..	—	1000
6. — ..	—	1820
7. — ..	Ingen Injektion	2000
8. — ..	—	333
9. — ..	—	200
10. — ..	—	143
11. — ..	—	111
12. — ..	—	66,7

Svingningerne i Agglutininstyrken er tegnet paa Fig. D.

Det fremgaar heraf, at ogsaa Zinkklorid er i Stand til at bringe Stigning i Agglutininkurven, samt at Ophør med Injektionerne straks ledsages af et Fald; de derefter følgende

Injektioner foranlediger — i Modsætning til Forsogene med Nikkel og Kobolt — en overordentlig stærk Stigning, saaledes at Dyrets Serum efter Zinkbehandlingen alene indeholder c. dobbelt saa meget Agglutinin som ved den første Kurves Akme.

I det efterfølgende Forsøg med den tidligere coliimmuniserede Gedebuk Nr. 2 (1 Aar, 25 kg) har jeg undersøgt Immuniseringsforlobet ved samtidig med Antigenet at injicere 25 cm^3 $\frac{1}{100}$ molær $MnCl_2$ og derefter samme Saltmængde hver af de følgende Dage. Resultatet er opført i Tab. V.

Dette Forsøg viser, at Immuniseringskurven med Antigen + $MnCl_2$ saavel i det første ringe Fald (forste negative Phase) som i den derefter følgende Stigning (positive Phase) ganske ligner det sædvanlige Immuniseringsforløb; derimod udebliver det paafølgende Fald (anden negative Phase), idet de daglige Manganinjektioner formaar praktisk talt at holde Agglutininkoncentrationen oppe paa samme Højde.

Ophører Injektionerne af Mangan, falder ogsaa i dette Tilfælde Agglutininstyrken hastigt, men ved de derefter følgende Injektioner bringes denne atter op til samme Højde som i den første Kurve.

Forsøg med Heste.

Disse Forsøg er udført med Heste, immuniserede med Diphtheritoxin, dels i Tilslutning til Gedeforsogene ved at foretage Injektionerne af Metalsaltene i Antitoxinkurvens Fald (anden negative Phase) og dels ved at injicere Saltene daglig under selve Immuniseringsprocessen.

Til disse Forsøg er kun anvendt Manganoklorid, og til hver Injektion, der foretoges intravenøst, 10 cm^3 $\frac{1}{2}$ molær $MnCl_2 \cdot 4H_2O$ (= 0,99 g).

Som det fremgaar af det senere meddelte Forsøg med Hest Nr. 309, er denne Saltmængde vistnok meget nær den største Mængde, der gennem længere Tid lader sig applicere uden i nogen væsentlig Grad at forstyrre Hestens Velbefindende Ved den intravenøse Injektion, der altid foretages i en af Halsvenerne, maa der udvises stor Paapasselighed for

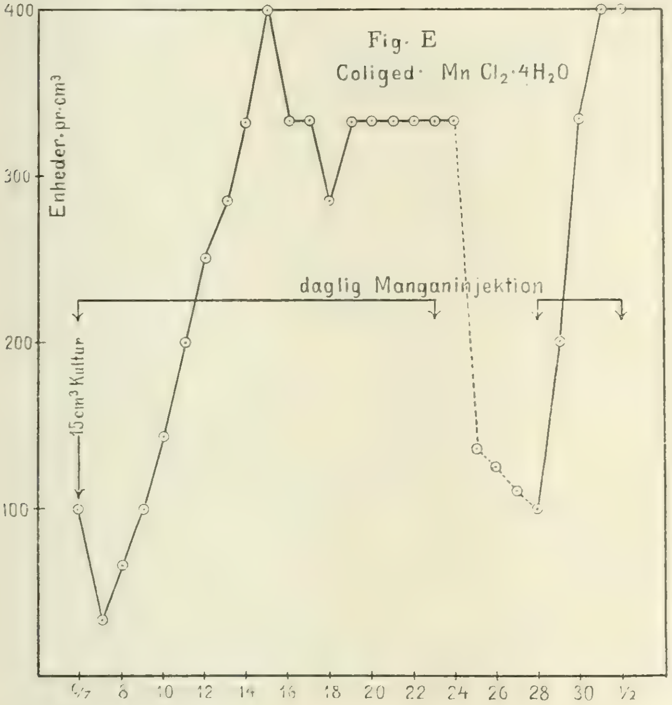
$MnCl_2 \cdot 4H_2O$

Tab. V. Coli-Ged Nr. 2.

Dato	Injektion	Aggl.-Enheder	
6. Juli	15 cm^3 Colikultur .... 25 cm^3 $\frac{1}{100}$ mol. $MnCl_2$	100	
7. —	25 cm^3 $\frac{1}{100}$ mol. $MnCl_2$	33	
8. —	—	66	
9. —	—	100	
10. —	—	144	
11. —	—	200	
12. —	—	250	
13. —	—	285	
14. —	—	333	
15. —	—	400	
16. —	—	333	
17. —	—	333	
18. —	—	285	
19. —	—	333	
20. —	—	333	
21. —	—	333	
22. —	—	333	
23. —	—	333	
24. —	Ingen Injektion	333	
25. —	—	135	
26. —	—	125	
27. —	—	110	
28. —	25 cm^3 $\frac{1}{100}$ mol. $MnCl_2$	100	
29. —	—	200	
30. —	—	333	
31. —	—	400	
1. August	—	400	

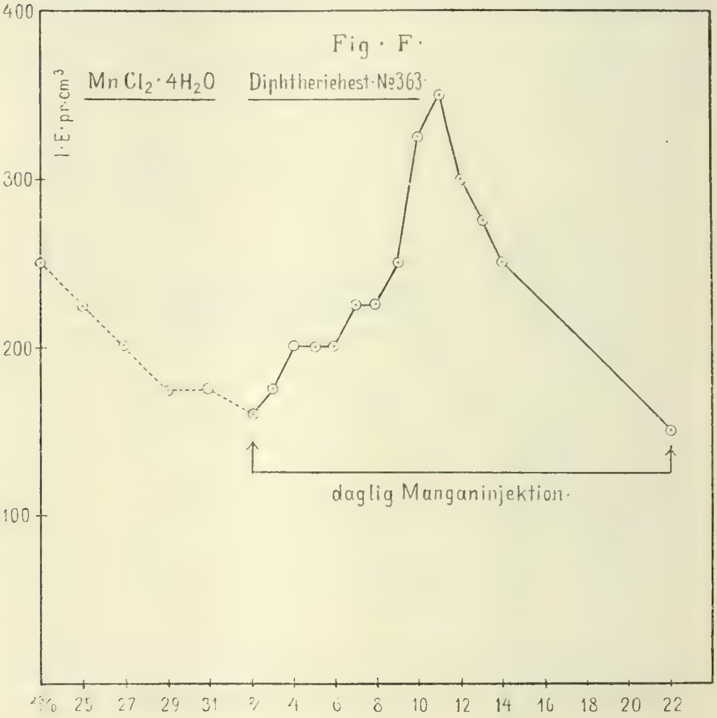
Immuniseringsforløbet er tegnet i Fig. E.

at ikke selv en meget ringe Mængde af Saltopløsningen injiceres i Vævene omkring Venen eller i det subkutane Væv; sker dette, fremkommer der paa Injektionsstedet meget hurtigt kraftige og haarde Infiltrationer, der efterhaanden kan brede sig stærkt; de generer Dyret meget og forringer i høj Grad dets Bevægelighed og Ædelyst. Som Regel formindskes disse Infiltrationer efter nogen Tids Forløb for oftest efterhaanden ganske at forsvinde.



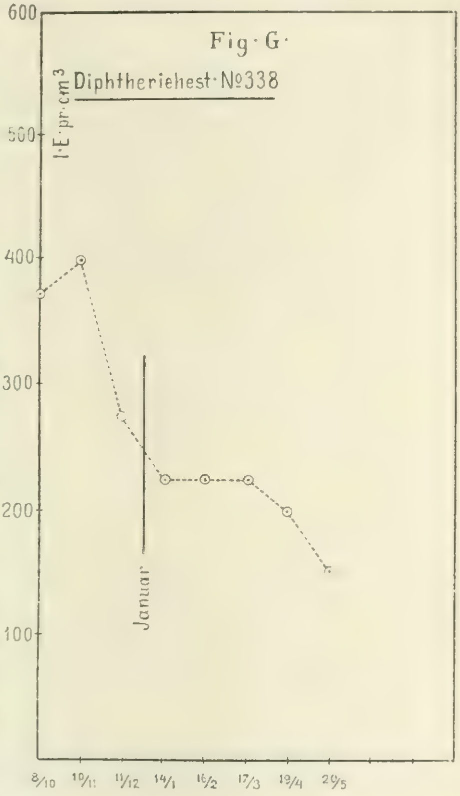
Injektion af Manganoklorid i Antitoxinkurvens Fald.

Hest Nr. 363. Denne Hest var aareladt første Gang $^{16}/_{8}$ (400 I. E. pr. cm^3), anden Gang $^{15}/_{9}$ (425 I. E. pr. cm^3) og tredie Gang $^{23}/_{10}$ (250 I. E. pr. cm^3); efter denne Aareladning toges Blodprøve hveranden Dag, i hvis Serum Antitoxinmængden bestemtes; $^{2}/_{11}$ var Styrken faldet til 160 I. E. pr. cm^3. Paa denne Dag og hver følgende Dag injiceredes 10 cm^3 $\frac{1}{2}$ molær Mangankloridopløsning indtil $^{22}/_{11}$, da Forsøget afsluttedes. Blodprøver toges hver Dag. Antitoxinkurven er tegnet i Fig. F.



Af dette Forsøg fremgaar det, at **Manganoklorid har en meget betydelig fremmende Indflydelse paa Produktionen af Diphtherieantitoxin i en immuniseret Hest; i det foreliggende Tilfælde steg Antitoxinstyrken ved Manganinjektioner alene fra 160 I. E. til 350 I. E. pr. cm^3 eller c. 120 %.**

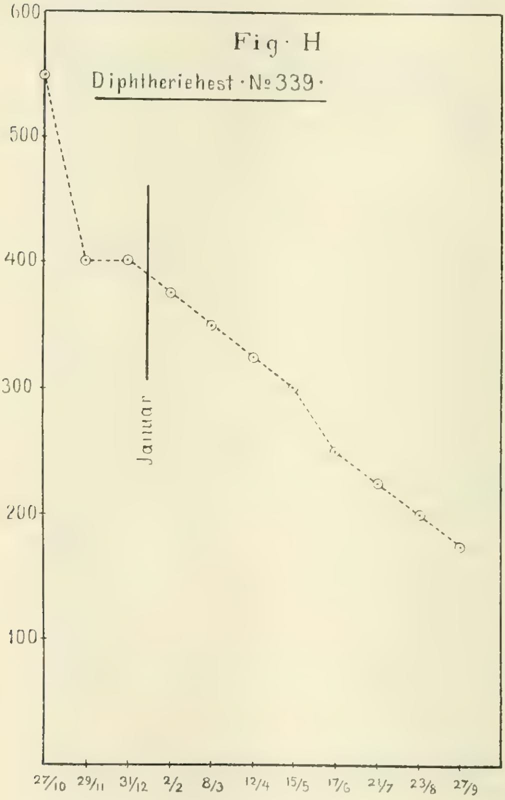
Af Forsøget ses det endvidere, at Antitoxinkurven stiger til et vist Punkt for derefter trods de vedblivende Manganinjektioner atter at falde; Kurvens Form er ganske som ved en almindelig aktiv Immunisering, endog Kurvens Akme falder paa den 9' Dag efter at Manganbehandlingen tog sin Begyndelse, men dette sidste beror dog maaske paa Tilfældigheder.



Injektion af Manganoklorid under selve Immuniseringsperioden.

Efter den første langsomme Immunisering med paafølgende Aareladning aarelades Diphtherieheste som Regel med omtrent een Maaneds Mellemrum; imellem disse Aareladninger injiceres subkutant et passende Antal cm³ Diphtherietoxin for om muligt at forhindre Blodets Antitoxinindhold i at formindskes eller eventuelt foranledige en Stigning heri inden næste Aareladning. Dette Immuniseringsforløb var for de til disse Forsøg anvendte Heste saaledes: efter Aareladningen staar Dyret uden Behandling i c. 8 Dage, derefter injiceres 200 cm³ Toxin, 5—6 Dage senere 400 cm³ Toxin, 6—7 Dage senere 600 cm³ Toxin og paa 9' Døgn efter denne Injektion foretages den store Aareladning.

I forskellige Perioder under denne Immunisering injiceredes daglig — eller i enkelte Tilfælde hver anden Dag — 10 cm^3 $\frac{1}{2}$ molær Oplosning af Manganoklorid; enten paabegyndtes denne Behandling efter Injektion af 200 cm^3 Toxin, eller efter 400 cm^3 Toxin, eller ogsaa først efter Injektionen af de 600 cm^3 Toxin, men i alle Tilfælde gennemførtes den til Dagen før Aareladningen.



Svingningerne i Antitoxinstyrken i Løbet af denne kombinerede Toxin-Mangan-Behandling har jeg ikke maalt, men indskrænket mig til at maale Serums Styrke paa selve Aareladningsdagen.

Som det er almindelig kendt, er de Antitoxinkoncentrationer, man ved Aareladningerne finder hos diphtherieimmuniserede Heste underkastet store Variationer, selv om Immuniseringen gennemføres paa ganske ens Maade. Dog forekommer der sædvanligt Perioder, i hvilke den antitoxinproducerende Evne i store Træk enten er tiltagende, nogenlunde konstant eller nedadgaaende. Det er klart, at der i en Periode, hvor Evnen til Antitoxindannelse er i Tiltagende, vilde kræves et meget betydeligt Forsøgsmateriale for med nogenlunde Sikkerhed at konstatere en gunstig Virkning af en saadan Behandling, hvorimod Forholdet i en Periode, hvor Variationerne var smaa, maatte være betydelig bedre, medens naturligvis en Periode, i hvilken Antitoxindannelsesevnen

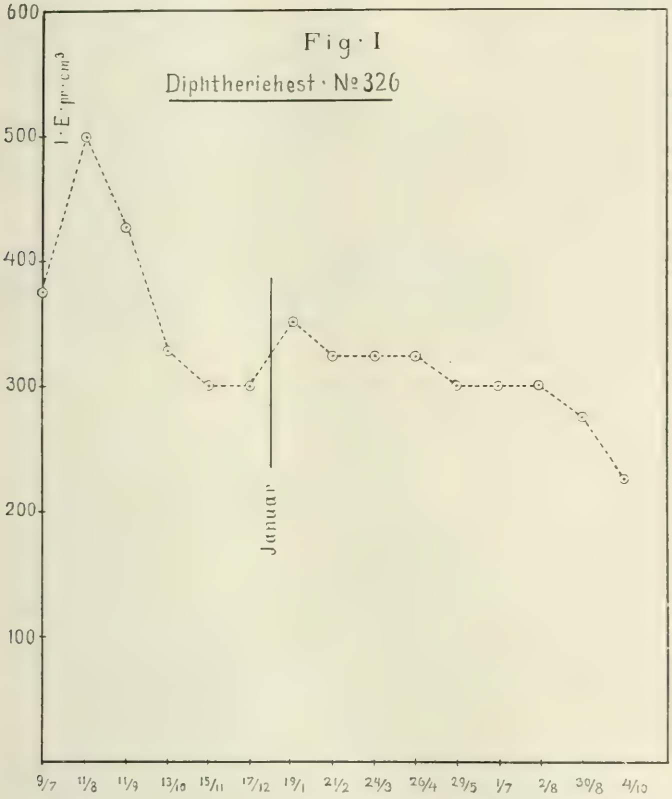


Fig · I

Diphtheriehest · № 326

var absolut aftagende, vilde være den bedste Basis for Forsøg af denne Art.

Jeg paabegyndte Forsøgene med Manganbehandlingen i April—Maj Maaned og fortsatte dem den resterende Del af Aaret; denne Periode viste sig at være særlig heldig til dette Formaal, idet samtlige diphtherieimmuniserede Heste havde været i uafbrudt Nedgang i Antitoxinstyrke fra Januar eller endnu tidligere, og at denne Nedgang fortsattes længe efter, at Manganbehandlingen havde taget sin Begyndelse og praktisk talt Aaret ud konstateredes ved at følge Forløbet af Kurverne for de Heste, der ikke blev manganbehandlede. Som Exempler paa disse har jeg her gengivet Kurverne for Hestene Nr. 338, 339 og 326 henholdsvis i Fig. G, H og I.

Som Exempel paa de Stigninger i Serums Antitoxinstyrke, som foraarsages af Manganinjektionerne, anføres Kurverne for de fire Heste Nr. 316, 334, 309 og 348 (Fig. K, L, M og N).

Ligesom for Forsøgene med Coliagglutininsvingningerne hos Geder er her de Ændringer i Antitoxinkoncentrationen, hvori Mangansaltet har været delagtig, trukket op med hele Linier.

Fig. K.

Diphtherihest Nr. 316.

Ved den sidste Aareladning før Manganbehandlingen $^{20}/_{5}$ indeholdt Serum **300 I. E.** pr. cm^3.

$^{11}/_{6}$—$^{23}/_{6}$ d. v. s. efter 600 cm^3 Toxin daglig Manganinjektion; ved Aareladning $^{23}/_{6}$ var Styrken **350 I. E.**

$^{25}/_{6}$—$^{24}/_{7}$ hver anden Dag Manganinjektion; ved Aareladningen $^{24}/_{7}$ var Styrken **400 I. E.**

$^{12}/_{8}$—$^{30}/_{8}$ d. v. s. efter 400 cm^3 Toxin daglig Manganinjektion, hvorved Styrken ved Aareladningen $^{30}/_{8}$ steg til **500 I. E.**

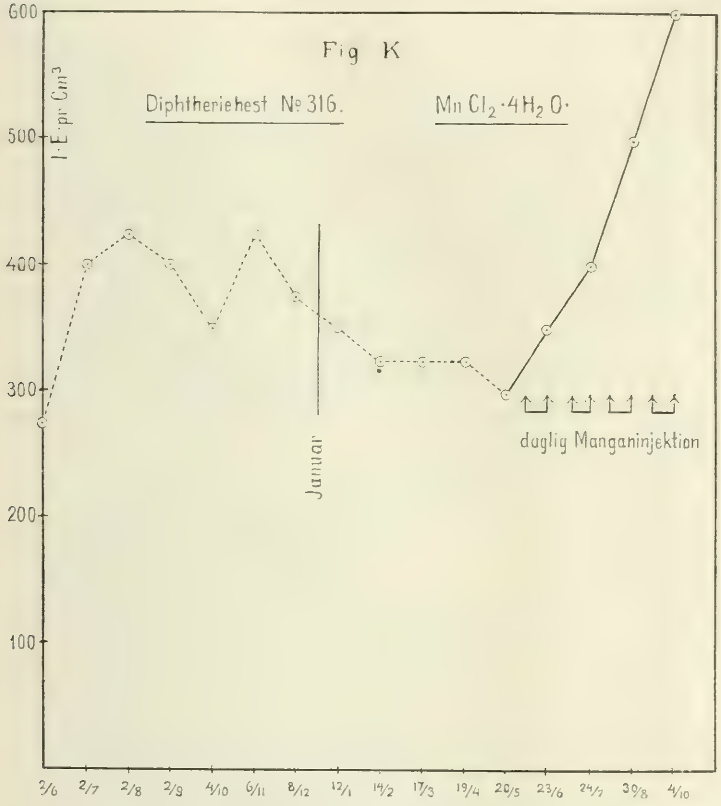
$^{17}/_{9}$—$^{4}/_{10}$ — tilsvarende Behandling.

Serums Styrke ved Aareladningen $^{4}/_{10}$ var nu **600 I. E.**

Hesten var meget gammel og maatte slagtes.

Dette Forsøg viser, at Injektion af Manganoklorid under Immuniseringsprocessen har en udpræget stimulerende Indflydelse paa Antitoxindannelsen.

Ved Sammenligning med Kontroldyrene tør man med ret stor Sikkerhed antage, at Antitoxinstyrken hos denne Hest ved Aareladningen $^{4}/_{10}$ vilde være



gaaet ned til c. 200 I. E. Ved Behandlingen med Mangan var det derimod lykkedes at bringe Styrken op paa 600 I. E.

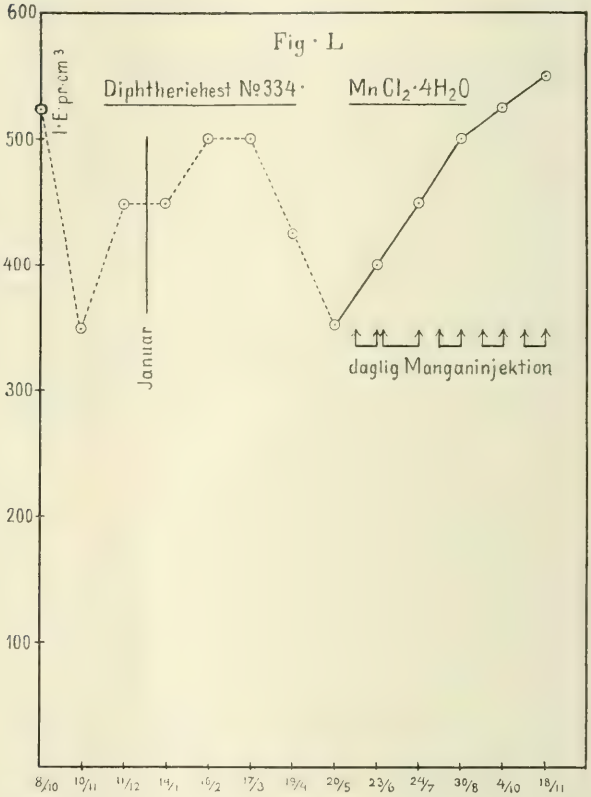
Fig. L.

Diphtherihest Nr. 334.

Ved Aareladningen $^{20}/_{5}$, for Manganbehandlingen paabegyndtes, var Serums Styrke **350 I. E.** pr. cm^{3}.

$^{14}/_{6}$—$^{23}/_{6}$ d.v.s. efter 600 cm³ Toxin daglig $MnCl_2$. Ved Aareladningen $^{23}/_{6}$ var Styrken steget til **400 I. E.**

$^{25}/_{6}$—$^{24}/_{7}$ hver anden Dag $MnCl_2$. Aareladning $^{24}/_{7}$. Serums Styrke var nu **450 I. E.**



$^{12}/_{8}$—$^{30}/_{8}$ d.v.s. efter 400 cm³ Toxin daglig $MnCl_2$. Ved Aareladningen $^{30}/_{8}$ var Serums Styrke **500 I. E.**

$^{17}/_{9}$—$^{4}/_{10}$ d.v.s. efter 400 cm³ Toxin daglig $MnCl_2$. Ved Aareladningen $^{4}/_{10}$ var Serums Styrke **525 I. E.**

$^{1}/_{11}$—$^{18}/_{11}$ d.v.s. efter 400 cm³ Toxin daglig $MnCl_2$. Ved Aareladningen $^{18}/_{11}$ var Styrken steget til **550 I. E.**

Hesten døde pludselig af Tarmslyng.

Forløbet her var som for Hest Nr. 316 — en jævn og stadig Tiltagen i Antitoxinproduktionen efter Manganbehandlingens Begyndelse.

Fig. M.

Diphtherihest Nr. 309.

Denne Hest aarelodes første Gang $^3/_3$, Aaret før disse Forsøg udførtes, men saavel ved denne Aareladning som ved de to følgende $^2/_4$ og $^2/_5$ var Antitoxinstyrken kun 200 I. E. pr. cm^3; paa Grund af denne ringe Evne til at danne Antitoxin blev Dyret afhændet, men foranlediget af særlige Forhold atter taget tilbage i December Maaned samme Aar; det immuniseredes nu som sædvanlig og aarelodes $^{29}/_1$, $^3/_3$, $^7/_4$ og $^8/_5$, men ved hver Aareladning var Styrken 200 I. E. pr. cm^3. At en Hest saaledes indstiller sig paa en ganske bestemt Antitoxinstyrke i længere Tid har vi iagttaget, omend ikke i særlig mange Tilfælde; erfaringsmæssigt bringer fortsat Behandling med Toxininjektioner sjælden Svingninger i Antitoxinkoncentrationen hos et saadant Dyr; sædvanlig bliver den staaende paa samme Styrke i lang Tid — ofte i flere Aar — og gaar efterhaanden langsomt tilbage. Denne Hest egnede sig saaledes ganske særlig til Forsøg af denne Art. Denne og Hest Nr. 348 var de første, paa hvilke Manganbehandlingen forsøgtes, og af denne Grund blev de anvendt til Indstilling af Dosis' Størrelse, om hvilke det paa Forhaand var vanskeligt at have nogen Mening.

$^{12}/_5$—$^{15}/_5$ daglig 10 cm^3 $\frac{1}{2}$ molær Opl. af $MnCl_2$ uden Forstyrrelse af Befindendet.

$^{17}/_5$ injic. 15 cm^3 af Opløsningen, hvilket fremkaldte en svag og ganske kortvarig Rysten.

$^{18}/_5$ injic. 20 cm^3; efterfulgtes af en stærk Rysten og Svedafsondring. Ildebefindendet varede c. 3 Timer og var ikke ledsaget af nogen Temperaturforhøjelse.

$^{19}/_{5}$ injic. **25 cm^3** med samme Virkning som Dagen forud, dog maaske lidt stærkere.

$^{20}/_{5}$ injic. **30 cm^3**. Hesten blev heftig syg med stærke Kuldegysninger, Aandenød, stærk Svedafsondring, og Temperaturen steg 3 Timer efter Injektionen til 40°.

$^{21}/_{5}$ Tp. 41,2°, stadig meget syg.

$^{22}/_{5}$ Tp. 40,7°, stadig meget syg.

$^{23}/_{5}$ Tp. 38,9°, meget mat.

$^{24}/_{5}$ omtrent rask.

$^{25}/_{5}$ Tp. normal. Rask.

$^{26}/_{5}$—$^{12}/_{6}$ injic. daglig **10 cm^3** MnCl$_2$-opl., uden at Befindendet paavirkedes. Hesten aarelodes $^{12}/_{6}$, og Serums Styrke var steget til **325 I. E.**

$^{22}/_{6}$—$^{15}/_{7}$ d. v. s. efter **200 cm^3** Toxin daglig 10 cm^3 MnCl$_2$. Ved Aareladningen $^{15}/_{7}$ var Styrken steget til **350 I. E.**

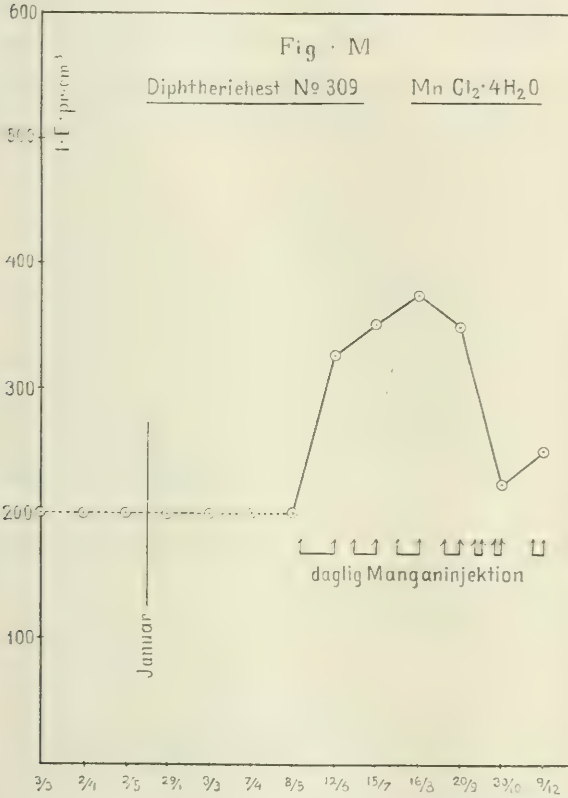
$^{30}/_{7}$—$^{16}/_{8}$ d. v. s. efter 400 cm^3 Toxin daglig MnCl$_2$. Aareladning $^{16}/_{8}$. Serums Styrke var nu **375 I. E.**

$^{10}/_{9}$—$^{20}/_{9}$ d. v. s. efter 600 cm^3 Toxin daglig MnCl$_2$. Aareladning $^{20}/_{9}$. Serums Styrke var nu faldet til **350 I. E.** Det maa hertil bemærkes, at Hesten i denne Periode ved mindre omhyggelig Behandling ved de intravenøse Injektioner af Mangansaltopløsning havde faaet ret store Infiltrationer paa begge Sider af Halsen.

$^{12}/_{10}$—$^{16}/_{10}$ d. v. s. efter 400 cm^3 Toxin daglig Injektion af MnCl$_2$. Manganinjektionerne maatte afbrydes $^{16}/_{10}$, da Infiltrationerne fra forrige Injektionsperiode var blevet saa udbredte og haarde, at det kun med største Vanskelighed var muligt at ramme Venen ved Indsprøjtningerne. For ikke herved maaske at forværre Tilstanden ophørtes med Injektionerne. Disse genoptoges

$^{27}/_{10}$, og Hesten aarelodes ^{30} $_{10}$, hvor det konstateredes, at Serums Styrke var faldet yderligere til **225 I. E.**

$^{1}/_{12}$—$^{9}/_{12}$ fik Hesten daglig 10 cm^3 Mangan, og ved Aareladningen havde Serum en Styrke af **250 I. E.**



Forsøget med denne Hest, der havde indstillet sig paa en konstant Antitoxinstyrke af 200 I. E. pr. cm^3, viser, at det ogsaa hos et saadant Individ er muligt ved Injektion af Manganoklorid at bryde denne Ligevægt og fremme Produktionen af Antitoxin i en betydelig Grad.

Som Forsøgenes videre Udvikling begynder at vise, er der naturligvis en Grænse for, hvor længe det er muligt at holde Dyrene oppe paa disse Antitoxinkoncentrationer; der kommer et Tidspunkt, hvor Serums Styrke trods fortsat Manganinjektion stadig bliver mindre og mindre; hvornaar dette Tidspunkt indtræder, synes at være individuelt forskelligt. I dette Tilfælde med Hest Nr. 309 tror jeg dog, Nedgangen allerede efter 3 Maaneders Behandling maa tilskrives de mægtige Infiltrationer med de deraf følgende Komplikationer.

Fig. N.

Diphtherihest Nr. 348.

Før Manganbehandlingen var Serums Styrke ved Aareladningen 8/5 **325 I. E.** pr. cm^3.

12/5—12/6 behandledes denne Hest paa ganske lignende Maade som Nr. 309 og med nøjagtig det samme Forløb. Ved Aareladningen 12/6 var Styrken steget til **575 I. E.** For at undersøge, hvilken Virkning det vilde have, hvis Manganindsprøjtningerne i den næste Periode udelodes, fik Hesten

12/6—15/7 kun Toxin. Følgen heraf blev, at Styrken faldt til **325 I. E.**

I den næste Periode injiceredes fra

30/7—16/8 d. v. s. efter 400 cm^3 Toxin daglig $MnCl_2$, og Antitoxinindholdet var ved Aareladningen 16/8 steget til **450 I. E.**

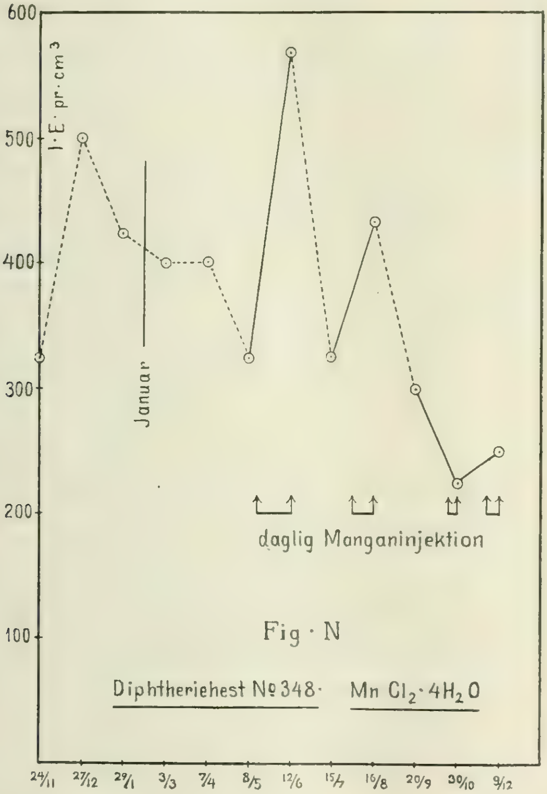
I den derpaa følgende Periode fra

16/8—20/9 injiceredes igen kun Toxin med det Resultat, at Styrken ved Aareladningen 20/9 var faldet til **300 I. E.**

Da Injektionerne fra den forrige Periode havde efterladt ret store Infiltrationer, kunde Manganindsprøjtningerne først fortsættes 27/10.

$^{27}/_{10}$—$^{30}/_{10}$ daglig 10 cm^3 MnCl$_2$. Ved Aareladningen $^{30}/_{10}$ var Styrken faldet til **225 I. E.**

$^{1}/_{12}$—$^{9}/_{12}$ daglig MnCl$_2$. Dyret blev aareladt og slagtet $^{9}/_{12}$, og Serums Styrke var **250 I. E.** Aarsagen til Nedgangen maa antagelig søges i de faa Manganinjektioner i Forbindelse med de udtalte Infiltrationer.



Dette Forsøg viser, ligesom de tidligere, Manganokloridets stærke stimulerende Virkning paa Antitoxindannelsen. At disse Stigninger i Produktionskurven alene bør tilskrives Manganet, gør disse Forsøg meget sansynligt, idet Udeladelsen af Mangantilførslen ledsages af et betydeligt Fald i Antitoxinstyrken, hvilket Eksperiment lader sig gentage flere umiddelbart paa hinanden følgende Gange (2) paa det samme Dyr.

Der er saaledes ifølge disse Undersøgelser ingen Tvivl om, at Injektioner af forskellige Metalsalte (Manganoklorid, Nikkelklorid, Koboltklorid og Zinkklorid) virker som en meget kraftig Stimulans for Dannelsen af Antistoffer (Coliagglutinin, Diphtherieantitoxin) i den dyriske Organisme.

Det forekommer mig, at disse Forsøg — bortset fra den praktiske — tør paaregne en ikke ringe teoretisk Interesse; før man tør vente at finde den endelige Forklaring paa disse Fænomener, maa naturligvis et meget betydeligt Arbejde udføres; Virkningen af talrige andre Salte (Katalysatorer?) bør undersøges og Forsøgene udstrækkes til at omfatte Repræsentanter for alle de forskellige Former af Antistoffer. At Metalsaltene foruden paa Antistofdannelsen tillige har en betydelig Indflydelse paa mange andre Processer og Foreteelser i den dyriske Organisme, har vi iagttaget.

Viser det sig ved fortsatte Undersøgelser, at Antistofdannelsen i al Almindelighed lader sig fremme ved Injektioner af Metalsalte el. l., bør det overvejes, om ikke Anvendelsen af saadanne »Katalysatorer« skulde kunne faa Betydning ved Behandlingen af Infektionssygdomme.

Influence of metallic salts in the formation of antitoxins.

Résumé.

Starting from the theoretical considerations adduced the object of the experiments was to investigate whether various metallic salts might possibly have a stimulating influence in the formation of antitoxins. The experiments were made partly on goats (coliagglutinin), partly on horses (diphtheria antioxin), and the metallic salts employed in the goat experiments were $MnCl_4 \cdot 4H_2O$, $NiCl_2 \cdot 6H_2O$, $CoCl_2 \cdot 6H_2O$, and $ZnCl_2$, whereas only $MnCl_2 \cdot 4H_2O$ was used in the experiments on horses.

The injections where made intravenously, into the goats in single daily doses of 25 cm^3 $\frac{1}{100}$ molecular solution, into the horses in doses of 10 cm^3 $\frac{1}{2}$ molecular solution.

The injections were made partly in the fall of the antitoxin curve, partly during longer or shorter uninterrupted periods of the immunisation process.

The experiments with agglutinin as well as with diphtheria antitoxin showed that the daily intravenous injection of the above metallic salts augmented the formation of these substances to no inconsiderable degree.

Horses immunized against diphtheria, which show a steady decrease in the power of the antitoxin, may, by the injection of $MnCl_2$, be made to produce antitoxin concentrations which are higher in several cases than those previously obtained for the horses in question by the ordinary immunisation technique.

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Biologiske Meddelelser. **III,** 7.

FORTSATTE UNDERSØGELSER OVER *CORPUS PINEALE* HOS PATTEDYRENE

AF

KNUD H. KRABBE

MED 3 TAVLER

AVEC UN RÉSUMÉ EN FRANÇAIS

1742

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI

1921

Fra Centraal-Instituut voor Hersenonderzoek i Amsterdam (Chef: Dr. C. U. Ariens Kappers) og Anatomiska Institutionen i Lund (Chef: Professor, dr. Ivar Broman).

I et tidligere arbejde[1] har jeg meddelt resultaterne af histologiske undersøgelser over corpus pineale hos en række pattedyr. Siden da har jeg haft lejlighed til at supplere disse undersøgelser ved studier paa det fortræffelige materiale, der findes paa Centraal-Instituut voor Hersenonderzoek i Amsterdam. Jeg bringer herved min hjærteligste tak til institutets leder, dr. C. U. Ariens Kappers for den store elskværdighed, hvormed han tillod mig at arbejde i sit laboratorium.

Endvidere har jeg paa Anatomiska Institutionen i Lund undersøgt snitserier af 6 sælhundefostre. For tilladelsen hertil bringer jeg professor, dr. Ivar Broman min hjærteligste tak.

Materialet bestod af pattedyrhjærner, skaaret i serier, dels kontinuerlige, dels trinserier, og for størstedelen farvet med Delafields hæmatoxylin og pikrofuchsin, eller med Weigert-Pals marvskedefarvning. Angaaende materialet henvises iøvrigt til central-institutets trykte katalog.[2]

Vi skal i det følgende give en oversigt over resultatet af undersøgelser for de enkelte pattedyrs vedkommende.

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[1] Bidrag til kundskaben om corpus pineale hos pattedyrene. Vidensk. Selsk. Biol. Medd. II, 2. 1920.

[2] Complete list of publications, brainmaterial, waxreconstructions etc. of the Nederlandsch Centraal-Instituut voor Hersenonderzoek 1909—1919. Amsterdam.

Echidna aculeata (Fig. 1—2 og tavle I, fig. 24).

Der forelaa en fuldstændig serie af frontale snit, gennemgaaende hvert 10ende snit, farvet efter Weigert og med karmin. Efter rekonstruktion at dømme er corpus pineale nærmest bønneformet, 2—3 mm i den største bredde, 1—2 mm tykt. Den lave recessus pinealis, der strækker sig et stykke ind i parenkymet, sender ude til siderne to korte forlængelser dybere ind i organet. Selve corpus pineale er solidt uden cystedannelse. Parenkymet er ensartet i sin struktur. Det bestaar af celler, hvis kærner viser to forskellige typer (Fig. 3). Den ene, som er den talrigeste, er lidt større, kromatinfattigere, indeholder 1—3 paafaldende store nucleoli,

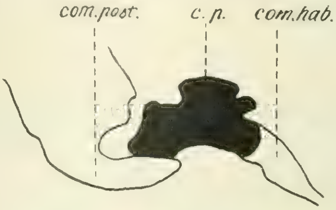

Fig. 1.

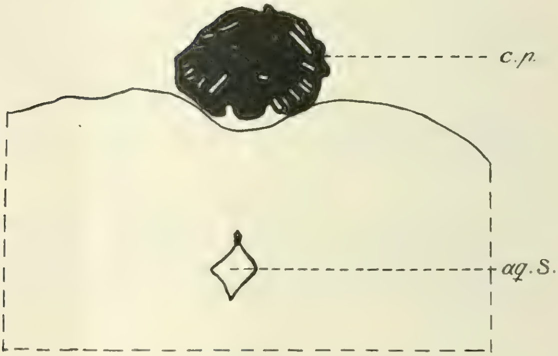

Fig. 2.

Fig. 1. Echidna aculeata. Sagittalsnit, rekonstrueret, 6 gange forstørret.
Fig. 2. Echidna aculeata. Frontalsnit, 6 gange forstørret. De hvide striber i *c. p.* betegner bundter af marvholdige nervetraade. Angaaende figurforklaring se iøvrigt S. 30.

som navnlig er store, naar der kun findes en enkelt. Den anden kærnetype findes noget sparsommere, den er mindre og kromatinrigere. De sidste kærner ses undertiden i tættere smaagrupper. Kærnerne er alle rundagtige, der ses ingen kantede eller aflange former. Protoplasmaet kunde ikke uddifferentieres.

I parenkymets randpartier ses en del smaa bundter af marvholdige nervetraade, for en stor del transversalt forløbende. Disse nervebundter er tættere i organets mest proximale del og hænger sammen med commissura posterior og commissura habenularum.

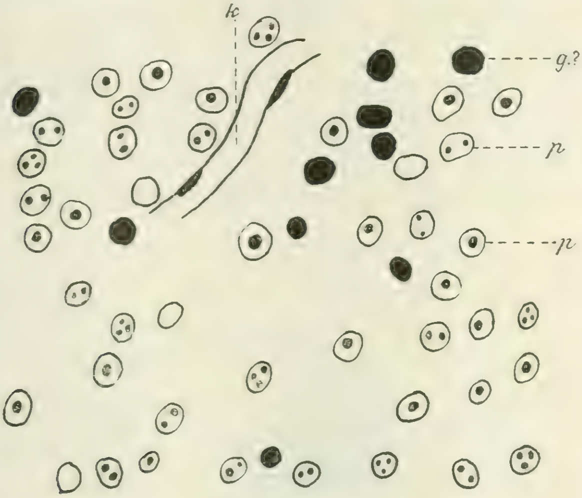

Fig. 3.

Fig. 3. Echidna aculeata. Parenkymet i *c. p.* 400 Gange forstørret. *g.* ? er mulige gliacellekærner.

Corpus pineale er ret stærkt vaskulariseret. Der synes ikke at være bindevævstrabekler i tilknytning til karrene, heller ikke ses der konkrementer eller gliaplaques.

Didelphys marsupialis (fig. 4—5).

Der forelaa til undersøgelse en komplet serie, hvert andet snit farvet efter Weigert-Pal, hvert andet med hæmatoxylin-syrefuchsin-pikrinsyre. Corpus pineale viste sig at være meget lidet udviklet. Det er $^{1}/_{2}$ mm langt, knap 1 mm

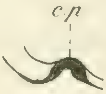

Fig. 4.

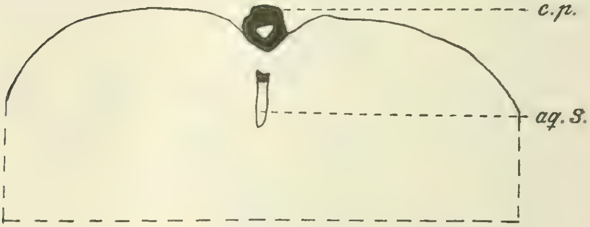

Fig. 5.

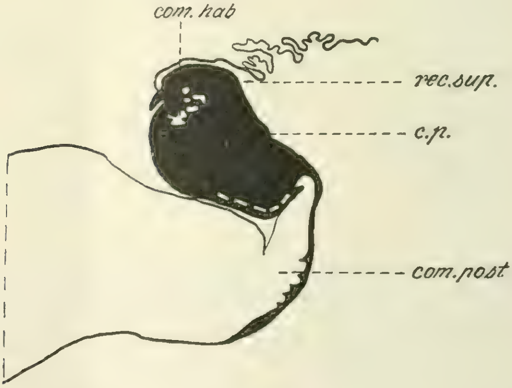

Fig. 6.

Fig. 4. Didelphys marsupialis. Sagittalsnit rekonstrueret. 6 gange forstørret.
Fig. 5. Didelphys marsupialis. Frontalsnit. 6 gange forstørret.
Fig. 6. Onychogale frenata. Sagittalsnit. 6 gange forstørret.

i bredde og tykkelse og danner en lille sækformet udbugtning, idet recessus pinealis strækker sig ind gennem næsten hele organets dybde. Væggene i dette dannes af et parenkym, der er ensartet i bygning og intet spor viser af follikeldannelse. Det bestaar af celler, hvis kærner er ensartede i størrelse, men uensartede i form, dels rundagtige, dels lidt aflange eller kantede, alle kromatinfattige. Der ses ingen marvholdige nervetraade i parenkymet.

Onychogale frenata (fig. 6).

Der forelaa en sagittalt skaaret serie, farvet dels efter v. Gieson, dels efter Weigert-Pal. Corpus pineale er paa sagittalsnittet nærmest aflangt firkantet med en stor flade vendende mod 3die ventrikel og uden nogen egentlig recessus pinealis. Commissura habenularum forløber ikke som ellers hos de fleste pattedyr udenpaa corpus pineale, men inden i dette, helt omgivet af parenkymet. Corpus pineale er 2$^1/_2$ mm langt, 1$^1/_2$ mm tykt. Parenkymet er stærkt vaskulariseret, ret homogent i bygning, dog er der noget stærkere ophobning af celler omkring karrene, hvorved parenkymet ved svagere forstørrelse viser en netformet tegning med mørkere masker af tætstillede kærner og lysere mellemrum med mere spredte kærner. Kærnerne er rundagtige og ensartede af udseende. Protoplasmaets forhold kunde ikke nærmere erkendes. Af marvholdige nervetraade ses, foruden det tværløbende bundt, der repræsenterer commissura habenularum, ogsaa længdeløbende fibre i den basale del, udgaaende fra commissura posterior.

Hypsiprymnus murinus (fig. 7—8).

Der forelaa til undersøgelse to alternerende frontale serier farvet efter henholdsvis v. Gieson og Weigert-Pal. Corpus pineale er efter rekonstruktionen nærmest bønneformet, har i forhold til hjærnens størrelse (tværdimension 3 cm) en ret betydelig udstrækning, navnlig i bredden.

idet det er 4 mm bredt og 3 mm langt, mens det paa rekonstruktionen har en tykkelse af ca. 2 mm. Der findes kun en ganske ubetydelig recessus pinealis. Organet er solidt og homogent bygget uden cyster eller alveoldannelse. Parenkymet bestaar af celler med kærner, der for størstedelen er ensartede, rundagtige og jævnt fordelte over hele organet. Mellem disse findes et lille antal noget mindre, mere kantede og kromatinrigere kærner. Protoplasmaets struktur kunde ikke bestemmes. Corpus pineale er

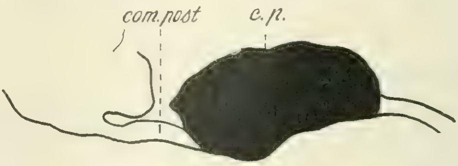

Fig. 7.

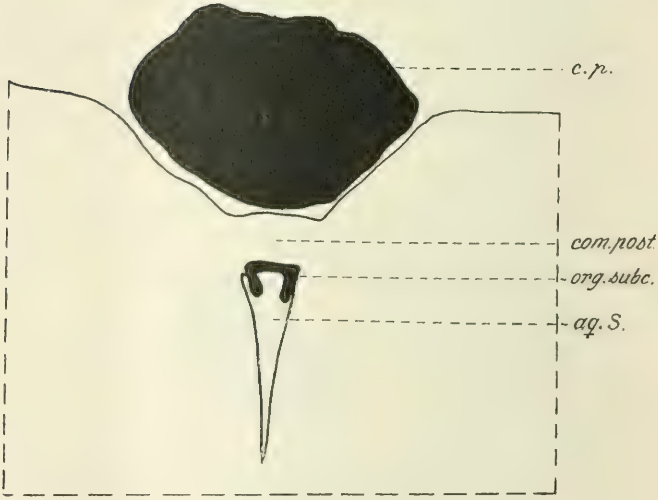

Fig. 8.

Fig. 7. Hypsiprymnus murinus. Sagittalsnit, rekonstrueret. 6 gange forstørret.

Fig. 8. Hypsiprymnus murinus. Frontalsnit. 6 gange forstørret.

meget stærkt vaskulariseret med ret store kar. Næst efter halichoerus er hypsiprymnus det af de undersøgte pattedyr, der har vist den stærkeste vaskularisation. Der ses ingen bindevævstrabekler.

Macropus robustus (Fig. 9—10).

Der forelaa to alternerende serier farvet efter henholdsvis WEIGERT-PAL og v. GIESON. Efter rekonstruktion at dømme

Fig. 9.

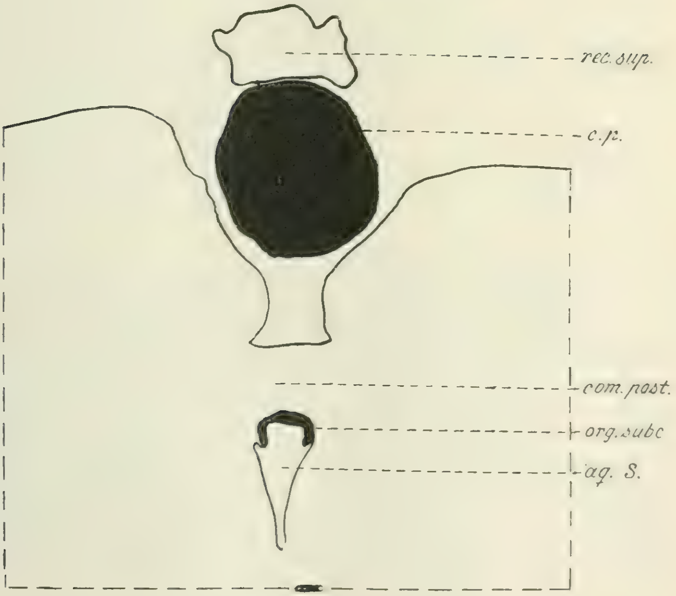

Fig. 10.

Fig. 9. Macropus robustus. Sagittalsnit, rekonstrueret. 6 gange forstørret.
Fig. 10. Macropus robustus. Frontalsnit. 6 gange forstørret.

repræsenterer corpus pineale en temmelig flad, skaalformet udbugtning mellem de to kommissurer, kun 1 mm tyk, 4 mm i længde og bredde. En lille glatvægget reces strækker sig ind mellem commissura posterior og corpus pineale, desuden et lille stykke ind i dettes parenkym; recessus suprapinealis naar til dets spids. Bortset fra en lille cyste tæt under overfladen er corpus pineale solidt og ensartet bygget uden follikeldannelse. Parenkymet bestaar af celler med ensartede, rundagtige kærner med en lille nucleolus og jævnt fordelt i parenkymet. Da stærk forstørrelse ikke kunde anvendes (tykt dækglas), kunde finere detailler ikke erkendes. Corpus pineale er omgivet af en bindevævskapsel, men der er ingen bindevævsstrøg i det indre. Derimod er der en meget stærk vaskularisation af parenkymet.

Paa marvskedepræparaterne ses i organets basale parti et bredt bundt af marvholdige nervetraade, der fra commissura posterior løber ud mod organets spids. I det øvrige parenkym ses kun ganske enkelte marvholdige nervetraade. Fra commissura habenularum løber ganske smaa bundter ind i organets dorsale parti.

Vespertilio murinus.

Der forelaa til undersøgelse en frontal serie farvet med Delafields hæmatoxylin. Corpus pineale syntes stærkt skrumpet ved fixeringen; det maalte ca. $^1/_3$ mm i bredden og var godt halvt saa tykt. Der var ovalt i tværsnit.

Parenkymet bestod af celler med rundagtige kærner, ensartede og tætstillede og med et stærkt skrumpet protoplasma. En lille reces gik ind i organet.

Vesperugo noctula.

Paa serier farvet efter Weigert-Pal saas udseendet lignende det af den tidligere beskrevne vesperugo. Fra commissura habenularum strakte nogle smaa marvskedebundter sig ind i organets basis.

Arctomys (marmotta?).

Der forelaa til undersøgelse trinserier (hvert 5te) af en hjærne, skaaret frontalt og farvet efter Weigert-Pal. Efter sammenstilling af snittene (der foretoges ikke rekonstruktion) maa corpus pineale antages at være ca. 1 1/2 ctm langt, kølleformet, kredsrundt i tværsnit med en diameter af 1 1/2 mm paa det tykkeste sted. Recessus pinealis strækker sig ret dybt ind i organet.

Corpus pineales parenkym synes ensartet i bygning, der ses ingen cyster eller follikler, men strukturen kan ellers ikke udredes paa grund af farvningen (marvskedefarvning). Der er meget stærk vaskularisation. I selve parenkymet ses ingen marvholdige nervetraade, derimod ses der mange saadanne i den basale del, der rørformet omgiver recessus pinealis.

Elephas indicus (fig. 11, tavle I fig. 25, tavle II fig. 26—27).

Der forelaa til undersøgelse snitserier af en elefanthjærne, der var skaaret i frontale snit paa 30 μ tykkelse; hvert 10ende snit var farvet efter v. Gieson, hvert 10ende var farvet efter Wiegert-Pal, og disse to snitrækker udgjorde det foreliggende materiale. Hjærnen var halveret ved et sagittalt snit, men heldigvis saaledes, at den undersøgte halvdel strakte sig lidt ud over midterplanet, saa at hele corpus pineale og en del af recessus suprapinealis var bevaret.

Svarende til regionen foran commissura posterior ses to udbugtninger, den ene foran den anden. Den forreste af disse svarer formentlig til det af Dexler beskrevne epifysesvælg, medens det bageste svarer til den ene af eller begge de to udbugtninger, som ses paa Dexlers billede, men som han ikke omtaler i texten. Efter beliggenheden mellem commissura posterior og et tværløbende bundt nervetraade, der maa antages at være commissura habenularum, maa den bageste udbugtning antages at være corpus pineale, den forreste recessus suprapinealis; desværre var den forreste og den yderste del af denne sidste revet fra, saa at forholdene kun tillader en overordentlig sandsynlig, men ikke absolut sikker bedømmelse.

Den dannelse, som maa antages at være corpus pineale, har en frontal bredde af 9 mm. Den er nærmest sækformet og bestaar hovedsagelig af en forreste og en bageste væg, mellem hvilke der ligger en ca. $2^1/_2$ mm dyb reces fra 3die ventrikel. Denne reces er ved indgangen bred i frontalplanet, smal i sagittalplanet, dybere inde bliver den noget smallere frontalt, og noget bredere sagittalt. Corpus pineales bageste væg bestaar i det yderste lag af marvholdige nervetraade, der hænger sammen med de tværløbende nervetraade i commissura posterior og formentlig kan opfattes som en del af denne. Paa den ind imod recessen vendende flade dannes væggen af et ca. $^1/_2$ mm tykt cellelag, der maa opfattes som en del af corpus pineales parenkym. Det bestaar af en ret ensartet cellemasse med tætstillede runde kærner; rundt om i denne cellemasse ses follikulære dannelser. Disse follikler, som er rundagtige, bestaar af tætte hobe af celler, der i midten ofte har et lysere protoplasmatisk parti. Saadanne follikulære dannelser ses iøvrigt ogsaa i det uden paa parenkymet liggende lag af marvholdige nervetraade, især langs den ydre rand af dette. Bagtil fortsættes den parenkymatøse substans udenpaa commissura posterior, hvor det taber sig jævnt. Fortil gaar den over i den parenkymatøse substans, som danner forreste væg af corpus pineale, og som for en del beklæder commissura habenularum. Parenkymet i denne forreste del er noget cellerigere, men med sparsommere follikeldannelse end den bageste del. Som helhed er parenkymet rigeligt vaskulariseret. En finere uddifferentiering af strukturen var ikke mulig paa grund af dækglassenes tykkelse, som var nødvendiggjort af de store snit.

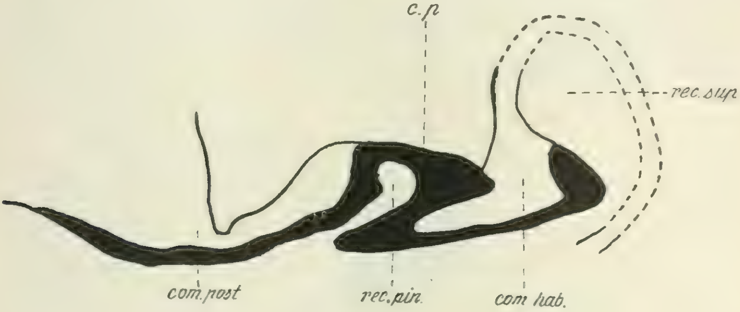

Fig. 11.

Fig. 11. Elephas indicus. Sagittalsnit rekonstrueret. 6 gange forstørret. Det punkterede parti svarer til den formodede udstrækning af recessus suprapinealis, som var revet løs paa præparatet med undtagelse af den nederste del.

Foran commissura habenularum findes den dybere recessus suprapinealis, hvis forreste væg var revet løs undtagen i den basale del. Corpus pineales parenkym fortsætter sig paa undersiden af commissura habenularum og et stykke op paa recessus suprapinealis' bageste væg, hvor den efterhaanden taber sig. At denne recessus suprapinealis virkelig er et hulorgan og ikke en sonderrevet massiv tap, kan sluttes af, at væggen paa mange steder ses beklædt med et eenlaget kubisk ependym. I den bageste del af bagvæggen i recessus suprapinealis findes, i sammenhæng med commissura habenularum, en del bundter af marvholdige nervetraade. I sammenhæng hermed kan det bemærkes, at ogsaa hos adskillige ungulater findes rigelige marvholdige nervetraade i recessus suprapinealis' bageste del.

Capreolus caprea (Fig. 12).

Et formolfixeret mellemhjærnestykke, som blev mig overladt fra centralinstitutet, har jeg skaaret i sagittale snit og farvet med Hansens hæmatoxylin-pikrofuchsin. Undersøgelsen heraf viste:

Fig. 12.

Fig. 12. Capreolus caprea. Sagittalsnit, 3 gange forstørret.

Corpus pineale er paa sagittalsnit elliptisk, ca. 7 mm langt, 4 mm bredt. En forholdsvis bred flade vender ind imod 3die ventrikel, beklædt med kubisk ependym. Kun en ganske lille reces gaar ind i organet.

Parenkymet bestaar af celler med ret ensartede kuglerunde eller let kantede kærner og et sparsomt protoplasma. Kærnerne er stillede temmelig spredt, og mellemrummene mellem cellerne er opfyldt af et udbredt netværk, der synes at være et glianetværk. Størstedelen af cellerne synes saaledes at være gliaceller, men mellem disse findes enkelte celler med lidt større og kromatinfattigere kærner og et ligeledes noget større rundagtigt protoplasma, celler som synes at svare til pinealceller.

Der var ligesom hos svinet, hesten og mennesket en rigelig udvikling af bindevæv. Dette ses i talrige, ret tynde, men velafgrænsede karrige trabekler, som gennemkrydser organet i alle retninger. Udenfor trabeklerne findes en sparsommere mængde kar. I centrum af organet ses talrige smaa kalkkonkrementer i parenkymet, ikke i bindevævstrabeklerne. Der ses ingen cyster eller begrænsede gliapletter.

Manatus americanus.

Der fandtes en frontalt skaaret trinserie (hvert 4de snit) af en halveret manathjærne. Der kunde intet spor ses af corpus pineale, men man maa dog regne med den mulighed, at dette kunde være revet løs ved præparationen.

Tamandua tetradactyla (fig. 13 og 14 og tavle III, fig. 28).

Der forelaa til undersøgelse to alternerende frontale serier, farvet efter henholdsvis Delafield-v. Gieson og Weigert-Pal. Paa en rekonstruktion efter snittene ses imellem commissura posterior og commissura habenularum en hætteformet udbugtning, ca. 3 mm i diameter og 1 mm høj. Ind i denne udbugtning strækker sig en fordybning, svarende til recessus pinealis. Væggene i udbugtningen dannes af tværløbende, marvholdige nervetraade, der bagtil hænger sammen med dem i commissura posterior, fortil med dem i commissura habenularum. Dette marvskedelag er paa den mod recessen vendende flade beklædt med et højt cylinderependym, som fortsættes i det commissura posterior beklædende cylinderependym, der svarer til organon subcommissurale. Der ses hverken i marvlaget eller imellem dette og ependymet nogen substans, der kan opfattes som corpus pineale-parenkym eller rester deraf. Et egentligt corpus pineale maa saaledes siges at mangle hos tamandua, ligesom hos dasypus, kun den ydre form deraf er bevaret.

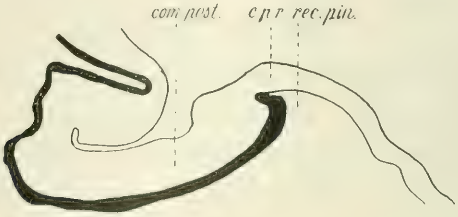

Fig. 13.

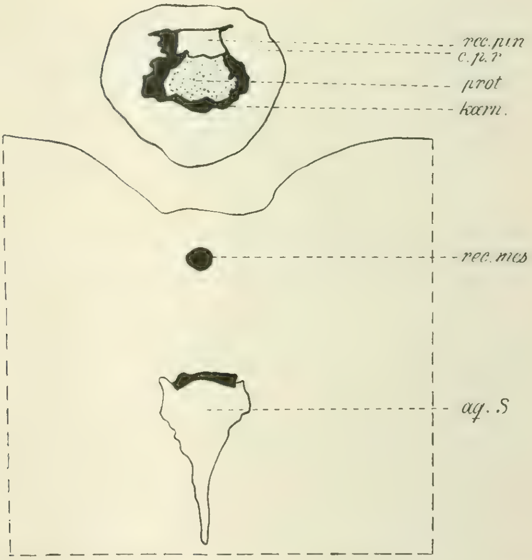

Fig. 14.

Fig. 13. Tamandua tetradactyla. Sagittalsnit rekonstrueret. 15 gange forstørret.

Fig. 14. Tamandua tetradactyla. Frontalsnit. 15 gange forstørret. *rec. mes.:* recessus mesocoelicus. *c. p. r.:* udbugtning svarende til corpus pineale; *kærn.* er det kærneholdige parti i ependymbeklædningen (organon subcommissurale); *prot.* er det yderste protoplasmatiske af denne, som snittet har tangeret.

Myrmecophaga jubata.

Der forelaa til undersøgelse to alternerende frontale serier, farvet efter henholdsvis v. Gieson og Weigert-Pal. Svarende til corpus pineale fandtes ligesom hos tamandua kun en lille udbugtning mellem commissura habenularum og commissura posterior. Denne udbugtning bestaar udelukkende af tværløbende, marvholdige nervetraade, paa ventrikulærsiden beklædt med et lavt ependym. Noget egentligt corpus pineale findes saaledes heller ikke her.

Choloepus didactylus (Fig. 15).

Der forelaa til undersøgelse ingen mikroskopiske præparater, derimod en gennemskaaret hjærne, som syntes at være uden defekter i corpus pinealeregionen. Ovenfor og foran commissura posterior ses en lille sækformet udbugtning med en knap ½ mm tyk væg, hvid og glat. Ved den forreste del af denne udbugtning er væggen lidt fortykket, formentlig svarende til commissura habenularum, og foran dette igen ses det tynde velum transversum. Udover den tyndvæggede sæk, der efter sit udseende gør indtryk af at bestaa af marvsubstans, ses intet spor af noget corpus pineale. Ved undersøgelsen af dette tilfælde, sammenholdt med resultatet af undersøgelserne af forholdene hos de andre

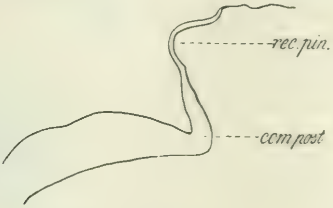

Fig. 15.

Fig. 15. Choloepus didactylus. Sagittalsnit. 2 gange forstørret.

edentater, tør man formentlig gaa ud fra, at corpus pineale ogsaa mangler hos choloepus.

Pinnipedia.

Der forelaa til undersøgelse paa Anatomiska institutionen i Lund 3 lobodon- og 3 leptonychotes-fostre, skaaret i kontinuerlige frontale serier og farvede med hæmatoxylin-eosin. Jeg foretog rekonstruktioner efter snittene i 50 ganges forstørrelse. Corpus pineale viste følgende forhold:

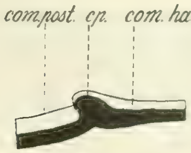

Fig. 16.

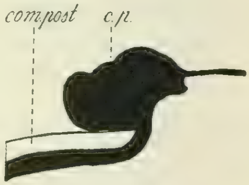

Fig. 18.

Fig. 17.

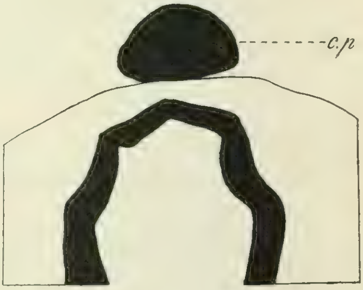

Fig. 19.

Fig. 16. Lobodon carcinophaga. Embryo 29 mm. Sagittalsnit, rekonstrueret, 25 gange forstørret.

Fig. 17. Lobodon carcinophaga. Embryo 29 mm. Frontalsnit, 25 gange forstørret.

Fig. 18. Lobodon carcinophaga. Embryo 62,5 mm. Sagittalsnit, rekonstrueret, 25 gange forstørret.

Fig. 19. Lobodon carcinophaga. Embryo 62,5 mm. Frontalsnit, 25 gange forstørret.

Lobodon carcinophaga.

Paa et foster af 13 mm længde lykkedes det ikke at paavise noget anlæg til corpus pineale.

Paa et 29 mm langt foster (fig. 16—17) saas svarende til beliggenheden af corpus pineale en lille flad fremhvælvning af diencephalons loft, ca. $^{1}/_{2}$ mm bredt, $^{1}/_{4}$ mm langt i sagittal retning; svarende til denne fremhvælvning paa ydersiden ses paa indersiden en flad udbugtning. Cellerne i anlægget havde tætstillede rundagtige kærner, der ikke var forskellige fra dem i inderkappen paa commissura posterior og commissura habenularum anlægget.

Paa et 62,5 mm langt foster (fig. 18—19) var anlægget til corpus pineale veludviklet. Det dannede paa ydersiden af diencephalon-loftet en solid kegleformet masse med bagud rettet spids; den var ved basis ca. 1 mm bred, forfra-bagtil ca. $^{1}/_{2}$ mm lang og i tykkelse ca. $^{1}/_{2}$ mm. Der strakte sig ingen recessus pinealis ind i organet. Vævet var ensartet, cellerne var kædeformet anordnet uden follikulær struktur. Kærnerne var tætstillede. Der fandtes talrige mitoser. Corpus pineale-anlægget var stærkt vaskulariseret. Anlægget til recessus suprapinealis var ganske lavt.

Leptonychotes Weddelii.

Paa et 23 mm langt foster (fig. 20—21) saas anlægget til corpus pineale som en lav frembugtning fra diencephalons loft, $^{1}/_{2}$ mm bred, $^{1}/_{10}$ mm forfra-bagtil. En ganske lav recessus pinealis strakte sig ind i anlægget. Cellerne var ensartede, der saas ingen follikulær anordning.

Paa et 32 mm langt foster (fig. 22) var anlægget betydelig større, ca. $^{1}/_{2}$ mm bredt, $^{1}/_{3}$ mm forfra-bagtil. Det var af form nærmest fladtrykt kegleformet med spidsen fremadrettet. Recessus pinealis var ganske lav, lidt dybere ud til siderne end i midterplanet. Vævet var ensartet, cellerne havde tætstillede rundagtige eller let kantede kærner. Der var antydning af follikulær anordning af cellerne i det indre af anlægget. Stærk vaskularisation. Recessus suprapinealis var antydet som en lav udbugtning fra velum.

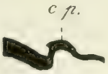

Fig. 20.

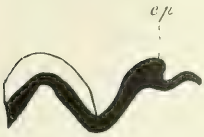

Fig. 22.

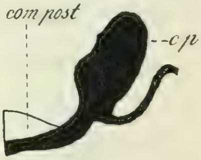

Fig. 23.

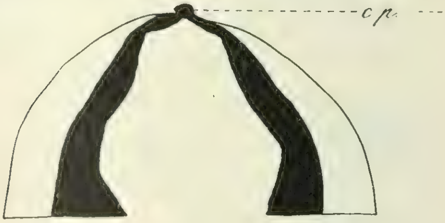

Fig. 21.

Fig. 20. Leptonychotes Weddelii. Embryo 23 mm. Sagittalsnit, rekonstrueret, 25 gange forstørret.

Fig. 21. Leptonychotes Weddelii. Embryo 23 mm. Frontalsnit, 25 gange forstørret.

Fig. 22. Leptonychotes Weddelii. Embryo 32 mm. Sagittalsnit, rekonstrueret, 25 gange forstørret.

Fig. 23. Leptonychotes Weddelii. Embryo 111 mm. Sagittalsnit, rekonstrueret, 25 gange forstørret.

Paa et 111 mm langt foster (fig. 23) var anlægget udviklet til en selvstændig dannelse. Det dannede en ægformet masse der ragede frit ud fra overfladen, ca. $^3/_5$ mm langt, $^1/_3$ mm bredt i det tykkeste parti og ca. $^1/_3$ mm tykt.

Overfladen er noget ujævn, idet der skyder sig smaa rundagtige udbugtninger ud i det omgivende bindevæv. Vævet er ensartet bygget, bestaar af celler med runde eller let kantede, tætstillede, intenst farvede kærner og meget sparsomt protoplasma. Cellerne er hist og her noget ringformet anordnede, men organet viser ingen follikulær struktur. Der er stærk vaskularisation af corpus pineale. En lang recessus pinealis, beklædt med cylinderependym, strækker sig et ganske lille stykke ind i den basale del af organet. Recessus suprapinealis naar ikke ud til corpus pineales spids.

Phoca vitulina.

Paa Centraal-Instituut voor Hersenonderzoek har jeg haft lejlighed til at undersoge et exemplar af en voxen, skaaret i frontale serier, 30 μ, hvert 4de snit, farvet efter v. GIESON. Dimensionerne var betydelig mindre end de af TURNER angivne, 3 mm i bredde og 3 mm i tykkelse. Men muligvis hænger dette sammen med, at organet var en del kadaverøst og i sammenhæng dermed skrumpet særlig stærkt ved fixeringen. Der fandtes i vævet talrige smaa hulheder fyldte med en kolloid masse, men disse hulheder gjorde ogsaa nærmest indtryk af at maatte henfores til kadaverositet. Vævet var iøvrigt ret ensartet, omend med lysere og mørkere partier; kærnerne var meget tætstillede. Der var ikke særlig stærk vaskularisation. Recessus pinealis strakte sig et lille stykke ind i corpus pineales parenkym.

Lemur catta.

Der forelaa to serier (hvert 3die snit, 30 μ), skaaret frontalt og farvet efter henholdsvis v. GIESON og WEIGERT-PAL. Hele corpus pineale ligger inde under corpus callosum. Det er $1^1/_2$ mm bredt, $^3/_4$ mm tykt og $1^1/_2$ mm langt.

Vævet var let kadaverøst. Det gjorde et ensartet indtryk, parenkymet bestod af celler med kærner, der var ensartede med hensyn til størrelse og jævnt fordelte. I organet saas, tættest ud imod spidsen, flere smaa cyster fyldte med en kolloid masse. Der fandtes ogsaa enkelte konkrementer. Organet var ikke særlig stærkt vaskulariseret. I den basale del saas ganske enkelte bundter af marvholdige nervetraade hovedsagelig udgaaede fra commissura posterior.

Nycticebus tardigradus.

Der forelaa til undersøgelse en hæmatoxylinfarvet trinserie (hvert 4de snit, 30 μ), af højre hjærnehalvdel skaaret frontalt. Da hjærnen var halveret ved sagittalsnit, var corpus pineale skaaret igennem, hvorfor formen og dimensionerne vanskeligt kan bedømmes.

Parenkymet bestaar af celler med sparsomt protoplasma og tætstillede rundagtige kærner, der for størstedelen er kromatinfattige; enkelte kærner er dog kromatinrigere og tillige mindre. Kærnerne er noget uregelmæssig fordelte, idet der rundt om i parenkymet findes lysere, kærnefattige strøg. Organet er stærkt vaskulariseret, væsentligst ved kapillærer.

Simia troglodytes.

Til sammenligning med et exemplar af simia troglodytes, jeg tidligere har beskrevet, havde jeg lejlighed til paa Centraal-Instituut at undersøge et andet exemplar, der var skaaret i frontale serier, hvert 4de snit (30 μ), farvet efter v. Gieson, hvert 4de efter Weigert-Pal. Der foretoges ikke rekonstruktion, men ved sammenstilling af snitrækkerne fandtes i det væsentligste samme forhold som hos det tidligere undersøgte exemplar: Corpus pineale dannede en knopformet opsvulmning (7 mm bred, 4 mm tyk) paa enden af en forholdsvis tynd stilk. En recessus pinealis strakte sig et lille stykke ind i stilken. Organet var stærkt vaskulariseret, væsentlig med kapillærer, mest i randpartierne. Der var kun en ringe mængde marvholdige nervetraade i parenkymet. Der saas ingen konkrementer og ingen gliaplaques, derimod fandtes tæt ved den ydre overflade enkelte ganske smaa cyster, hvis væg var beklædt med et kubisk ependym.

Supplerende undersøgelser fra senere aars litteratur.

Efter at mit forrige arbejde om corpus pineale var udkommet, og dette var afsluttet, er jeg blevet opmærksom paa et større arbejde af F. Tilney og L. F. Warren, som udkom i 1919: The morphology and evolutional significance of the pineal body (The american anatomical memoirs, number 9, Philadelphia 1919). Arbejdet omhandler i det væsentlige forholdene hos lavere hvirveldyr. Angaaende pattedyrene er der givet ny, selvstændig beskrivelse af følgende:

Macropus grayi.

Forfatterne finder fire celletyper, 1) store celler med stort protoplasma og mørktfarvede kærner, 2) do. med lysere kærner, 3) mindre celler med lille protoplasma og store basofile kærner, 4) smaa celler med store svagtfarvede kærner. De store celler danner acini, de mindre er uregelmæssigt fordelte. Organet er stærkt vaskulariseret. Strukturen er glandulær.

Capra hylocrius.

Der findes ligeledes fire celletyper tildels ordnede i acini. Stærk vaskularisation. Tykke bindevævstrabekler.

Camelus dromedarius.

I corpus pineale ses 4 celletyper af vekslende størrelse og farveintensitet. Mindre udtalt acinøs struktur. Rigelig vaskularisation og bindevævsdannelse. Ingen konkrementer.

Zalophus californianus.

Adskillelsen mellem de 4 celletyper mere tvivlsom. Cellerne er ordnede i strænge og søjler. Ingen konkrementer.

Lepus cuniculus.

Forfatterne mener ogsaa her at kunne adskille 4 celletyper, en anskuelse, mine tidligere undersøgelser ikke kan bekræfte.

Simia satyrus.

Forfatterne har ligeledes her fundet de 4 celletyper. Fint bindevævsnetværk og talrige kapillærer, ingen konkrementer.

Noget forsøg paa sondring mellem nerveceller, gliaceller og pinealceller foreligger ikke. Endvidere refererer forfatterne ganske korte beskrivelser af forholdene hos macropus giganteus (Lotheissen), halmaturus dorsalis (Condorelli-Francaviglia), camelus dromedarius (Parisini), elephas indicus (Parisini), dasyprocta agouti (Sperina og Balli) og felis leo (Parisini).

Intet af disse arbejder (for størstedelen italienske) har været mig tilgængelige i original.

Sammenfattende betragtninger.

Sammenfatter vi de ovennævnte undersøgelser og sammenholder dem med vore tidligere, giver de et uddybende supplement til disse og forlænger de linier, vi har draget gennem de vekslende former af corpus pineales bygning hos pattedyrklassen, men ændrer iøvrigt ikke vort syn paa organets biologiske stilling.

Af størst interesse forekommer undersøgelsen af organet hos echidna. Hos denne viser corpus pineale en bygning, som slutter sig ret nær til hvad man finder hos adskillige andre pattedyr, navnlig chiroptera og visse insectivora. Derimod adskiller organet sig i sin bygning ganske fra det hos fuglene og amphibierne. Hvad reptilierne angaar er som bekendt slangerne de eneste, hos hvilke corpus pineale viser lighed med pattedyrenes, og dette gælder ikke echidna mere end andre pattedyr. Den mest bemærkelsesværdige ejendommelighed ved corpus pineale hos echidna er de store nucleoli.

Hos marsupialierne viser corpus pineale to stærkt forskellige typer. Hos didelphys marsupialis er det meget lille og nærmer sig til den rørformede bygning, man finder hos mange pattedyrfostre og hos visse fisk. Hos hypsiprymnus er det derimod paafaldende stort, massivt, stærkt vaskulariseret. Ogsaa hos onychogale og macropus er organet veludviklet.

Angaaende corpus pineale hos elephas har der tidligere hersket nogen uenighed. Organet existerer utvivlsomt, men er paafaldende lille og sækformet, og end ikke hele den udbugtning, der svarer til corpus pineale, bestaar af dettes specifike parenkym, en del er forholdsvis store tværløbende nervebundter. Af særlig interesse er det, at der i parenkymet findes udtalte follikulære dannelser. Dette har jeg ellers kun fundet hos pattedyrfostre.

Resultatet af undersogelserne af hjærnen af tamandua, myrmecophaga og choloepus viser tilslutning til de tidligere undersøgelser over forholdene hos dasypus. De tyder paa, at corpus pineale hos edentaterne i al almindelighed maa antages at være rudimentært, saaledes at der svarende til det sted, hvor organet findes hos andre dyr (mellem commissura posterior og commissura habenularum) findes en udbugtning af diencephalons loft. Men denne udposning indeholder intet specifikt parenkym, den bestaar kun af tværløbende marvholdige nervetraade, der paa fladen ind mod 3die ventrikel er beklædt med et cylinderependym, som svarer til forreste del af subcommissuralorganet.

Hos capreolus ses som hos de andre ungulater en enorm udvikling af neuroglia, mens egentlige pinealceller er sparsomme. Paafaldende er den rigelige bindevævsudvikling.

Bedømmelsen af forholdene hos phoca vanskeliggjordes noget af organets kadaverøsitet. Det er dog ved sammenligning med corpus pineale hos halichoerus paafaldende.

at organet er forholdsvis lille og ikke viser den enorme karrigdom som halichoerus. Fortsatte undersøgelser over corpus pineale hos sælerne vil derfor være af særlig interesse.

De to undersøgte halvabearter viste baade i corpus pineales form og struktur en vis lighed, til den ene side med forholdene hos nogle af marsupialierne (hypsiprymnus, macropus, onychogale) og insectivora, til den anden side med bygningen hos lavere staaende aber.

De embryologiske undersøgelser af corpus pineale hos lobodon og leptonychotes viste tilslutning til det tidligere undersøgte phoca-embryo. Organet anlægges først som en udbugtning fra diencephalons loft. Denne fortykkes efterhaanden, saa at anlægget danner en solid, ensartet bygget, stærkt vaskulariseret cellemasse, hvori en ganske lav recessus pinealis strækker sig ind. Cellerne er tildels ordnede i ringe, men kun paa et forbigaaende stadium findes der antydning af follikulær anordning, dog ikke saa udtalt som paa et vist stadium hos kaninen og svinet. Af andre udviklingstyper nærmer denne sig mest til den, jeg har fundet hos chiroptera; den er ret forskellig fra udviklingstypen hos gnaverne, ligeledes fra den hos mennesket.

Betragter man i det hele de variationer, corpus pineale er underkastet indenfor pattedyrene, viser organet en relativ ensartethed baade i form og bygning hos echidna, visse marsupialier (hypsiprymnus, macropus, onychogale), insectivora (erinaceus og sorex), halvaber (lemur og nycticebus) og visse aber (callithrix, macacus). Denne grundtype viser sig ved en rundagtig snart lidt affladet, snart lidt tilspidset form. Dens bygning er ensartet i corpus pineales forskellige partier; organet bestaar overvejende af celler med rundagtige kærner og et ret sparsomt protoplasma uden paaviselige cellegrænser (pinealceller). Mellem pinealcellerne findes undertiden et mindre antal gliaceller. Organet er sædvanlig stærkt vaskulariseret.

Fra denne grundtype devierer organet hos de andre pattedyrordener i forskellige retninger. Hos gnaverne har det gennemgaaende en aflang form, kølle- eller traadform, men iøvrigt lignende struktur som hos grundtypen. Hos halichoerus viser det en enorm vaskularisation. Hos heste, svin, capreolus og mennesker er der en betydelig udvikling af bindevævstrabekler inde i parenkymet. Hos ungulaterne er der en enorm gliamængde. Hos mennesket, simia troglodytes og cynocephalus er der talrige nervøse elementer. Endelig er organet fuldstændig rudimentært hos edentater, delvis rudimentært hos i hvert fald visse hvaler og elefanter. Den phylogenetisk mest primitive bygning synes at findes hos didelphys.

Résumé.

Investigations microscopiques sur une série d'exemplaires de glandes pinéales de différents mammifères. Ces investigations ont été faites à »Centraal Instituut voor Hersenonderzoek« à Amsterdam (chef: Dr. C. U. ARIENS KAPPERS) et à »Anatomiska Institutionen« à Lund (chef: Prof. IVAR BROMAN). Elles ont donné les résultats suivants:

Echidna aculeata. La glande pinéale est solide, en forme de fève et de structure homogène. Elle consiste en deux types de cellules dont l'une qui se trouve en plus grand nombre a des noyaux, qui contiennent des nucléoles remarquablement grandes et l'autre des noyaux intensivement colorés. Forte vascularisation. Assez bien de fibres myéliniques dans les bords.

Didelphys marsupialis. Une petite élévation dont les parois sont formées d'un parenchyme de construction homogène, sans formation de follicules.

Onychogale frenata. La glande pinéale, plutôt en forme de fève. Le parenchyme laisse voir un amas plus considérable de cellules autour des vaisseaux; en somme, cellules très homogènes.

Hypsiprymnus murinus. Glande pinéale étonnamment grande, de construction homogène avec une très forte vascularisation.

Macropus robustus. Le glande pinéale forme un renflement assez plat, en forme d'écuelle. Le parenchyme consiste en cellules avec des noyaux arrondis et homogènes qui sont très vasculaires.

Vespertilio murinus présente une ressemblance considérable avec le vesperugo décrit precédemment.

Arctomys (*marmotta?*). La glande pinéale est allongée en forme de massue. Le recès pineal s'étend profondément dans l'organe. Le parenchyme est de consistance homogène très vasculaire.

Elephas indicus. La glande pinéale forme un petit renflement de 9 mm, en forme de sac, dans lequel, à une profondeur de $2^1/_2$ mm, le recès s'étend presque jusqu'au fond du renflement. Le parenchyme laisse voir partiellement une structure homogène, mais on y voit, ça et là, des formations folliculaires. Les cellules ont des noyaux ronds et homogènes. Devant la glande pinéale se trouve vraisemblablement un assez profond recès suprapinéal avec une épaisse paroi postérieure dans laquelle se perdent des fibres myéliniques.

Chez *capreolus caprea*, l'organe est essentiellement formé de névroglie, comme chez les autres ungulata. Il y a, en outre, une abondante formation de tissu conjonctif.

Chez *tamandua tetradactyla, myrmecophaga jubata* et *choloepus didactylus* la glande pinéale est comme chez *dasypus villosus*, absolument rudimentaire, parceque chez les deux premiers, peut-être aussi chez le choloepus, elle ne consiste qu'en fibres myéliniques qui s'étendent transversalement et sont couvertes d'épendyme cylindrique sans contenir la moindre trace de parenchyme spécifique.

Chez *phoca vitulina*, la glande pinéale est considerablement plus petite et beaucoup moins vasculaire que chez halichoerus.

Lemur catta et *nycticebus tardigradus* laissaient voir une construction homogène qui était beaucoup plus vasculaire chez le second que chez le premier. L'investigation de l'organe d'un *simia troglodytes* confirme mes découvertes antérieures chez cet animal.

Les recherches embryologiques sur *lobodon* et *leptonychotes* laissent voir un type de développement qui ressemble à celui que j'ai trouvé chez chiroptera.

En général, les investigations citeés plus haut, approfondissent les recherches anterieures de l'organe chez les mammifères, sans pourtant fournir de nouvelles hypothèses.

La glande pinéale montre chez ceux-ci un type fondamental que l'on retrouve avec de légères variations chez echidna, hypsiprymnus, macropus, onychogale, sorex, talpa, vesperugo, canis, felis, lemur, nycticebus, callithrix et macacus. Ce type fondamental laisse voir une construction de forme arrondie, tantôt un peu aplatie, tantôt légèrement pointue. La structure est homogène. L'organe consiste en cellules avec des noyaux arrondis et un protoplasma pauvre (cellules pinéales). Parmi celles-ci se trouve parfois un petit nombre de cellules névrogliques. L'organe est généralement très vasculaire.

Comme déviation du type fondamental, les rodentia ont une glande pinéale en forme de massue; halichoerus a une énorme vascularisation; le cheval, le porc, capreolus et l'homme ont un copieux développement de tissu conjonctif dans le parenchyme. Chez les ungulata il y a une grande formation de fibres névrogliques. Chez l'homme, simia et cynocephalus il y a de nombreux élements nerveux. La glande pinéale est absolument rudimentaire chez les édentés; elle semble partiellement rudimentaire chez certains cétacés et chez les éléphants. La construction phylogénétique la plus primitive semble se trouver chez didelphys.

Figurforklaring.

(Explanation des figures.)

Bogstaverne har følgende betydning:

c. p.	corpus pineale (glande pinéale)
com. hab.	commissura habenularum (commissure habénulaire)
com. post.	commissura posterior (commissure postérieure)
fol.	follikulære dannelser (formations folliculaires)
k	kar (vaisseaux)
marv.	marvholdige nervetraade (fibres myéliniques)
org.	organon subcommissurale
rec. pin.	recessus pinealis (recès pinéal)
rec. sup.	recessus suprapinealis (recès suprapinéal).

Tavle I. Fig. 24. Frontalsnit af corpus pineale hos *echidna aculeata.* 25 gange forst. Weigerts marvskedefarvning-karmin.
Fig. 25. Frontalsnit af corpus pineale hos *elephas indicus.* 9 gange forst. V. Gieson-farvning. Til venstre ses den mest distale del af corpus pineale, tilhøjre den halve væg af recessus suprapinealis.

Tavle II. Fig. 26 og 27. Frontalsnit af corpus pineale hos *elephas indicus.* 9 gange forst. V. Gieson-farvning. Fig. 26 er et snit nærmere ved 3die ventrikel, fig. 27 mere distalt.

Tavle III. Fig. 28. Frontalsnit fra *tamandua tetradactyla* af den udbugtning *(c. p. r.)* af marvholdige nervetraade og subcommissuralorganet, som svarer til corpus pineales beliggenhed. 40 gange forst. V. Gieson-farvning. *rec. mes.*: recessus mesocoelicus.

Færdig fra Trykkeriet d. 28. Juni 1921.

Fig. 24.

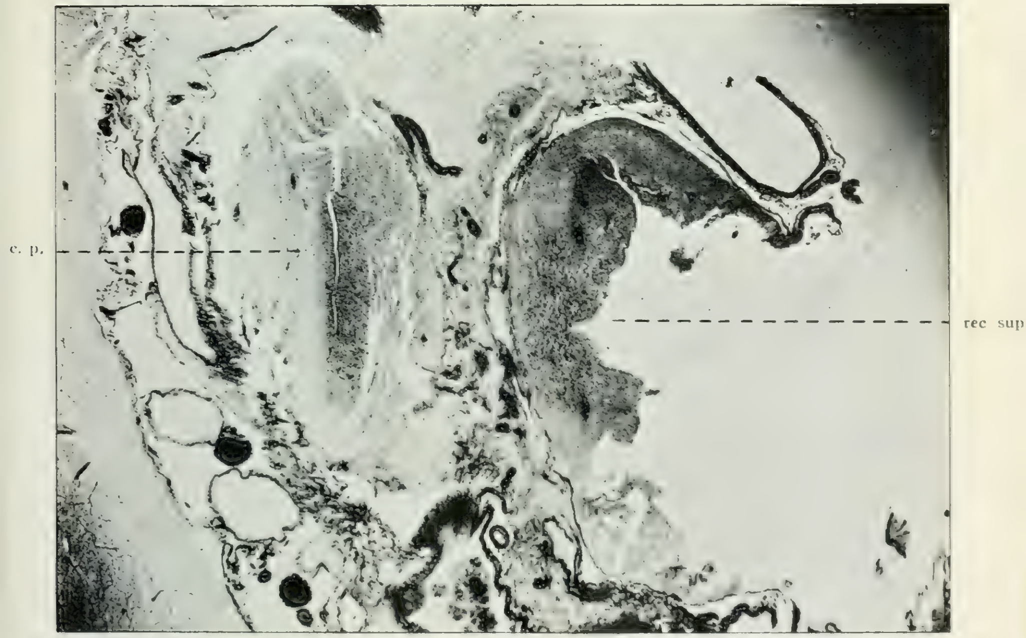

Fig. 25.

Fig. 26.

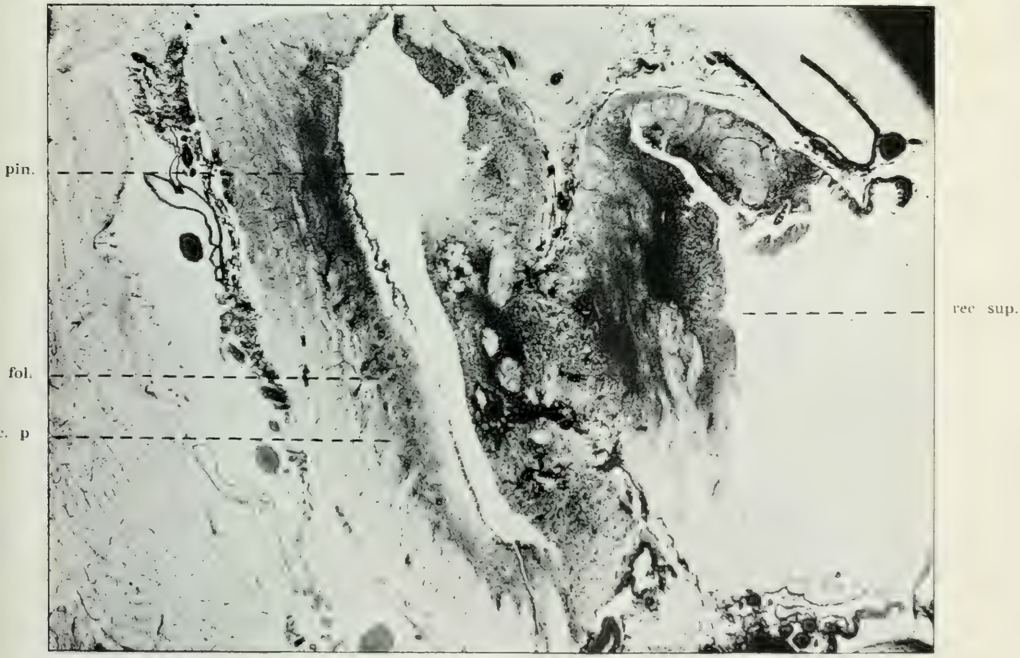

Fig. 27.

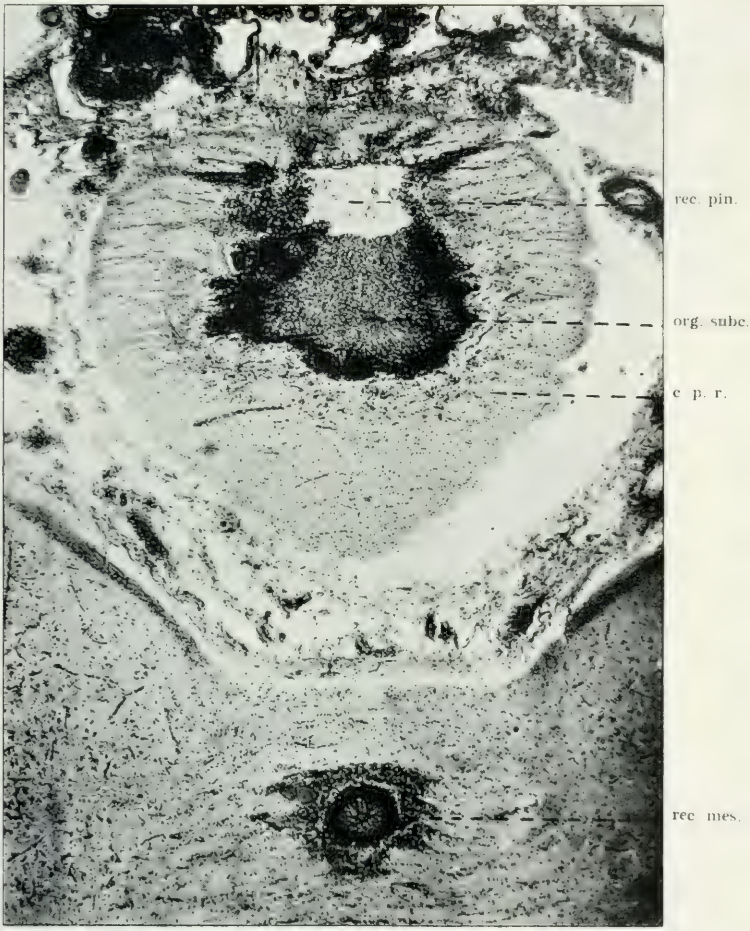

Fig. 28.

Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **III,** 8.

STUDIES ON THE PATH OF TRANSMISSION OF PHOTOTROPIC AND GEOTROPIC STIMULI IN THE COLEOPTILE OF *AVENA*

BY

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1742

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BIANCO LUNOS BOGTRYKKERI
1921

A. Historical Survey.

Investigations on the transmission of a phototropic stimulus date from the latter half of the nineteenth century. Since the results of the earlier investigators have been discussed and cited more or less in detail in the literature of succeeding workers, I shall make no attempt at a complete historical survey but rather mention some of the more recent articles, having a direct relation to the special problem in question.

Boysen Jensen (1910, 1911, 1913) obtained a transmission of a phototropic stimulus from the unilaterally illuminated tip to the shaded base of the coleoptile of *Avena*, although direct contact between the plasma of the tip and base was broken. In the experiments of Boysen Jensen the tip of the coleoptile was removed with a sharp scalpel, a drop of a 10 % solution of neutralized gelatine was applied to the injured surface of the stump, the tip reset in the original position and the wound ringed with melted cocoa butter. On exposure of the tip to unilateral illumination, in the majority of cases a transmission of the phototropic stimulus to the shaded base was evidenced by a positive basal curvature, while the shaded control plants for the most part remained straight. A similar transmission of a geotropic stimulus was also accomplished by Boysen Jensen.

Later PAÁL (1914, 1918) investigated the probability of "Reizleitung über einen Schnitt" and arrived at the same conclusion as BOYSEN JENSEN. PAÁL further demonstrated the transmission of a phototropic stimulus through an interposed gelatinous membrane of at least 0.05—0.10 mm in thickness. This point was established by placing a thin slice of *Calamus,* previously soaked in a 10 % solution of gelatine, between the severed tip and stump of the coleoptile.

The extensive experiments of STARK (1921) show that transmission of traumatropic and haptotropic stimuli may take place over a cut from the tip to the base of the coleoptile in *Avena* and also in other *Gramineae.* Also a positive response was produced in the base upon stimulation of the tip, not only when the tip was reset on the individual to which it belonged, but also when it was placed on the stump of another individual of the same species, a different species of the same genus, a genus of the same sub-family, or a genus of a different sub-family.

With the fact fairly-well established, that phototropic, geotropic, traumatropic and haptotropic stimuli can be transmitted over a cut from the stimulated tip to the base of the coleoptile, the question of the nature of transmission arises.

At present the balance of evidence seems in favor of one or more substances migrating between the stimulated tip and base of the coleoptile, with which the transmission of the stimulus is closely connected. In the following citation BOYSEN JENSEN (1911, 24) expresses this view: "On n'a jamais pu constater de transmission de l'irritation à travers une incision lorsque les plantes d'experience se trouvaient sous l'eau. L'eau doit être en état d'empêcher cette transmission, ce qui ne peut s'expliquer que dans l'hypothèse où la transmission de l'irritation serait du à une migration de substance ou d'ions, qui se diffusent dans l'eau et ne peuvent plus agir."

The pertinent work of Ricca (1916) on *Mimosa* also lends support to this theory. Ricca inserted a small glass tube filled with water between the tip and the base of the upper portion of a shoot and upon excitation of the base he noted a green fluid exuding from its cut surface and diffusing through the water. When the volume of water was not too large, the spreading of the substance to the cut surface of the tip was observed and under that condition only a response in the leaflets followed. Thereupon Ricca inferred that the green fluid contained matter, which was carried along through the medium of water and was involved in the transmission of the stimulus.

From his experiments on the transmission of a phototropic stimulus through a gelatinous membrane Paál (1918, 431) concludes: "Dass . . . die phototropische Reizleitung durch die Gelatineschicht nicht durch elektrische Ströme, sondern durch diffundierende Stoffe vermittelt wird."

Stark demonstrated the existence of a relation between matter and tropic response in his final experiments. He placed a small cube of agar, containing an extract of the sap of injured coleoptiles, directly on the cut-surface of one side of a stump, while he used only pure agar in the control plants. The presence of the extract caused a marked increase in the number of individuals giving a response.

Since the association of the above-mentioned stimuli with diffusible matter seems to be generally conceded, let us consider the debatable issue, the probable path of transmission of the stimuli. Does transmission take place universally throughout the coleoptile or is the path restricted?

As the result of experimentation FITTING (1907) formulated the theory of transmission of a tropic stimulus universally throughout the living cells of the coleoptile.

In contradiction to FITTING, BOYSEN JENSEN demonstrated experimentally that transmission of the stimulus takes place mainly on the side of the coleoptile farthest from the light and on the lower side in geotropic experiments. As stated above, BOYSEN JENSEN obtained a transmission of a phototropic stimulus over a wound, therefore, his chief objection to the method employed by FITTING was that in the greater part of his experiments no steps were taken to prevent this transmission. BOYSEN JENSEN found that by inserting a mica plate in the cut, a transmission of the stimulus took place, when the incision was nearest to light, but when farthest, the transmission observed was practically negligible. Consequently, he drew the conclusion: "Für die Annahme, dass die Reizleitung sich allseitig fortpflanzen kann, sind noch keine Beweise vorhanden. Im Gegenteil spricht alles dafür, dass die Reizleitung in der *Avena*-koleoptile lokalisiert ist."

VAN DER WOLK (1911) favors the opinion of FITTING that transmission of a phototropic stimulus takes place universally in living cells.

PAÁL and STARK have contributed considerable discussion of the subject but no decisive experimental work.

Since the path of transmission of a stimulus is a question of the utmost importance in the study of tropisms, and the results of experiments in this field require substantiation, I shall proceed to give a detailed account of my recent investigations treating the subject of transmission of both phototropic and geotropic stimuli in *Avena.*

B. Method.

The experiments were carried out on *Avena sativa* (var. "Gul Næsgaard") kindly provided by the Experimental Station at Lyngby. The grains were soaked for twenty-four hours in a shallow dish with just sufficient water to cover them. About twenty-five were planted daily in fresh, moist soil, contained in glass cylinders (10 cm in height and 2.5 cm in diameter). Germination took place in an electrically-heated thermostat at a temperature of 16—18° C. They were watered on the day of planting and on the following morning. This proved to be the most satisfactory course from the results of preliminary experiments, which showed that the degree of moisture greatly influenced the effectiveness of the experimental method. An excess of water frequently caused displacement of the foil, while dried out or freely-watered plants were only slightly sensitive. At the end of 4—6 days straight plants from 1.5—2.5 cm in length were chosen, all plants in which the hypocotyledonous stem had developed were discarded. The experimental work was carried out in a room completely darkened except for a dim, red, electric light.

The object of the experiments was to determine whether or not the position of the incision in relation to the source of illumination or gravity influenced the transmission of the stimulus. Therefore I exposed plants with the cut on the side of the coleoptile farthest or nearest in respect to the direction of the lighting, and above or below in regard to geotropic exposure. A quantitative determination of the response to the stimuli was made by actually measuring the curvature produced in the plants.

In general the experimental method employed was similar to that of BOYSEN JENSEN. By means of a very sharp scalpel, I made an incision 3—5 mm from the tip and inserted a small rectangular piece of platinum foil. To prevent a possible transference of stimulatory substances from plant to plant, the pieces of foil were kept immersed in distilled water, when not in use, and the scalpel was carefully washed after making each incision.

The size of the curvature produced in the region of the coleoptile below the incision, was determined by the following method.[1] At the end of the period of exposure, the plants were uprooted and the foil removed. The curvature was then compared with arcs of circles having radii from 0.6—20 cm. When the concave side of the curvature was found to coincide with an arc, the length of the radius producing this arc was recorded (r), also the length of the shorter side of the curvature (l), measured with millimeter paper. The average thickness of the plants was obtained by measuring carefully with a micrometer several representative ones. The difference between the lengths of the shorter and longer sides of the curved base of the coleoptile (d) was

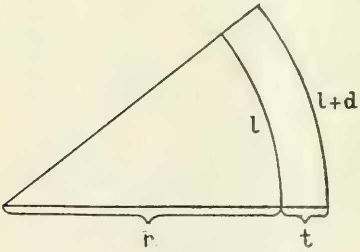

Fig. 1.

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[1] A similar method is used by Sachs (1873, 392).

regarded as an indication of the response produced, being computed in this manner (cf. fig. 1):

$$\frac{r}{l} = \frac{r+l}{l+d}; \quad \frac{r}{r+t} = \frac{l}{l+d};$$

$$\frac{r}{t} = \frac{l}{d}; \qquad d = \frac{tl}{r}.^{1}$$

Since the incision made in the coleoptile produces a traumatropic response, the curvature resulting upon phototropic or geotropic stimulation is not solely due to the effect of light or geotropic influence. Therefore, a series of control experiments was run. In the phototropic experiments the controls consisted of plants completely shaded and placed between the experimental plants; in the geotropic experiments, plants stood in an upright position in the dark. The traumatropic response of the corresponding series was determined and added to or deducted, as the case required, from the curvature produced in the experimental plants.

The existence of these two simultaneous reactions[2] leads to uncertainty in the interpretation of the results. In order to avoid this complication, I repeated the above experiments with plants which had recovered from the traumatropic response occasioned by the incision.

Plants from 4—8 mm in length were cut late in the afternoon preceding the experiment. On the following morning the straight ones were selected for use.[3] The

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[1] This equation can be found in Rothert (1894, 171).

[2] Van der Wolk in particular has objected to this complication involved in the above method.

[3] During the night if the plants had developed so that the incision in the inner leaf had grown beyond that in the side of the coleoptile, it was impossible to insert the foil securely. In this case, a second, slight

effectiveness of using recovered plants for the elimination of a traumatropic response from the results is clear on examination of the control plants. (cf. tables II & IV). Out of the ninety-five recovered plants, 95 % were straight at the end of the period of exposure.

For the purpose of ascertaining the reaction of the plants to the injury resulting from the incision, 17 straight plants from 1.0—1.4 cm in length were cut and observed at various intervals during part of the period of recovery. Complete measurements of the curvature taking place were made at each observation and the values for **d** computed. (cf. the table & fig. 2).[1]

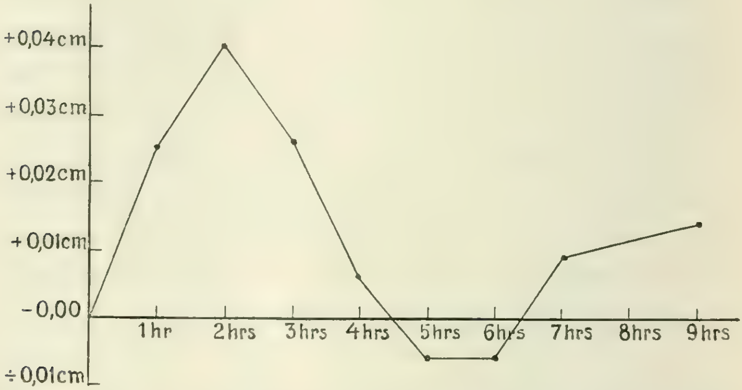

Fig. 2. Graph representing the traumatropic response of the seedlings of *Avena sativa* taking place during the nine hours following the making of the incision. The abscissae indicate the time in hours, the ordinates the mean **d** of the curvature.

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cut was made in the leaf with the edge of the foil by drawing it back and forth a few times against the leaf. The dried out incision in these plants also lessened the probability of the displacement of the foil by water collecting in the cut.

[1] Although the number of plants used is insufficient to enable drawing a general conclusion, the results give an approximate idea of the response of the plants to the incision during the period of recovery.

Traumatropic response of the seedlings of *Avena sativa* (cf. fig. 2).

No. of plant	Period of Observation							
	1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	6 hrs.	7 hrs.	9 hrs.[1]
1	+ .04	+ .04	+ .02	.00	.00	.00	.00	+ .03
2	.00	.00	.00	.00	— .03	— .04	— .04	.00
3	+ .06	+ .07	+ .02	.00	.00	.00	+ .02	.00
4	+ .06	+ .06	+ .06	+ .03	+ .02	+ .02	+ .06	+ .04
5	+ .04	+ .04	+ .02	.00	— .03	— .02	.00	.00
6	+ .05	+ .07	+ .08	+ .03	.00	.00	+ .06	+ .07
7	.00	+ .03	+ .02	+ .02	.00	.00	+ .04	+ .04
8	+ .03	+ .03	.00	.00	.00	.00	.00	.00
9	.00	+ .03	.00	— .04	— .04	— .04	.00	+ .02
10	+ .02	+ .04	+ .03	+ .02	.00	.00	.00	.00
11	.00	+ .03	.00	— .05	— .05	— .04	+ .02	+ .04
12	+ .04	+ .06	+ .04	+ .02	.00	.00	.00	.00
13	.00	+ .02	+ .01	.00	.00	.00	.00	.00
14	+ .02	+ .03	+ .03	.00	.00	.00	.00	.00
15	+ .03	+ .06	+ .06	+ .03	.00	.00	.00	.00
16	.00	+ .03	.00	00	.00	.00	.90	.00
17	+ .03	+ .04	+ .04	+ .04	+ .03	+ .02	.00	.00
Mean **d**	+ 0.025	+ 0.040	+ 0.025	+ 0.006	— 0.006	— 0.006	+ 0.009	+ 0.014 cm

To determine whether or not a slight traumatropic response might be produced in the recovered plants immediately after insertion of the foil, I observed at intervals of one hour a small number of plants, eigth in all, in which foil had been inserted. At the end of six hours no curvature was noted.[2]

In the phototropic experiments the method employed by BOYSEN JENSEN in shading the plants was followed. In every case a cover of black paper was used with a hole pierced in the center through which the tip of the coleop-

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[1] No further observations were made until the following morning, when all the plant were straight.

[2] To prove that this result was not due to the fact that these seedlings had lost their sensibility, I placed them in a horizontal position with the incision on the upper side, and in one and one-half hours a strong, negative, geotropic response had begun to take place.

tile might pass. The plants were arranged in a row in a box with a glass front in air saturated by means of moist paper. The tip of the coleoptile was exposed in a temperature of 13—15° C. to unilateral illumination produced by an electric light bulb of 100 candle power about 2 meters distant. The bulb was enclosed in a wooden box having a circular opening in front 7 cm in diameter. In this manner a stream of light was directed to the row of plants in the opposite box. The periods of exposure of the tips of the coleoptiles include a range of $3^1/_2$—7 hours, the most favorable period being 5 hours.

Observations of preliminary experiments led me to make the incision, in the plants allowed to recover, less deep than in the plants used at once. My reason for doing this was that while the deeper incision seemed to produce less traumatropic response, it could not be used in the recovered plants, because during the long period of recovery a protrusion of the intersected leaf resulted, bending backwards and frequently breaking off the tip of the coleoptile. The incision in the recovered plants extended through about $^1/_2$ of the coleoptile and that in the plants used at once, about $^2/_3$. The same depth, of course, was used in cutting the individuals belonging to the same set of experiments. In the geotropic experiments a similar procedure was carried out.

In the geotropic experiments the plants were placed horizontally in a box where the air was saturated by means of moist black paper and a temperature of 13—18° C. was maintained. The periods of exposure varied from 3—7 hours, the most favorable period apparently being 4 hours. In these experiments not the tip alone but the entire plant was exposed to the stimulus.

C. Results.

a. Phototropic Experiments.

Experiment I (cf. table I).

Plants with incision made just before exposure.

a. Incision on side of coleoptile farthest from light.

Out of 47 plants, 5 individuals were curved in a positive phototropic direction, 6 in a negative while 36 were straight. The mean value for **d** = — 0·002 cm ± 0·003 cm.[1]

b. Incision on side of coleoptile nearest light.

Out of 52 plants, 51 individuals were curved in a positive direction, 1 was straight. The mean value for **d** = + 0.085 cm ± 0.007 cm.

c. Control plants completely shaded, placed between the experimental plants, some with incision farthest from light, others nearest.[2]

Out of 49 plants, 29 individuals curved in a positive traumatropic direction, 1 in a negative, while 19 were straight. The mean value for **d** = + 0.018 cm ± 0.004 cm.

In the plants with the incision nearest the light the curvature produced should be regarded as a combination of the phototropic and traumatropic responses, occurring simultaneously. Therefore, to obtain a value for **d** in these plants, which may be attributed to the phototropic stimulus

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[1] These figures represent the mean error which was computed for each series of experiments. The method employed was that described in Johannsen (1913, 54).

[2] The results show that the response given by the control plants is unaffected by the position of the incision in relation to the source of illumination. Therefore the two lots will be considered as a whole in the computation of the results.

Table I. Phototropic Experiments — Fresh cuts.

a, represents values for **d** in plants with incision farthest from light; **b**, nearest light; **c**, control plants, (1) incision farthest from light, (2) incision nearest.

a	b	c	
		(1)	(2)
.00	+ .10	+ .02	+ .03
+ .05	+ .11	+ .02	+ .03
.00	+ .16	+ .03	+ .10
.00	+ .07	.00	+ .08
.00	+ .12	.00	+ .03
.00	+ .08	.00	.00
.00	+ .11	.00	+ .00
.00	+ .05	+ .00	+ .04
.00	+ .05	+ .00	.00
.00	+ .12	+ .00	.00
.00	+ .00	+ .00	+ .00
+ .02	+ .09	.00	+ .05
.00	+ .08	.00	.00
.00	+ .09	+ .03	+ .04
.00	+ .14	.00	.00
+ .00	+ .07	+ .05	+ .00
.00	.00	.00	.00
+ .04	+ .07	.00	.00
.00	+ .03	+ .03	+ .00
.00	+ .00	+ .00	.00
.00	+ .09	+ .04	+ .08
+ .00	+ .10	+ .04	.00
.00	+ .12	+ .09	+ .00
.00	+ .20	+ .08	.00
.00	+ .20		— .02
.00	+ .11		
.00	+ .08		
.00	+ .09		
.00	+ .05		
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.00	+ .06		
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.00	+ .04		
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.00	+ .05		
.00	+ .11		
.00	+ .13		
.00	+ .09		
.00	+ .07		
.00	+ .03		
— .01	+ .11		
— .03	+ .16		
— .05	+ .09		
.06	+ .15		
— .05	+ .10		
— .00	+ .06		
	+ .07		
	+ .11		
	+ .16		
	+ .09		
	+ .00		
Mean **d** = — 0.002 cm.	+ 0.085 cm.	+ 0.018 cm.	
Mean error = ± 0.003 cm.	± 0.007 cm.	± 0.004 cm.	

Table II. Phototropic Experiments—Recovered plants.

a, represent values for **d** in plants with incision farthest from light; **b**, nearest light; **c**, control plants, (1) incision farthest from light, (2) incision nearest.

a	b	c	
		(1)	(2)
.00	+ .05	+ .07	.00
.00	+ .05	.00	.00
.00	+ .07	.00	.00
.00	+ .08	.00	.00
.00	+ .04	.00	.00
.00	+ .04	.00	.00
.00	+ .04	.00	.00
.00	+ .03	.00	.00
.00	+ .07	.00	+ .00
.00	+ .07	.00	.00
.00	+ .11	.00	.00
.00	+ .11	.00	.00
+ .05	+ .08	.00	.00
.00	+ .11	.00	.00
.00	+ .10	.00	.00
.00	+ .07	.00	.00
.00	+ .04	+ .06	.00
+ .06	+ .07	+ .00	.00
.00	+ .07	.00	.00
.00	+ .07	.00	.00
.00	+ .08	.00	.00
+ .07	+ .06	.00	
.00	+ .12	.00	
.00	+ .06		
.00	+ .07		
.00	+ .05		
.00	+ .05		
.00	+ .05		
.00	+ .09		
.00	.00		
.00	+ .11		
.00	+ .07		
.00	+ .05		
+ .00	.00		
.00	+ .06		
.00	+ .07		
.00	+ .04		
.00	+ .03		
+ .07	+ .08		
.00	+ .12		
.00	+ .00		
+ .06	+ .05		
.00			

Mean **d** = + 0.007 cm. + 0.064 cm. + 0.003 cm.
Mean error = ± 0.003 cm. ± 0.005 cm. ± 0.002 cm.

alone, it is necessary to subtract the mean **d** in the control plants of this experiment from the mean **d** of the experimental plants with the incision nearest light.

Similarly, the slight response in the plants with the incision farthest from light may be considered the result of a partial compensation of the opposing phototropic and traumatropic reactions. In this case then, the value for **d** should be subtracted from the mean value for **d** in the control plants considering both values positive.

The result of the above computation gives a value for **d** in the plants with the incision farthest from light of + 0.016 cm ± 0.005 cm, in the plants with the incision nearest to light + 0.067 cm ± 0.008 cm.

The above final results show that in the plants with the incision nearest to light a positive curvature has taken place, which is more than four times as great as that in the plants with the incision farthest from light.

Experiment II (cf. table II).

Plants with incision made on day preceding exposure.

a. Incision on side of coleoptile farthest from light (cf. fig. 3).

Out of 43 plants, 6 individuals were curved in a positive phototropic direction, 0 in a negative, while 37 were straight. The mean value for **d** = + 0.007 cm ± 0.003 cm.

b. Incision on side of coleoptile nearest light. (cf. fig. 4).

Out of 42 plants, 40 individuals were curved in a positive phototropic direction, 2 were straight. The mean value for **d** = + 0.064 cm ± 0.005 cm.

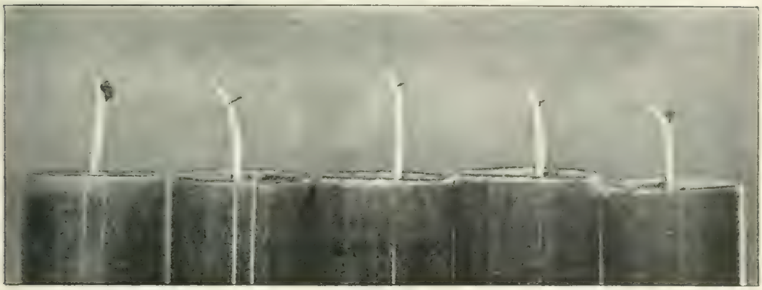

Fig. 3. Plants with incision farthest from light.

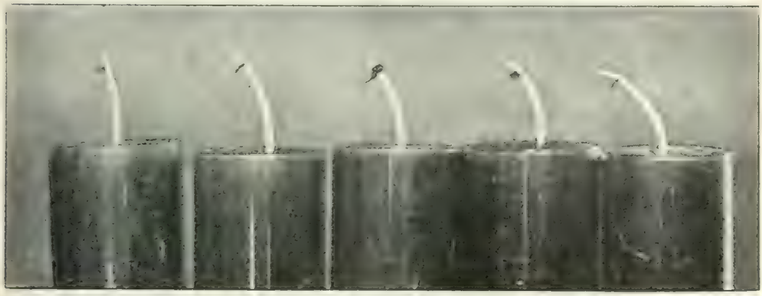

Fig. 4. Plants with incision nearest light.

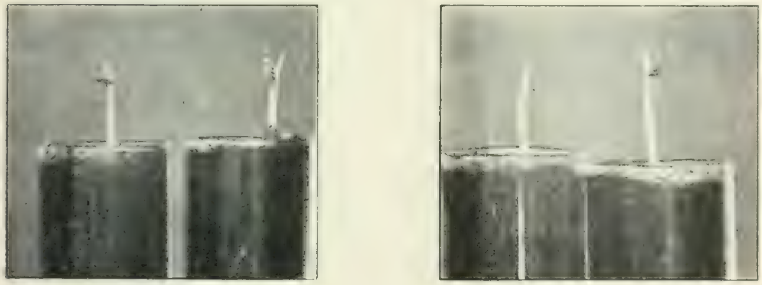

Fig. 5. Control plants.

Table III. Geotropic Experiments. — Fresh cuts.

a represents values for **d** in plants with incision on lower side of coleoptile; **b**, on upper side; c, control plants.

	a	b	c
	.00	— .12	.00
	.00	— .11	+ .04
	.00	— .15	+ .02
	.00	— .17	+ .06
	.00	— .09	+ .08
	.00	— .14	+ .04
	.00	— .12	+ .09
	.00	— .18	+ .04
	.00	— .24	.00
	.00	— .19	+ .00
	.00	— .14	.00
	.00	— .25	+ .06
	.00	— .18	+ .10
	.00	— .21	+ .05
	.11	— .23	+ .08
	.00	— .16	+ .14
	.00	— .05	.00
	.00	— .15	+ .05
	.00	— .13	+ .00
	.00	— .04	+ .11
	.00	— .09	.00
	.00	— .20	.00
	.00	— .21	+ .05
	— .04	— .15	+ .10
	- .04	— .23	.00
	.00	— .10	.00
	— .06	— .20	+ .14
	.00	— .21	.00
	.00	— .14	+ .06
	.00	— .19	.00
	— .00	— .12	.00
	— .00	— .13	+ .05
	— .00	— .14	+ .04
	.00	— .32	.00
	— .10	— .21	+ .00
	.00	— .19	+ .00
	.00	— .14	.00
	.00	— .39	.00
	.00	— .35	+ .04
	.00	— .32	+ .04
	— .06	— .35	+ .05
	- .03	— .10	.00
	.00	— .22	.00
	.00	— .30	.00
	.00	— .32	.00
	— .08	— .03	.00
	— .06	— .03	.00
		- .05	+ .00
		— .07	.00
		— .07	.00
		- .16	
		.18	
		— .25	
		- .24	
Mean **d**	= — 0.012 cm.	— 0.175 cm.	+ 0.031 cm.
Mean error	= ± 0.004 cm.	± 0.012 cm.	± 0.006 cm.

c. Control plants completely shaded, placed between the experimental plants, some with incision farthest from light, others nearest.[1] (cf. fig. 5).

Out of 44 plants, 4 curved in a positive traumatropic direction, 40 were straight. The mean value for **d** = + 0.003 cm ± 0.002 cm.

It is noteworthy that a traumatropic response following the insertion of the foil occurred only in about 9 % of the plants. However, as in Experiment I, it is necessary to eliminate this reaction from the results by adding the mean **d** of the control plants to that of the plants with the incision farthest from light and subtracting the same from the mean **d** of the plants with the incision nearest light.

The result of the above computation gives a value for **d** in the plants with the incision farthest from light of + 0.010 cm ± 0.004 cm, in the plants with the incision nearest to light + 0.061 cm ± 0.005 cm.

The above final results show that in the plants with the incision nearest to light a positive curvature has taken place, which is almost six times as great as that in the plants with the incision farthest from light. An examination of table II also reveals the fact that in the case of the plants placed in the latter position only about 14 % reacted in a positive phototropic direction as contrasted with about 95 % in the former.

b. Geotropic Experiments.

Experiment III (cf. table III).

Plants with incision made just before exposure.

a. Incision on lower side of coleoptile.

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[1] Cf. foot-note 2 page 13.

Out of 47 plants, 12 individuals were curved in a negative geotropic direction, 35 were straight. The mean value for **d** = — 0.012 cm ± 0.004 cm.

b. Incision on upper side of coleoptile.

Out of 54 plants, the entire number curved in a negative geotropic direction. The mean value for **d** = — 0.175 cm ± 0.012 cm.

c. Control plants set in an upright position.

Out of 50 plants, 28 curved in a positive traumatropic direction. The mean value for **d** = + 0.031 cm ± 0.006 cm.

In order to obtain relative values for the geotropic curvature taking place in the plants, it is necessary to eliminate the traumatropic response from the above results.

The result of the computation gives a value for **d** in the plants with the incision on the lower side of the coleoptile of — 0.043 cm ± 0.007 cm, in the plants with the incision on the upper side — 0.144 cm ± 0.013 cm.

These final results show that in the plants with the incision on the upper side of the coleoptile a negative geotropic curvature has taken place, which is about three and one-half times as great as that in the plants with the incision on the lower side.

Experiment IV (cf. table IV).

Plants with incision made on day preceding exposure.

a. Incision on lower side of coleoptile. (cf. fig. 6).

Out of 51 plants, 43 individuals were curved in a negative geotropic direction, 8 were straight. The mean value for **d** = — 0.074 cm ± 0.007 cm.

Table IV. Geotropic Experiments. — Recovered plants.

a represents values for **d** in plants with incision on lower side of coleoptile; **b** on upper side; **c** control plants.

a	b	c
— .11	— .14	.00
— .06	— .13	.00
— .11	— .23	.00
— .08	— .18	.00
— .17	— .20	.00
— .16	— .21	.00
— .12	— .16	.00
— .09	— .15	.00
— .11	— .22	.00
— .12	— .25	.00
— .18	— .20	.00
— .17	— .28	.00
— .10	— .26	.00
— .02	— .20	.00
— .09	— .14	.00
— .11	— .11	.00
.00	— .13	.00
— .06	— .14	.00
— .11	— .16	.00
— .04	— .17	.00
— .14	— .16	.00
— .04	— .17	.00
.00	— .09	.00
— .03	— .20	.00
— .03	— .15	.00
— .07	— .16	.00
— .08	— .08	.00
— .04	— .18	.00
— .06	— .23	.00
— .10	— .27	.00
— .06	— .14	.00
— .15	— .25	.00
— .09	— .03	.00
.00	— .13	.00
— .03	— .06	.00
— .07	— .16	.00
— .05	— .20	.00
— .08	— .06	.00
— .03	— .20	.00
— .06	— .23	.00
— .12	— .25	.00
— .05	— .17	00
— .19	— .21	.00
— .06	— .19	— .00
.00	— .27	.00
.00	— .16	.00
.00	— .06	.00
.00	— .13	.00
.00	— .23	.00
— .09	— .14	.00
— .03	— .15	.00
	— .20	

Mean **d** = — 0.074 cm. — 0.173 cm. 0.000 cm.
Mean error = ± 0.007 cm. ± 0.008 cm.

Fig. 6. Plants with incision on lower side of coleoptile.

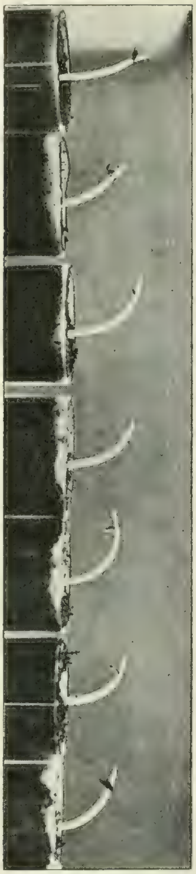

Fig. 7. Plants with incision on upper side of coleoptile.

Fig. 8. Control plants.

b. Incision on upper side of coleoptile (cf. fig. 7).

Out of 52 plants, the entire number curved in a negative geotropic direction. The mean value for **d** = — 0.173 cm ± 0.008 cm.

c. Control plants set in an upright position. (cf. fig. 8).

Out of 51 plants, only 1 individual curved very feebly in a negative traumatropic direction, 50 remained straight. The mean value for **d** = 0.000 cm.

In this experiment the traumatropic response was practically eliminated.

The above results show that in the plants with the incision on the upper side of the coleoptile a negative geotropic curvature has taken place more than twice as great as that in the plants with the incision on the lower side.

A graphic representation of the results of the above experiments is given in fig. 9. The radius (r) of the mean curvature for the different series of plants was determined from the mean **d** by means of the equation:[1]

$$r = \frac{tl}{d}$$

where $t = 0.14$ cm, d = the mean d for a given series of plants, l = the approximate average length of all the plants of one set of experiments. The following drawings were constructed from the data obtained.

Since the curves a and b represent the mean response of the plants in the respective series to both traumatropic and phototropic or geotropic stimuli, that part of the reaction which may be considered as solely phototropic or

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[1] cf. method for measurement of curvature page 8.

geotropic response is the angle through which the plant moves from right to left between the dash-and-dot arc *c* and the curves *a* or *b*.

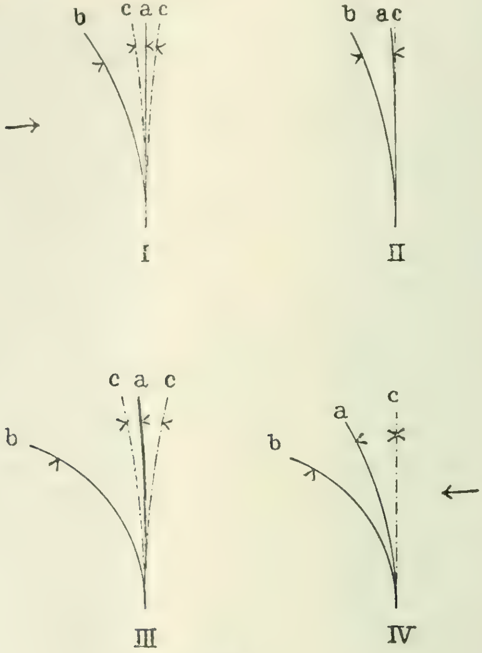

Fig. 9.

I represents the phototropic experiments with fresh cuts, II phototropic, recovered plants, III geotropic, fresh cuts, IV geotropic, recovered plants. *a* represents the curvature taking place in the plants farthest from light, or on the lower side in geotropic exposure, *b* plants nearest light or on upper side, *c* control plants. The carets indicate the position of the incision; the arrows the direction of the stimuli. Magnified 2 times.

D. Conclusions.

From the results of these experiments, considered both individually and collectively, the following conclusions may be drawn:

1. When the plants are placed with the incision on the side of the coleoptile either nearest

to the source of unilateral illumination or on the upper side in an exposure to geotropic stimulation, a marked transmission of the stimulus takes place from the tip to the base of the coleoptile.

2. When the plants are placed with the incision on the side of the coleoptile either farthest from the source of unilateral illumination or on the lower side in an exposure to geotropic stimulation, transmission of the stimulus from the tip to the base is only slight.

It should be borne in mind that the slight transmission of the stimulus taking place in the latter case may be due to the fact that it is not easy to effect an absolute prevention of transmission, since the cut sometimes fills with exuding sap.

Another explanation which may be offered for the results leading to the second conclusion is that the side of the coleoptile in which the incision is made is perhaps rendered practically insensible in consequence of the injury. This argument is met by experiment V in which 30 plants were exposed to unilateral illumination with the incision placed on the side of the coleoptile farthest from the light. The entire coleoptile of 15 of these plants was exposed, the roots being shaded, while only that portion of the tip above the incision was illuminated in the remaining plants. The results (cf. table V & fig. 10) show a mean curvature, as determined by

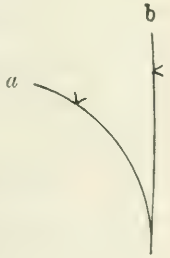

Fig. 10.
a represents the mean curvature of plants with entire coleoptile exposed, *b* plants with only tip exposed.

d, taking place in the former plants equal to about fourteen times as great as that in the latter.

Table V.

a	b
.00	+ .08
.00	+ .16
.00	+ .25
+ .00	+ .32
.00	+ .31
+ .04	+ .22
+ .05	+ .19
+ .11	+ .21
— .00	+ .18
.00	+ .16
.00	+ .20
.00	+ .21
.00	+ .09
.00	+ .16
.00	+ .03
Mean **d** = + 0.013 cm.	+ 0.185 cm.

E. Theoretical Considerations.

Fitting (1907, 241, 244) holds the following theory concerning the transmission of tropic stimuli in the coleoptile of *Avena*: "Durch die einseitige Beleuchtung wird in allen Teilen, wahrscheinlich in allen Zellen, des Perzeptionsorganes während oder infolge des Perzeptionsvorganges ein "polarer Gegensatz" geschaffen. Je nach der, allein vom Lichte abhängigen, Lage der Pole wird die "Reizstimmung" der Perzeptionszone und durch eine geradlinige oder quere Fortleitung, die ganz unabhängig ist von der Lage der Bahnen, auch die Stimmung der Reaktionszone verschieden. Die Stimmung entscheidet über die Richtung der Krummung." He also states, "Dass der polare Gegensatz, der in allen Teilen (Zellen) des Perzeptionsorganes durch den Aussenreiz induziert wird, sich auf lebenden Bahnen in die physiologisch radiär symmetrische, in seitlicher Richtung apolar gebaute Reaktionszone so ausbreitet, dass auch in ihr ebenso wie in den Zellen der Reizleitungsbahnen alle Teile in gleicher Weise 'polarisiert' werden."

If we are to agree with FITTING then we may suppose that on exposure of *Avena* to light the illuminated cells of the tip become "polarisiert", and this reaction spreads to the unilluminated cells through transmission not only in a straight line but also "um die Ecke", until a state of polarization is maintained throughout the cells of the coleoptile.

On the other hand, if transmission of the stimulus is to be attributed to the migration of one or more substances, it is obvious that since such an occurrence could not produce polarization of the cells, the theory of FITTING is entirely out of harmony. Since the most probable theory at the present time is the migration one, let us attempt on this ground to interpret briefly the results of the foregoing experiments. To produce a curvature a difference must exist not between the front and back of each cell but between the front and back of the unilaterally illuminated tip as a whole. This condition may be brought about by an unequal concentration of one or more substances. Furthermore it may be presumed that this difference is maintained by transmission of the stimulus to the base of the coleoptile. Only under these circumstances is it possible to conceive of a phototropic or geotropic curvature taking place.

Let us now consider the results of the recovered plants.[1] In view of the fact that a marked transmission of the

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[1] Since the traumatropic response in this case need not be taken into consideration, these experiments were chosen.

stimulus occurs when the incision is placed on the side of the coleoptile nearest the light, and either no transmission or only a slight one is observed, when the incision is placed farthest from light, the conclusion of Fitting (1907, 237) "Dass die Reiztransmission keineswegs verlangsamt wird, wenn man eine longitudinale Reizübermittelung verhindert, woraus man schliessen muss, dass der Reiz sich ebenso gut in der Quer- wie in der Längsrichtung ausbreitet," must be erroneous. On the contrary the results[1] point out that the strongest tendency is for transmission of the stimulus to take place in a longitudinal direction, mainly localized in the side of the coleoptile farthest from light. Likewise in the geotropic experiments the results show that the greatest tendency for transmission of the stimulus is in the longitudinal direction, chiefly restricted to the lower side of the coleoptile. It is apparent, that this conclusion is in perfect harmony with the migration theory.

The above experiments, begun in the fall of 1920 and completed the following spring, were carried out in the Plant Physiology Laboratory of the University of Copenhagen. To Professor Johannsen, Director of the Laboratory, I wish to express my sincere appreciation of the courtesies of the laboratory extended to me, and of his stimulating and kindly interest in the work. To Dr. Boysen Jensen I

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[1] Cf. also the results of the experiments of Stark, referred to in the text above, in which he placed cubes of agar containing an extract of one or more stimulatory substances on one side of the coleoptile directly on the cut surface. The curvature produced in this manner suggests the probability of migration of one or more substances in a more or less restricted path.

am deeply grateful for untiring and invaluable supervision of these investigations, inspired by the publication of his former research on the same problem.

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Færdig fra Trykkeriet den 9. December 1921.

Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **III,** 9.

OM TIDSBESTEMMELSE OG ERNÆRINGSFORHOLD I DEN ÆLDRE STENALDER I DANMARK

EN BIOLOGISK STUDIE

AF

C. G. JOH. PETERSEN

(MED EN KORTSKITSE)

WITH A RÉSUMÉ IN ENGLISH

1742

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
1922

Den ældre Stenalder maa have varet i Aarhundreder; efter et Skøn over alle Forhold maa den have haft en Varighed af over et halvt Aartusinde; saaledes omtrent udtaler nogle Arkæologer sig om denne Sag (S. Müller: Vor Oldtid pg. 41—42. 1897); men hvor længe det har varet at opdynge vore store Køkkenmøddinger, har egentlig ingen mig bekendt udtalt sig om; de er jo ikke ene om at repræsentere den ældre Stenalder i Danmark, omend de vel almindelig er antaget at have været opdynget i Løbet af hele den ældre Stenalder. Særlig om den Tid, det maa have varet at opdynge den enkelte Køkkenmødding, er der næsten fuldstændig Tavshed.

I 1893 udtaler Zinck (Stenalderstudier pg. 129), efter at have beregnet, hvormange Østers der findes opdynget i Køkkenmøddingen ved Meilgaard, at 20 Mennesker kan have spist disse Østers paa 50 Aar, med et dagligt Forbrug hver af 25 Østers. Selv havde jeg aldrig, skønt jeg har deltaget i Udgravningen af mange Køkkenmøddinger siden 1888, tænkt mig Muligheden af at kunne opstille nogen Tidsberegning ved Hjælp af Østersens eller de andre Dyrs Mængde; thi saalænge man ikke vèd, hvormange Mennesker der har deltaget i Maaltiderne, synes al saadan Beregning umulig; hvad 20 Mennesker kan spise i 50 Aar, kan 2 jo spise af i 500 Aar.[1] Men efter at jeg i en Aarrække har været borte fra

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[1] N. C. Nelson har i 1909 og 1910 for de store californiske Shellmounds, blandt hvilke en er 20 Gange større end Meilgaarddyngen, ved

Kokkenmodding-Studierne og haft at gøre med Østersfiskerierne i Limfjorden ex officio, stiller Sagen sig anderledes for mig; kan vi ikke bruge Menneskeantallet til vore Beregninger over Tidsrummene, kan vi maaske bruge Østersantallet.

Som særlig egnet for saadanne Studier har jeg valgt Meilgaards store Køkkenmødding; i den har jeg gravet sammen med Kaptajn A. P. Madsen i 1888, saa jeg kender den af Selvsyn.

Hosføjede Kort, som Statsgeolog Axel Jessen velvilligst har tegnet for mig, giver en Oversigt over Meilgaards Køkkenmøddings Beliggenhed og viser, hvad der nu er Kattegats Grænselinie, og hvor den laa i Stenalderen; en Hævning af Landet paa ca. 5 m har her fundet Sted siden da; endvidere er der angivet, hvad der var gammelt Land i Stenalderen, medens der er set bort fra alle de nyere Klitdannelser paa det hævede Havomraade; dette er nu gaaet over til at blive lave, jævne Strækninger delvis med Skov, hvor man kun ved Boring eller Gravning kan paavise den oprindelige Havbund, hvorpaa Stenalderens Folk fiskede deres Østers. En saadan Gravning foretog jeg i 1888 lige ud for Køkkenmøddingen, men traf allerede paa faa Fods Dybde saa meget Vand, at videre Gravning var umulig; imidlertid viste den marine Natur sig allerede tydelig selv i denne ringe Dybde. Hvor mægtige de yngre Dannelser er ovenpaa Havbunden, er ikke undersøgt; bestemte Tal kan

at gaa ud fra Folkeantallet, beregnet efter de tilstedeværende Hyttetomters Antal, og ved at antage, at hvert Menneske har spist en passende Mængde Skaldyr daglig, beregnet denne Skaldynges Opdyngningsalder til ca. 3500 Aar. I Californien har Stenalderen jo varet til op i den nyeste Tid. Gennem Professor Aug. Krogh og Dr. Gudmund Hatt er jeg bleven gjort opmærksom paa disse Publicationer.

I Danmark kendes intet til Hustomter fra Køkkenmøddingerne.

Stenaldershavet ved Meilgaards Kokkenmødding.

derfor ikke gives for, hvor dybt Vand der var i denne Vig i Stenalderen, men det kan, om man ønsker det, paavises ved Boring. Synderlig dyb har denne Vig næppe været selv paa det dybeste; jeg vil skønne 4—8 m; paa de fleste Steder har den dog sikkert været langt grundere. Interessant vilde det være at kende ogsaa Mægtigheden af de marine Lag her. I den inddæmmede Del af Odensefjord ved Egense har jeg før 1888 fundet lignende Lag indtil over 3 m mægtige og østersførende.

Paa en gammel Halvø's Nordvestside er den store Køkkenmøddings Beliggenhed antydet ved en —; paa Nordsiden af Græskjærholm og paa Sydsiden af Hagenskov, den Gang en Ø, er der ogsaa fundet Spor af Køkkenmøddinger, altsaa paa 3 Steder i den Vig, der ligger omkring Halvøen med den store Køkkenmødding, og som nu dækkes af de lavere Dele af Nederskov.

I dette Vand maa Køkkenmøddingens Østers være fisket; thi Østers er ikke egnet til lang Transport som Haandbagage, og de smaa Køkkenmøddinger andetsteds ved Vigen viser, at Østersen har været spist nær de Steder, hvor den er bleven fisket. Det hele Areal vest for de to Øer ved Vestenden af Hagenskov har derfor næppe ydet noget Bidrag til Køkkenmøddingen, om dette Vand i det hele har været østersgivende; det laa saa aabent ud mod Kattegat og har maaske været meget for grundt i Forhold til Bølgeslagets Størrelse.

Regnes derfor Arealet øst for disse to Øer, syd for Hagenskov til om øst for Køkkenmøddingen for det østersgivende Areal, faar vi et samlet Areal paa c. 500 ha til at fiske Østers paa, et Areal, der kun er c. 1/231 af det Areal, vi nu fisker Østers paa i den vestlige Limfjord. I denne fiskes der i de senere Aar c. 4 Millioner Østers om Aaret med de bedst udrustede Motorbaade, og saaledes, at det er kendeligt paa Limfjordens Bestand af Østers; ved Meilgaard skulde der saaledes kun have kunnet fiskes c. 17.000 Østers aarlig.[1]

Vel har jeg i min Disputats af 1888 paavist, at Klimatforholdene i Stenalderen var bedre end nu i vore Vande; men dels var Klimatforholdene ikke meget forskellige fra den vestlige Limfjords nuværende, vel nok som Regel noget mildere Vintre og noget varmere Somre, men i hele Grader C. drejer det sig vist kun om meget lidt; saa meget forskellige fra Forholdene i Limfjorden i Nutiden har Forholdene ved Meilgaard næppe været i Stenalderen, at man af den Grund kan antage en meget større Produktion af Østers pr. ha paa sidstnævnte Sted.[2] Har Klimatforholdene

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[1] Ved denne Regnemaade er jeg gaaet ud fra, at der, ligesom i Limfjordens Bredninger i Nutiden, ogsaa i Vigen ved Meilgaard har været bløde Arealer i Midten, der ikke var østersproducerende; om denne Forudsætning er rigtig, kan kun oplyses ved mange Boringer paa Stedet. En nærmere Undersøgelse af den hele Vig vilde have sin betydelige Interesse ved at fastslaa Mægtigheden af de marine Lag, deres nærmere Beskaffenhed og Fauna samt deres Dybde under Havspejlet i Stenalderen. Jeg anser det imidlertid ikke for min Opgave at foranstalte en saadan Undersøgelse i Detaillerne.

Vil man komme den hele Sag nærmere, end jeg her er kommen den, maa man først have en Detailundersøgelse af Vigens marine Lag og saa om muligt finde en lignende Nutidsvig beliggende under lignende Klimatforhold som i Stenalderen, for der nøjere at studere Udbyttet af Østersfiskeriet under den Form, hvori det blev drevet i Stenalderen.

Limfjordens østersbærende Areal er udregnet ved at addere Arealerne af Nissum Bredning, Lavbjerg Bredning, Venø Bugt, Kaas Bredning, Thisted Bredning, Visby Bredning og Vilsund, Sallingsund, Livø Bredning, samt Risgaards Bredning efter Opmaalinger i Biologisk Stations Beretning VI, 1895; disse Arealer udgør tilsammen 209.298 Tønder Land eller c. 115.455 ha eller c. 231 Gange mere end 500 ha.

[2] I Knud Jessens Moseundersøgelser 1920 pg. 240 angives efter A. C. Johansen Julitemperaturen i Danmark i den ældre Stenalder til c. 17° C og i den historiske Tid til c. 16° C; begge Dele maa vel nærmest opfattes som Middeltal for mange Aar, d. v. s. at man sikkert nu ofte har Aar med ligesaa høj Julitemperatur som visse Aar i den ældre Sten-

været bedre for Østersen, har de vel ogsaa været det for dens Fjender, saa man kan ikke af den Grund vente nogen særlig stor Østersbestand. Noget andet er det, at heldige Yngelaar maaske nok er indtruffet hyppigere den Gang end nu; det kan have bidraget til, at Bestanden har kunnet holde imod i saa mange Aar paa det grunde Vand, trods sikkert hensynsløs Behandling. Jeg har foran sammenlignet hele Arealet ved Meilgaard med alle vore bedste Egne for Østersfangst i Limfjorden og ikke taget Hensyn til, at man i Nutiden bedre forstaar at faa de paa dybt Vand, 6—10 m., liggende Østers med, hvor de fleste Østers findes. En Sammenligning med de nutidige ligesaa grunde Vige som Meilgaards Indvig vilde have givet et meget mindre Resultat af Stenalderens Østersfiskeri. Det maa antages, at Østersen i Stenalderen har kunnet trives bedre end nu, navnlig paa det grundere Vand, ellers vilde det have set meget daarligere ud for Østersproduktionen i Vigen ved Meilgaard, end det gør efter ovenstaaende Beregning. Østersen i Køkkenmøddingen ligner ellers meget Østersen fra visse af Limfjordens indre Bredninger; men de er gennemgaaende meget mindre i Køkkenmøddingen, end dem vi bruger nu; nogle er endog saa smaa, 3—4 cm, at de aldeles ikke er talt med i efterfølgende Beregninger; disse ganske smaa Østers er maaske ikke brugt til Føde; de kan være fulgt med, fastsiddende paa andre Skaller. Østersens Gennemsnitsstørrelse

alder. Jeg maa bl. a. derfor bestemt advare mod at sammenligne Østersbankerne ved Meilgaard med andre, der ligger under sydligere Breddegrader, f. Eks. i Frankrig, navnlig Arcachon-Bugten; thi her er stærk Ebbe og Flod og højere Temperatur, efter Oplysning fra Meteorologisk Institut op mod 21° i Juli, samt ingen Is om Vinteren, hvilke Forhold i høj Grad øger Østersproduktionen. At man i enkelte af Revolutionsaarene omkring 1800 her fiskede et ganske enormt Antal Østers, hvilket senere havde Bestandens næsten totale Ruin tilfølge, kan jeg ikke tillægge nogen Vægt i denne Sammenhæng; se herom Hornell, 1920, pg. 8.

i Køkkenmøddingen synes at ligge ved 7—8 cm Længde; men Størrelsen er meget vekslende paa forskellige Steder; ogsaa meget store Østers findes i visse Dele af Køkkenmøddingen. Skallerne er saa vel bevaret, at Tælning af dem ikke volder nogen Vanskelighed, selv om de forekommer i Brudstykker; man tæller da kun de Stykker, paa hvilke Baandgruben sidder.

Jeg gaar ud fra, at man i Stenalderen ikke kunde skrabe Østers; thi dertil fordres Motorer eller Damp eller stor Sejlkraft eller tunge Baade med adskillige Mennesker til Roning, og det har næppe været præsteret; jeg antager, man kun har taget med Haand eller Kætser, hvad man kunde faa paa lavere Vand (Briling); ja ikke engang paa Dykning som almindelig Beskæftigelse kan jeg tro; det vil, som det senere skal vises, næppe have kunnet betale sig.

Jeg tror derfor, man regner passende højt, naar man sætter den aarlige Østersfangst til c. 17.000 ved Meilgaard; men heraf følger, at hvis Mennesker til Stadighed har levet der og spist c. 20 Østers hver om Dagen, er der kun Østers til knap 3 Mennesker om Aaret, idet $20 \cdot 365 = 7300$ Østers aarlig.

Vidste man, hvormange Østersskaller der har ligget i hele Meilgaards Køkkenmødding, kunde man ved Division med 17.000, regne sig til, hvorlænge det mindst har varet at opdynge den; jeg tror, dette forholdsvis let lader sig oplyse tilnærmelsesvis. I SEHESTEDS udmærkede Opmaaling af Køkkenmøddingen fra 1880 har vi Oplysning om dens Størrelse, nemlig meget nær 2000 m^3; det gælder altsaa nærmest om at faa at vide, hvormange Østersskaller der gennemsnitlig gaar paa 1 m^3. ZINCK's foran omtalte Undersøgelse giver for faa Østers pr. Rumenhed; han regnede med 150 Østers (dobbelte Skaller) pr. Kubikfod, eller c. 4800

Østers pr. m^3; men om Størrelsen af de benyttede Østers har han ikke udtalt sig. Ved en Optælling af mindre Limfjordsøsters pr. 1 m^3, Størrelse c. 8 cm, har Direktør Villars Lunn, den nuværende Østersforpagter, fundet Tallet 8100 Østers; Skallerne var ved Tælningen adskilt og laa hovedsagelig alle vandret. Denne Størrelse af Østers syntes mig at passe nogenlunde godt paa Gennemsnitsstørrelsen af Østers i Køkkenmøddingen ved Meilgaard. Men for at være sikker paa at komme de virkelige Forhold saa nær som muligt, fik jeg gennem Ejeren, Hr. Kammerherre N. Juel, og, da Køkkenmøddingen er fredlyst, ogsaa gennem Nationalmuseet, Tilladelse til at optælle Østersskaller paa tre forskellige Steder i den, hvert Sted en Kubikfod. Dette iværksattes ved Hjælp af Hr. Skovfoged C. Fog og Inspektør ved Nationalmuseet P. M. Thomsen. Optællingen udførtes i Februar 1921 paa den Maade, at der i en renset Væg blev indstukket 1 Fod lange Jernpinde, der omgrænsede 1 Kubikfod, efter at det overliggende Lag var fjærnet; der udpilledes og optaltes nu alle[1] Skallerne indenfor Jernpindene, dette gentoges paa 3 i en lodret Pille liggende Steder. I den øverste Kubikfod fandtes 640 Skaller, i den mellemste 615, men her var iblandet en Del Mytilusskaller, og i den underste 695; Gennemsnittet bliver altsaa 650 Skaller pr. Kubikfod. Zinck havde kun beregnet 300 Skaller paa 1 Kubikfod, hvad altsaa er meget for lidt. 650 Skaller paa 1 Kubikfod giver 20.800 pr. 1 m^3, eller 10.400 hele Østers. Lunns Optælling gav 8.100 Østers; men det er jo meget rimeligt, at Skallerne synker noget sammen ved at ligge i Køkkenmøddingen i mange Aar. Da Køkkenmøddingen var 2000 m^3, bliver det samlede Østersantal i denne derfor 20,8 Millioner;

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[1] Som nævnt foran er nogle ganske smaa Skaller ikke talt med, gennemsnitlig omtrent 50 Enkeltskaller paa hver Kubikfod.

og regner man, at der er fisket 17.000 om Aaret, maa det have varet mindst over 1200 Aar at opdynge Køkkenmøddingen. Dette Tal er selvfølgelig kun et tilnærmet Tal, og betydelig større end det, Arkæologerne synes at tænke sig; det nærmer sig derimod meget mere de Tidsrum, som Geologerne regner med. Jeg skal ikke komme nærmere ind paa disse Tal, men blot henvise til Knud Jessen: Moseundersøgelser i det nordøstlige Sjælland, 1920; pg. 240.

Længe har det altsaa varet at opdynge den store Køkkenmødding ved Meilgaard, og længe har den ældre Stenalder derfor varet i Danmark; dens Køkkenmøddinger kendes jo paa overordentlig mange Steder af vore Kyster; men jeg har ikke anset det for min Sag at gøre nogen anden af disse til Genstand for Undersøgelse. Meilgaard synes mig bedst at give Hovedtrækkene, dels fordi den er den største Køkkenmødding, dels fordi den ligger saa isoleret ved en lille Fortidsvig.

Det vides, at den ældre Stenalders Befolkning har levet spredt over hele Landet, ikke alene ved Kysterne, men ogsaa ved Aaer og Søer, hvor der derfor blandt deres Efterladenskaber ikke findes Østersskaller; de har altsaa helt kunnet undvære denne Næring og har kunnet leve af Jagt og Fiskeri alene, med samt den Smule Plantekost, der kunde skaffes af vore vildtvoksende Planter, vel mest Nødder, Agern, Æbler og Rødder etc.

Et spredt Jæger- og Fiskerfolk har det været med en dertil hørende faatallig Befolkning. I Ratzels Anthropogeographie II Bd. 2 Udg. 1912, hvilken Bog Dr. Gudmund Hatt har gjort mig bekendt med, angives, at blandt Jægerfolkene lever der èn Patagonier paa hver 10 Kvadratmil, en Australier paa hver 2. Blandt de Nutidsindianere i Nordamerika, der havde mindst med Agerbrug at gøre, fandtes der 4 pr. Kvadratmil; kun hos Jægerfolk, der er særlig heldigt stillet[1] og helst driver Handel eller har lidt Agerbrug, kommer man op paa meget højere Befolkningstal. Nogen Befolkningsstatistik hos et Folk, der lever under ganske samme Betingelser, som vor Stenalders Befolkning gjorde det, har jeg ikke kunnet finde; men det ovenstaaende, synes mig, tyder paa, at vi maa tænke os ganske faa Mennesker pr. Kvadratmil.

Østersen har gennem de lange Tidsrum kun kunnet betyde overmaade lidt selv for en faatallig Befolkning, den kunde jo ogsaa helt undværes. Dr. R. Ege oplyser, at 20 Østers kun har en Værdi af c. 100 Kalorier eller c. $^1/_{30}$ af et voksent Menneskes daglige Næringsbehov; 20 Østers svarer i Næringsværdi omtrent til $^1/_6$ Liter Mælk. 17.000 Østers pr. Aar er derfor uden Betydning; en Slags Dessert for 3 Mennesker. Skulde en Mand tilfredsstille hele sit Forbrug ved Østersspisning, maatte han spise c, 650 om Dagen, over 200.000 om Aaret, over 2 Millioner i 10 Aar og hele Møddingen i 100 Aar. Fiskeriet i en saa liden Vig som den ved Meilgaard, hvor paa Grund af manglende Redskaber Stimer af Vandrefisk som Sild og Makrel ikke har kunnet fiskes i Mængde, har sikkert kun haft ringe Betydning; til Fiskeri som vort Nutidsfiskeri med uhyre store Net eller til det søgaaende Fiskeri kendte Stenalderen sikkert intet; man har, som Knoglerne i Udgravningen viser, prikket en Flynder, stanget en Aal og Ørred, eller med primitive, faa Kroge fanget en Torsk eller en Gedde engang imellem; endog Knogler af Hundestejler spiller en vis Rolle sammenlignet med de andre Fisk.

Hovednæringsmidlerne stammer sikkert fra

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[1] Visse Jæger- og Fiskerfolk i det nordvestlige Amerika kan opvise langt tættere Befolkningstal, men de har været knyttet til de lakserige Floder, hvor Laksen gaar ind i Millioner og er let at fange uden Garnredskaber; de danner Undtagelser fra Regelen.

Jagten paa Pattedyrene: Kronhjorte, Raadyr, Vildsvin og Sæler; thi ved deres Hjælp kan der i en Aarrække skaffes tilstrækkelig Næring for nogle haardt arbejdende Mennesker; Østersen har kun været en kærkommen Afveksling, hvor den fandtes, ligesom Fiskene.

Om de Fiske-, Fugle- og Pattedyrslevninger, der i 1888 fandtes i de af Kaptajn MADSEN og Forfatteren udgravede 50 m^3 i Meilgaards Køkkenmødding, findes Oplysning i den lille Afhandling af PETERSEN, WINGE etc. fra 1888. (Aarbøger for Nord. Oldk. og Hist. 1889).

Af Fisk fandtes mindst 28 Smaaflyndre, altsaa maa der i hele Køkkenmøddingen være saadan noget som 1120 Smaaflyndre; thi den hele Køkkenmødding er 40 Gange større end det af os undersøgte Kvantum; desuden fandtes nogle faa Knogler af en enkelt Torsk, Laks, Ørred og Gedde samt ganske lidt andet; det hele repræsenterer ialt af Fisk ikke mere end omtrent et Krondyrs Vægt.

Af Fugle fandtes i de 50 m^3 34, mest Svaner og Maager; i hele Køkkenmøddingen maa der da være c. 1360 Fugle, repræsenterende en Vægt af omtrent 20—30 Krondyr à c. 150 kg hver.

Af Pattedyr fandtes der 52 Individer; de vigtigste Fødedyr var 11 Vildsvin, 9 Kronhjorte, 7 Raadyr, 2 Okser og 7 Sæler foruden mindre, og mindre hyppige, Dyr; ialt efter Dr. R. EGES Beregning af Vildt af alle Slags c. 6—7000 kg i de 50 m^3, i hele Køkkenmøddingen derfor 240—280.000 kg Kød; en Mængde, der efter hans Beregning dog kun kan afgive Føde for 1 Mand i 4—500 Aar.[1]

Efter H. WINGES Udtalelser til mig er de ovennævnte

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[1] En fuldvoksen Mand antages at maatte have 3000 Kalorier daglig; Fedtmængden i 1 kg Vildt er sat til 10%, Æggehvidestofmængden til 20%, 1 kg Vildt derfor til 1750 Kalorier.

Bestemmelser af Dyre-Individernes Antal selvfølgelig kun Minimumsbestemmelser; de enkelte Skeletter er jo delt i Smaastykker for Marvens Skyld og spredt vidt om af Mennesker og Tamhunde samt vel ogsaa af vilde Dyr, saa det er et rent Tilfælde at træffe den samme Knogle af de forskellige Individer, og paa dette Tilfælde alene beror Optællingen af Individernes Antal; der kan i Virkeligheden gerne have været mange Gange saa mange Dyr, som Optællingen har givet Bevis for, at der mindst var. Paa denne Maade faar vi altsaa kun en højst ufuldstændig Forestilling om den i Stenalderen virkelig tilstedeværende Fødemængde. Jeg har derfor ad anden Vej søgt Oplysning om, hvad der kan antages at have staaet til Raadighed for Dyngedannerne ved Meilgaard.

Jessens Kort over Stenalderhavet i det nordlige Jylland viser, (Danm. geol. Unders. II R. 35. 1920), at Meilgaard har ligget paa en c. 8 Kvadratmil stor Ø; Kolindsund skar sig som et smalt Sund ind fra Grenaa syd om Meilgaard og op forbi Gammel Estrup til Mariagerfjord. Ved dette Sund ligger der andre Køkkenmøddinger fra den ældre Stenalder; saa disse Kyster har ogsaa været beboet af Jægerfolket; der kan derfor ikke have staaet alt for store Jagtdistrikter til Raadighed for de Grupper af Mennesker, som man jo sædvanlig mener har boet nogenlunde stadig paa de samme Pladser. Jap. Steenstrup har paavist, at der har levet Mennesker til alle Aarets Tider ved de store Køkkenmøddinger. Jeg vil antage, at c. 1 Kvadratmil har staaet til Raadighed som Jagtdistrikt for Meilgaarddyngens Dannere. Hvad maa man da antage, at der af Pattedyr har kunnet dræbes paa dette Areal aarlig i en lang Aarrække?

Man kan sikkert som en Regel gaa ud fra, at af Hjorte, Raadyr, Urokser og Vildsvin udelukker den ene Art den anden, saaledes at de vel kan trives sammen paa 1 Kvadratmil, men at èn af disse Arter vil give ligesaa meget Udbytte i Kød pr. Aar, som hvor de alle 4 lever tilsammen. Jeg har derfor valgt at søge Oplysning om, hvad der kan skydes alene af Krondyr i Nutiden pr. 1 Kvadratmil; thi at faa Oplysning fra Steder, hvor blot de tre Hovedvildtarter lever sammen i Nutiden, har været mig umuligt. De mig foreliggende Oplysninger stammer saavel fra Europas Fastland som fra Skotland, og varierer mellem c. 30 og c. 90 Stykker skudt Kronvildt pr. 1 Kvadratmil Skov pr. Aar; det lille Tal 30 stammer fra Skotland (W. Scrope: Days of Deer Stalking in the Scottish Highlands 1838. Reprint 1894.), hvor der kun skydes Hjorte, ikke Hinder, men hvor Bestanden ved stærk Fredning er meget stor; rimeligvis kunde et ligesaa stort Antal Hinder dog ogsaa været skudt uden Skade for Bestanden; et Udbytte af 60—90 Stk. Kronvildt pr. Kvadratmil maa derfor anses for muligt i Nutiden under heldige Forhold.

Selv om der levede ligesaa meget Kronvildt ved Meilgaard i Stenalderen, var hele denne Mængde sikkert ikke kommet Mennesket tilgode; thi Rovdyr saasom Ulv, Los, Vildkat, Bjørn fandtes der i Nærheden; vel er kun Vildkatten paavist i selve Køkkenmøddingen ved Udgravningerne, men Bjørn, Ulv og Los er dog kendt fra andre Køkkenmøddinger i Nord- og Midtjylland, saa en stor Del af Vildtet er sikkert, navnlig som unge Dyr, gaaet til Rovdyrenes Forbrug; endvidere er Bestanden sikkert bleven alt andet end jægermæssig udnyttet i Stenalderen, en Del unge Dyr findes saaledes i Køkkenmøddingen, saa ogsaa af denne Grund maa der trækkes adskilligt fra den Del, der blev tilbage til Mennesket. Jagtmaaden har vel meget været Fangst af Dyrene i Fælder eller paa lignende Maader. Det er saaledes meget vanskeligt at opgive bestemte Tal for den Vildtmængde, der har staaet til Raadighed for Stenaldersbefolkningen pr. Kvadratmil; for ikke at vælge for stort et Udbytte, vil jeg antage, at der aarlig er tilfaldet Jægerne ved Meilgaard c. 20 Krondyr, store og smaa, gennemsnitlig à 150 kg. eller ialt 3000 kg Kød. Hertil maa lægges det Antal Sæler, der ifølge Udgravningens Tal har udgjort omtrent $^1/_5$ af den øvrige Vildtmængdes Vægt, altsaa 600 kg. Vi faar derved ialt 3600 kg aarlig til Raadighed for Dyngedannerne ved Meilgaard. Heraf kan ifølge R. EGE godt 5—6 voksne Mennesker ernære sig pr. Aar. Meilgaard Dyngen kan derfor være dannet gennem det lange Tidsrum af ganske faa Mennesker, og, hvis de har boet der til Stadighed, maa den være dannet af faa Mennesker. Om der i Virkeligheden har været flere om det i afbrudte Tidsrum, kan jeg ikke afgøre; men længe har det i hvert Fald varet at danne den.

Ved SEHESTEDS Udgravning i 1880, der kun omfattede 4,59 m^3, fandtes èt Menneskeskelet; ved Udgravningen af de 50 m^3 fandtes et Fingerled nær dette Sted, rimeligvis af det samme Skelet; SEHESTED omtaler imidlertid pg. 155 et tidligere fundet Skelet, der havde ligget ganske nær, 2—2$^1/_2$ m fra det af ham fundne Skelet; altsaa er der i omkring 60 m^3 fundet 2 Skeletter; man kan da jugere, at der maa være c. 60—70 Skeletter i hele Dyngen. Hvis det har været Regel, at Dyngedannerne begravedes i Dyngen, og det synes jo meget antageligt, især da der næsten overalt ved store Udgravninger findes Skeletter i den ældre Stenalders Køkkenmøddinger, kan disse 60—70 Skeletter antages at svare til en stor Del af det Antal Mennesker, der i 1200 Aar maa dø, naar hele Befolkningen antages at have været 5—6 Mennesker.

Det er ikke bevist, at disse Skeletter i Køkkenmøddingen tilhører Stenalderen; de kunde tænkes nedgravet senere. Hvis de, hvad Arkæologerne, bl. a. CARL NEERGAARD, synes mest tilbøjelige til at antage, tilhører Dyngedannerne, har man i deres beregnede Antal dog nogen Overensstemmelse med den Tanke, at de repræsenterer en stor Del af Befolkningsmængden i det lange Tidsrum. Denne Begravelsesmaade skal, ifølge NEERGAARD, have været Skik i det sydvestlige Europa i den tidlige Stenalder; ligesom den var det i de californiske shellmounds.

I Vildtbestandens Størrelse og Produktionsevne har man sikkert det bedste Grundlag for Bedømmelsen af Stenalderfolkets Talrighed i Danmark i den ældre Stenalder; efter de Oplysninger, jeg har kunnet skaffe om Vildtstatistik, pr. Kvadratmil, har Folkemængden i hele Danmark den Gang næppe været over nogle faa Tusinde Mennesker.

Med en Tak til alle, bl. a. Nationalmuseets Mænd, der har assisteret mig ved denne Undersøgelse, vil jeg slutte denne Meddelelse.

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MEANS OF CALCULATING THE TIME OF ACCUMULATION OF KITCHEN MIDDENS. FOOD SOURCES IN DENMARK DURING THE EARLY STONE AGE.

RÉSUMÉ.

The great quantities of oyster shells found in certain of our kitchen-middens at a first glance give exaggerated notions of the nutritive value they represented. Only a closer examination will show that their nutritive value is of negligible import for the maintenance of human beings for any fairly long period. It must have taken long time before the kitchen-midden at Meilgaard was formed as a result of the oyster-fishing in the little shallow cove off the Kattegat by which it was surrounded in the stone age. This cove may be computed to constitute abt. $^1/_{231}$ of the oyster areas of the Limfiord and, if it gave a yield corresponding to that now given by the Limfiord, only abt. 17000 oysters on an average will have been caught annually. Hence it must have taken abt. 1200 years to build up the kitchen-midden which contains shells of $17000 \cdot 1200$, or abt. 20 million, oysters. During this long period 3 people could have eaten all the 20 million oysters by each eating abt. 20 oyster a day without obtaining more than abt. $^1/_{30}$ of their daily requirement of food; the rest they had to supply chiefly by means of the flesh of animals suitable for hunting, mainly boar, red deer, seals, roe-deer, and aurochs. The contents of 50 m^3 out of the 2000 m^3 of the whole kitchen-midden have been closely examined, and the bones of chasable animals found therein have been counted, but in computing how many individuals these bones represent we can only arrive at a minimum figure, and get no correct idea of what was consumed at the kitchen-midden. The meat represented by this minimum figure would only furnish food for one man for 400—500 years, but it must be assumed that the land animals suitable for hunting could supply abt. 3000 kilos or 20 red deer for each Danish square mile, and this together with 600 kilos of seals would supply food for 5—6 men through the ages. Hence the flesh of chasable mammals was the chief food during the early stone age, and in many parts of Denmark the population subsisted on this without the aid of oysters.

A very sparse population, a few thousands throughout the whole of Denmark, must have been able to accumulate the large kitchen-middens by the old oyster-coves through long periods. It must be assumed that there are abt. 60—70 human skeletons buried in the kitchen-midden at Meilgaard, two having been found in the excavated portion. These 60—70 skeletons may very well be assumed to represent a large part of the population that lived and died there, so that we may take it to be the rule rather than the exception that the dead were buried in the kitchen-middens as it was also the custom elsewhere during the stone age.

A closer investigation, for instance in other places, would perhaps furnish more accurate figures for the elucidation of these questions than those here given. As I myself shall hardly find opportunity to proceed with this enquiry I have thought it incumbent on me to supply what information I could, all the more so because I have before taken part in such investigations at the request of the National Museum, but at that time I had not the knowledge of oyster fishery that I have since acquired.

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FORSKELLIGE VEGETATIONSTYPERS FORSKELLIGE INDFLYDELSE PAA JORDBUNDENS SURHEDSGRAD (BRINTIONKONCENTRATION)

AF

C. RAUNKIÆR

1742

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
1922

Indledning.

Hvor der i Nærheden af plantedækket Land opstaar ny Jord, f. Eks. Klitter, Marsk, Aflejringer ved Vandløb, etc., eller hvor forhen bevokset Bund blottes, vil denne ny Jord snart blive besaaet med Frø, der paa forskellig Vis — ved Vinden, Dyr, etc. — hidføres fra det omgivende Lands Vegetation; og den ny Jord vil blive bevokset med de af de hidførte Arter, der overhovedet kan spire og trives under de givne Kaar. Saa længe Plantedækket endnu er aabent og Konkurrencen derfor ikke i særlig Grad kan gøre sig gældende, vil det i Regelen have en ret broget og tilfældig Karakter, væsentlig bestemt af Indvandringsbetingelserne; men efterhaanden som Bevoksningen bliver tættere og tættere, og Konkurrencen om Livsgoderne derved bliver skrappere og skrappere, bukker saa een saa en anden Art under, og i Løbet af et kortere eller længere Aaremaal vil Udviklingen være naaet til det Resultat, at vi har en relativt stabiliseret tæt Vegetation af de af det omgivende Lands Arter, der er bedst skikkede til at vokse og hævde sig under de paa den givne Lokalitet eksisterende Kaar; og hvor disse er ens, vil ikke alene Artssammensætningen, men tillige Arternes Frekvens og indbyrdes Masseforhold være væsentlig ens, medens selv en tilsyneladende ringe Afvigelse i de for Planterne væsentlige Faktorer vil give sig Udslag i tilsvarende Afvigelser i Vegetationens Sammensætning og Kaarpræg.

Skønt der stadig udefra tilføres Frø af forskellige Arter, vil en stabiliseret Vegetation ikke mærkelig forandres, saa længe Kaarene forbliver de samme; men ændres Kaarene i væsentlig Grad, hvad enten det sker ved Vegetationens egen Indflydelse paa Jordbunden eller paa anden Maade, saa at andre Arter end de først sejrende kan faa Indpas og tage Konkurrencen op, vil Vegetationens Sammensætning undergaa Forandringer, der efter kortere eller længere Tids Forløb atter vil føre til en vis Ligevægtstilstand. Hvor Vegetationen har haft Tid til at komme i Ligevægt, vil enhver given Standplads derfor være bevokset med de af det paagældende Omraades Arter, der er bedst skikket til at eksistere under de givne Kaar. I Overensstemmelse hermed viser Erfaringen det Forhold, at hvor vi indenfor de enkelte Omraader har en af Terrænets Form og Beskaffenhed betinget Standpladsserie, hvis enkelte Leds Forskellighed især er bestemt ved Forskelligheden i et enkelt for Planterne særlig vigtigt Kaarled, f. Eks. Jordbundens af den forskellige Højde over Grundvandet betingede forskellige Fugtighed, — dér genfindes en ganske tilsvarende Planteformationsserie, hvis enkelte Led er de samme og følger efter hverandre i samme ufravigelige Rækkefølge, hvor ofte den paagældende Standpladsserie end gentages indenfor Omraadet. Paa mangfoldige Steder i vort Land, navnlig i Vestjyllands Klitterræn og paa vore Heder og Strandenge, ses paa Hundreder og atter Hundreder af Lokaliteter denne lovmæssige Forbindelse mellem Standpladsserier og bestemte Formationsserier.

Det er saaledes let nok at se, at den overalt sig gentagende Bæltedannelse (Zonation) i Vegetationen omkring enhver Lavning i Hede, Klit, osv., er betinget af Forskel i Fugtighed; og det er let nok at genkende Bælterne, Formationerne, paa de forskellige Steder. Men saa snart man foretager en mere indgaaende statistisk-floristisk Analyse af Vegetationen, vil man i Almindelighed hurtig opdage Forskelligheder, der i hvert Tilfælde ikke umiddelbart kan ses at være betinget af Forskel i Fugtighed. I nogle Tilfælde kan Forskellighederne maaske alene skyldes Forskel i Indvandringshistorie og blot betyde, at Vegetationen endnu ikke er stabiliseret. Men hvor man har at gøre med Omraader, der i længere Tid ikke har været udsat for lokale Kulturindgreb, vil det ligge nærmest at forudsætte andre Aarsager.

Foruden Fugtigheden kan jo mange andre Forhold i Jordbunden være medbestemmende for, hvilken Kombination af Arter der kommer til at beklæde en given Standplads. En meget vigtig Faktor er uden Tvivl Jordbundens Reaktion ɔ: dens Brintionkoncentration; og efter at vi i den af S. P. L. Sørensen grundlagte kolorimetriske Brintionkoncentrationsbestemmelsesmetode har faaet et Middel, der efterhaanden ogsaa er bleven praktisk anvendeligt ved Bestemmelsen af Jordbundens Brintionkoncentration, vil denne i Fremtiden sikkert ogsaa og med Fordel blive draget med ind i de økologiske Undersøgelser, idet vi ved den nævnte Metode er blevet i Stand til paa overkommelig Maade at gradere Jorbundens Reaktion ganske anderledes fint end forhen.

Hidtil er det navnlig amerikanske Forskere, der har arbejdet paa dette Omraade; men for nylig er ogsaa fra dansk Side Spørgsmaalet taget op til Behandling, taget op paa bredere Basis og mere indgaaende end hidtil er sket, nemlig i C. Olsens Afhandling: »Studier over Jordbundens Brintionkoncentration og dens Betydning for Vegetationen særlig for Plantefordelingen i

Naturen«. Ved en formationsstatistisk Undersøgelse af Vegetationen paa en Række Eng- og Skovstandpladser sammenholdt med Bestemmelsen af Brintionkoncentrationen i disse Standpladsers Jord har C. Olsen vist, at i de naturlige Formationer forekommer de enkelte Arter kun paa Jordbund, »hvis Brintionkoncentration ligger indenfor et bestemt, for hver enkelt Art karakteristisk Omraade«; og at der indenfor dette atter »findes et snevert Omraade, i hvilket Arten har sin største gennemsnitlige Hyppighed«. Ved en Række Vandkulturforsøg har C. Olsen dernæst vist, »at Arter, der i Naturen kun forekommer paa stærkt sur Bund (Surbundsplanter), opnaaede deres kraftigste Vækst i Næringsopløsninger, hvis p_H-Værdier laa i Nærhedeu af 4, medens Arter, der i Naturen kun forekommer paa svagt sur, neutral eller basisk Bund (Basebundsplanter), opnaaede deres kraftigste Vækst i Næringsvædsker, hvis p_H-Værdi laa mellem 6 og 7. I de svagt sure Næringsopløsninger, i hvilke Basebundsplanterne opnaaede deres kraftigste Vækst, trivedes Surbundsplanterne kun daarligt og blev klorotiske«. (C. Olsen, l. c., Pag. 144).

Der kan saaledes næppe være Tvivl om, at Jordbundens Brintionkoncentration har stor Betydning ved Forstaaelsen af de enkelte Plantearters Forekomst i Naturen; og der er her en vid Mark for fremtidige Undersøgelser. Et andet Spørgsmaal er, om Planterne paavirker Jordbundens Brintionkoncentration og, i bekræftende Fald, i hvilken Retning og i hvilken Grad. Hvis det kan konstateres, at en Planteart eller en Formation eller Formationstype paavirker Jordens p_H-Værdi i en bestemt Retning, vil der derved være paavist een af de Faktorer, der kan være medbestemmende i det Forhold, at en given Formation eller Formationstype i Tidens Løb forandrer de oprindelige Kaar og derigennem maaske betinger sin egen Undergang ved at forandre Kaarene til Gunst for en anden Formation, en anden Kombination af Arter. Førend jeg nærmere kommer ind paa Omtalen af de Undersøgelser, jeg har anstillet for at efterforske forskellige Formationstypers Indflydelse paa Jordbundens Brintionkoncentration, skal jeg kort omtale visse Forhold ved selve Metoden.

Bestyreren af Carlsberglaboratoriets kemiske Afdeling, Professor S. P. L. Sørensen, skylder jeg Tak for den Velvilje, med hvilken der fra Laboratoriet er blevet mig overladt de til mine Undersøgelser nødvendige Standardvædsker og Indikatorer; og jeg skylder Tak til Laboratoriets Assistent, Dr. phil. C. Olsen, der har sat mig ind i de Fremgangsmaader, som han har fulgt ved de af ham foretagne Bestemmelser af Jordprøvers Brintionkoncentration. Jeg bringer ogsaa min Tak til Kgl. Skovrider N. Vestergaard for de for mit Arbejde vigtige Oplysninger om forskellige Punkter i Dyrehavens Historie, og Dr. phil. Boysen Jensen for gode Raad vedrørende Konstruktionen af det Pag. 65 omtalte Atmometer.

Om forskellige Forhold ved Metoden.

Med Hensyn til Fremgangsmaaden ved den kolorimetriske Bestemmelse af Jordens Brintionkoncentration kan jeg for de fleste Punkters Vedkommende her nøjes med at henvise til Fremstillingen hos C. Olsen. Enkelte Forhold maa dog nærmere omtales, navnlig Spørgsmaalet om Størrelsen af Variationen i Jordbundens Brintionkoncentration paa samme Standplads, dels i samme Dybde paa forskellige Steder, dels i forskellig Dybde paa samme Sted. Desuden Spørgsmaalet om Ekstraheringstidens Længde, det til

Ekstraheringen anvendte Vands Beskaffenhed og Ønskeligheden af at kunne undvære de med Indikatorer farvede Standardopløsninger.

Variationen i Jordbundens Brintionkoncentration i samme Dybde paa de enkelte Standpladser. Undersøgelsen er baseret paa Jordprøver, der er udtaget i 7—10 cm Dybde. — Paa Forhaand er der ingen Grund til at vente, at Jordekstrakters p_H-Værdi vil vise sig at være ens paa hvert Punkt indenfor samme, tilsyneladende selv nok saa ensartet udseende Omraade. Undersøgelserne viste, at Variationen kan være ret stor. Der er jo heller ingen Grund til at vente, at de formodentlig komplicerede men iøvrigt kun lidet kendte Forhold, der betinger Brintionkoncentrationen, skulde være ens paa alle Punkter paa samme, selv nok saa ensartet udseende Standplads; Vegetationen danner jo et Mosaik og Dyrelivet er uensartet og bevægeligt. Vegetationens Forhold til Jordens Brintionkoncentration er saaledes ikke dette, at de tilstedeværende Arter er i Ligevægt i Forhold til en bestemt Brintionkoncentration, lige saa lidt som Plantevæksten selv i de mest stabiliserede Formationer er et Udtryk for Øjeblikkets ganske bestemte Kaarforhold. Kaarene veksler fra Aar til Aar, fra Dag til Dag, fra Time til Time, men Artsammensætningen kan derfor alligevel forblive væsentlig den samme; det ene Aar kan Nedbøren være saa rigelig, at en given Lokalitet er ganske mættet med Vand omtrent hele Sommeren, medens samme Lokalitet i et andet, mere tørt Aar kan være saa tør det meste af Sommeren, at man kan ligge paa Jorden uden at mærke Spor af Fugtighed. Hvis disse to Tilfælde var permanente gennem en længere Aarrække paa hver sin Del af den paagældende Lokalitet, vilde de to Steder tilsidst uundgaaelig blive forskellige med Hensyn til Plantevækst, hvert med sin ganske bestemte stabiliserede Formation. Allevegne hvor et Terræn ved Afvanding bliver permanent mere tørt end forhen eller ved Opstemning af Vandet bliver permanent mere fugtigt, har vi tilstrækkelig oplysende Eksempler af tilsvarende Art. Men hvor Forholdet er det, at Forskellen i Kaar skyldes de forskellige Aars vekslende Klima, medens Gennemsnitsklimaet forbliver det samme, dér forbliver Vegetationen, hvad Artsammensætning og i Almindelighed ogsaa hvad Arternes Frekvens angaar, væsentlig den samme; derimod vil naturligvis Arternes Trivsel være forskellig i de vekslende Aar. Med andre Ord: Formationernes Artsammensætning og Arternes Frekvens er i Almindelighed ikke et stabiliseret Udtryk for de øjeblikkelige Kaar, men et stadigt vibrerende, kun relativt stabiliseret Udtryk for en Aarrækkes Gennemsnitskaar.

Noget lignende som det, der gælder Tidens Forhold, gælder ogsaa Rummets, saaledes Betydningen af de smaa Forskelligheder i Jordbunden paa samme Standplads og da ogsaa Forskellighederne med Hensyn til Brintionkoncentration; en stabiliseret Vegetation er ikke stabiliseret i Forhold til en og samme, paa hvert Punkt herskende p_H-Værdi, men er stabiliseret i Forhold til et Mosaik af forskellig store Felter med mere eller mindre forskellig p_H-Værdi, der vel kan være underkastet større eller mindre Svingninger, men hvis statistisk bestemte Gennemsnitsværdi forbliver væsentlig den samme fra Aar til Aar. Det er derfor nødvendigt ogsaa ved Bestemmelsen af Jordbundens Brintionkoncentration at anvende den statistiske Metode.

Højest sandsynligt er p_H-Værdiens Variation ret forskellig paa forskellige Standpladser. C. Olsen fandt paa de af ham undersøgte Enge, at Variationen paa samme lille

Plet kun var højest 0,3 i p_H; det er jo muligt, at de paagældende Enge er meget ensartede med Hensyn til de enkelte Omraaders p_H-Værdi; men jeg er dog mest tilbøjelig til at tro, at en Underøgelse af flere Prøver paa enkelte Steder vilde have vist en betydelig større Forskel mellem højest og lavest p_H-Værdi. I hvert Tilfælde har mine Undersøgelser vist en langt større Variation indenfor de enkelte, snevert begrænsede, kun faa m^2 store Standpladsfelter. For at studere Forholdet har jeg undersøgt dels en Række Standpladser paa Ore (Overdrev), især paa Eremitagesletten i Dyrehaven, dels en Række Skov-Standpladser saavel i Granskov som i Bøge- og Egeskov. Der blev undersøgt ialt 100 Lokaliteter, og paa hver af disse blev der i 7—10 cm Dybde udtaget 5 Jordprøver, hvis p_H-Værdi blev bestemt hver for sig. De 500 Prøvers p_H-Værdi svingede mellem 3,7 og 7,6, spændte saaledes over det p_H-Omraade, indenfor hvilket de allerfleste danske Jorders p_H-Værdi ligger. I den 5-Talsgruppe, der viste den største Forskel mellem højest og lavest p_H-Værdi, var denne Forskel meget stor, nemlig 2,6; og i 30 % af 5-Talsgrupperne var den største Forskel i den enkelte Gruppe over 1 i p_H. I ingen af de 100 5-Talsgrupper var den største Forskel mindre end 0,3; gennemsnitlig var den 0,89.

Saavidt der kan dømmes ud fra det foreliggende Materiale, synes der ikke at være nogen nævneværdig Forskel i Størrelsen af Brintionkoncentrationens Variation paa Skovstandpladser og paa Orestandpladser; i de 56 5-Talsgrupper fra Skovstandpladser var den største Forskel gennemsnitlig 0,92; i de 44 5-Talsgrupper fra Orestandpladser var det tilsvarende Tal 0,86.

Et andet Forhold, som det i denne Sammenhæng maaske kan have nogen Interesse at prøve, er Spørgsmaalet om, hvorvidt der er nogen kendelig Forskel i Variationen af p_H-Værdiens Størrelse i Jorder med forskellig Surhedsgrad. Da de Tal, ved hvilke p_H-Værdien udtrykkes, ikke danner en æquidistant Række, naar de omsættes i Tal, der angiver den absolute Vægtmængde Brintioner (udtrykt i gr) pr. Liter, kunde man tænke sig Muligheden af, at der kunde være Forskel i Størrelsen af p_H-Værdiens Variation i Jorder med forskellig Brintionkoncentration. Dette synes dog ikke at være Tilfældet; i hvert Fald viser mit Materiale ikke noget saadant. Deler man de af mig undersøgte 100 Standpladser i to Grupper, den ene omfattende de mest sure, den anden de mindre sure og de basiske Standpladser, og bestemmer den gennemsnitlige Størrelse af p_H-Værdiens Variation i de to Grupper, viser der sig ikke, som det ses af nedenstaaende Tal, nogen kendelig Forskel. Størrelsen

51 Standpl. med p_H = 3,6—5,4, gennemsnitl. Variation 0,87
49 — - - = 5,5—7,6 — — 0,91

af p_H-Værdiens Variation paa de forskellige Standpladser synes at være uafhængig af p_H-Værdiens absolute Størrelse.

Den ret store Variation af p_H-Værdien, som samme, tilsyneladende ensartede Standplads kan udvise, gør det nødvendigt at bestemme flere Jordprøvers p_H-Værdi, naar det gælder om at angive en Lokalitets aktuelle Surhedsgrad. Hvor Tallene, som i det følgende, skal tjene som Basis for en Sammenligning af forskellige Standpladser, har jeg derfor gjort det til Regel at undersøge 5 Prøver paa hvert Sted; i visse Tilfælde kan det være nødvendigt at anvende flere; jo flere der undersøges, desto mere nærmer man sig jo til, at det fundne Gennemsnitstal bliver konstant. Naturligvis vilde det være betydelig nemmere at blande de paa en Lokalitet udtagne Prøver og saa af Blandingen udtage en enkelt Prøve til Bestemmelse af p_H-Værdien, saaledes som C. Olsen har gjort; men jeg kan ikke anbefale denne Fremgangsmaade, især fordi man ved den ikke faar noget at vide om Variationens Størrelse, der kan være meget forskellig paa forskellige Standpladser, og som ikke kan lades ude af Betragtning, naar det gælder om at forstaa Standpladsernes Natur.

Brintionkoncentrationens forskellige Størrelse i forskellig Dybde paa samme Standplads. Angaaende dette Spørgsmaal skriver C. Olsen (l. c., Pag. 25): »Der fremkom ikke væsentlig Forskel, om Jordprøverne udtoges i 5, 10 eller 20 cm's Dybde, de indbyrdes Afvigelser var her aldrig større end 0,3 i p_H«. Samme Sted henviser Olsen til, at ifølge O. Arrhenius aftager Brintionkoncentrationen med tiltagende Dybde, medens Plummer for Agerjordens Vedkommende har iagttaget, at Brintionkoncentrationen stiger med tiltagende Dybde. Der synes saaledes at være god Grund til, at dette Spørgsmaal bliver taget op til en mere indgaaende Undersøgelse og paa den Maade, at Bestemmelsen paa hvert enkelt Sted baseres paa flere Prøver. Selv har jeg ikke foretaget en saadan omfattende Undersøgelse; ved den foreliggende Opgave har jeg ikke haft speciel Brug derfor. For at danne mig et foreløbigt Skøn over Forholdet har jeg dog paa et Par Steder udtaget en Række Jordprøver i forskellig Dybde og bestemt p_H-Værdien.

I en c. 75-aarig Granskov i Fortun-Indelukket blev der indenfor en 0,25 m^2 stor Plet udtaget Jordprøver i tre forskellige Dybder, nemlig i 7—10, 17—20 og 27—30 cm Dybde; der blev udtaget 5 Jordprøver i hver Dybde; Resultatet af Bestemmelsen af disse Jordprøvers p_H-Værdi fremgaar af Tab. 1.

Tab. 1. Jordbundens p_H-Værdi i tre forskellige Dybder i en c. 75-aarig Granskov.

Dybde i cm	De enkelte Prøvers p_H-Værdi					Gennemsnitlig p_H-Værdi	Største Afvigelse
7—10	4,7	4,9	4,9	5,1	5,3	4,98	0,6
17—20	4,9	4,9	5,1	5,8	5,9	5,32	1,0
27—30	4,8	4,8	5,4	5,4	5,9	5,26	1,1

I dette Tilfælde bliver Jorden saaledes lidt mindre sur nedefter; men Forskellen er kun lille, langt mindre end den største Forskel mellem de enkelte, i samme Dybde udtagne Prøver.

Tab. 2. Jordbundens p_H-Værdi i tre forskellige Dybder paa Nørrefælled ved Kjøbenhavn.

Dybde i cm	De enkelte Prøvers p_H-Værdi					Gennemsnitlig p_H-Værdi	Største Afvigelse
7—10	6,6	6,6	6,7	6,7	7,1	6,74	0,5
17—20	5,7	5,8	5,9	6,0	6,2	5,92	0,5
27—30	5,5	5,6	5,7	6,1	6,2	5,82	0,7

I Tab. 2 ses Resultatet af en Undersøgelse af Jordens p_H-Værdi i forskellig Dybde paa en 0,25 m^2 stor Plet paa Nørrefælled ved Kjøbenhavn. Ligesom i det foregaaende Tilfælde er der ogsaa her kun ringe Forskel i Surhedsgrad i 17—20 og i 27—30 cm Dybde; tages disse to Dybder under eet, faas en p_H-Værdi paa 5,87; her er de dybere Jordlag saaledes en Del surere end i 7—10 cm Dybde, altsaa det omvendte af, hvad der var Tilfældet med den ovenfor omtalte Granskovs betydelig surere Jord.

Disse Kendsgerninger i Forbindelse med de ovenfor berørte, tilsyneladende modsigende Opgivelser fra Litteraturen kan maaske forklares paa den Maade, at hvor vi har at gøre med Lokaliteter, der er dækket af en Vegetation, der — som den tætte Granskov — betinger, at Jorden bliver surere, der vil Jorden, i hvert Tilfælde i den forholdsvis unge Skov, vise sig mindre sur nedefter, idet de nedre Jordlag ikke er naaet at blive saa stærkt paavirkede som de øvre; omvendt vil Lokaliteter, som ved Kultur eller paa anden Maade er blevet paavirket saaledes, at de øvre Jordlags p_H-Værdi er blevet højnet, vise det af Plummer paaviste Fænomen, at Jorden nedefter er mere sur end de øvre, stærkere paavirkede Lag.

De fremdragne Forhold viser det ønskelige i, at Spørgsmaalet maa blive taget op til en langt mere indgaaende Undersøgelse end hidtil er sket; Undersøgelsen bør omfatte en Række Jorder af forskellig Art og med forskellige Vegetationstyper og maa baseres paa 5 eller endnu flere Enkeltbestemmelser af p_H-Værdien i hver Dybde paa hver enkelt, snevert begrænsede Plet.

Behandlingen af Jordprøverne. Ved Anvendelsen af den kolorimetriske Metode er det jo nødvendigt at filtrere Jordekstrakterne; og da disse er næsten stødpudefrie og derfor let forandre Brintionkoncentration, er det nødvendigt stedse at arbejde saa ensartet som muligt — navnlig hvor det som her gælder en sammenlignende Undersøgelse, hvor selv mindre Afvigelser i Brintionkoncentration kan faa Betydning.

Ved Indsamlingen af Jordprøverne har jeg stedse benyttet cylinderformede, i begge Ender aabne Glasrør, der lukkedes med Korkpropper; herved opnaaes, at hele Jordprøven meget let paa een Gang kan trykkes ned i det Glas, hvori den skal ekstraheres med Vand, især naar der hertil benyttes Glas, f. Eks. Maltglas, med en saa vid Munding, at den passer til de Glasrør, hvori Jordprøven er opbevaret. De anvendte Glasrør rummede c. 70 cm^3 Jord, til hvis Ekstrahering der anvendtes c. 80 cm^3 Vand eller lidt mere; det kan nemlig undertiden ske, især naar man har Brug for at anvende flere Indikatorer, at man faar en for Undersøgelsen for ringe Mængde filtreret Vædske, hvis man nøjes med det til Jordprøvens Rumfang svarende Rumfang Vand; og, som C. Olsen fremhæver og jeg selv kan bekræfte, giver det ingen paaviselig Forskel, om der anvendes lidt mere eller lidt mindre Vand til Ekstrahering af Jordprøverne; dog gør man naturligvis ogsaa her bedst i at arbejde saa ensartet som muligt.

Ekstraheringstiden. C. Olsen meddeler desværre ingen Oplysninger om, hvilken Indflydelse en forskellig Længde af Ekstraheringstiden har paa Størrelsen af den filtrerede Vædskes Brintionkoncentration. Han siger kun (l. c., pag. 14), at de med Vand tilsatte Jordprøver henstod i c. 24 Timer, under gentagen Omrøring med en Glasspatel, hvorefter Bestemmelsen af Brintionkoncentrationen fandt Sted.

Hvis man ikke har for lang Vej til Undersøgelsesomraadet, kan man hente et Sæt Jordprøver om Eftermiddagen, hensætte dem med Vand efter Hjemkomsten om Aftenen og saa, efter at de har staaet Natten over, bestemme deres p_H-Værdi næste Formiddag, efter at Glassene er blevet rystet godt nogle Gange, dels om Aftenen, dels næste Morgen; paa denne Maade kan man naa at hente og bestemme et Sæt paa 20—30 Jordprøver om Dagen. Bærer man sig saaledes ad, ekstraheres Jordprøverne kun i c. 15 Timer; dette har været Tilfældet med alle de Jordprøver, hvis p_H-Værdi er blevet bestemt til Benyttelse i denne Afhandling. Iøvrigt vil det neppe give nogen kendelig Forskel, om Jordprøverne ekstraheres i 15 eller 24 Timer. Da det imidlertid kan have Interesse at vide, om man ikke lige saa godt kan anvende en betydelig kortere Ekstraheringstid end 15 Timer, saa at man kan bestemme Jordprøvernes p_H-Værdi samme Dag, Jordprøverne indsamles, har jeg foretaget en Prøve paa den Maade, at der af samme godt blandede Jordmasse blev udtaget 15 Prøver, hvoraf de 5 ekstraheredes i 3 Timer, 5 i 6 Timer og 5 i 15 Timer; Resultatet ses af Tabel 3, der viser, at det ikke synes at gøre nogen nævneværdig Forskel, om Jordprøverne ekstraheres i 6 eller i 15 Timer, men at det giver en kendelig større Forskel, om de ekstraheres i 6 eller i 3 Timer. — Spørgsmaalet fortjener en indgaaende Undersøgelse, især da det kan faa praktisk Betydning ved Planlæggelsen af Arbejdet.

Tab. 3. Ekstraheringstidens Betydning.

Ekstraheringstid	De enkelte Jordprøvers p_H-Værdi					Gennemsnitlig p_H-Værdi
3 Timer	7,4	7,4	7,4	7,5	7,5	7,44
6 —	7,6	7,6	7,7	7,7	7,7	7,66
15 —	7,6	7,7	7,7	7,8	7,9	7,74

Det til Jordprøvernes Ekstrahering anvendte Vands Art. Det gælder naturligvis ogsaa her at arbejde saa ensartet som muligt; det kunde derfor synes, at der ikke her kunde være Tale om andet end stedse at anvende destilleret Vand; og C. Olsen omtaler heller ikke andet. Praktiske Hensyn gør det dog ønskeligt ogsaa at komme ind paa denne Sag og at undersoge, om det ikke lader sig gøre at anvende andet Vand, f. Eks. Regnvand, filtreret kogt Ledningsvand eller paa samme Maade behandlet Brøndvand. Hvor man har Adgang til destilleret Vand, er det jo det naturligste at benytte dette; men der kan let indtræde Tilfælde, hvor man meget vanskeligt kan skaffe sig destilleret Vand, f. Eks. hvis man arbejder med Jordbundsundersøgelser i en afsides Egn i Landet. Jeg mener derfor, at det fortjener en indgaaende Undersøgelse, hvilken Forskel i Bestemmelsen af en Jordprøves p_H-Værdi der fremkommer, eftersom man anvender destilleret Vand eller Vand af anden Art. For den foreliggende Afhandlings Opgave har Spørgsmaalet ganske vist ingen Betydning, idet jeg her stedse har anvendt destilleret Vand. Men det kan ikke nægtes, at Spørgsmaalet kan faa praktisk Betydning; og for at orientere mig lidt deri, har jeg foretaget en lille Prøve, hvis Resultat jeg her vil give.

Ved Forsøget blev der prøvet tre Slags Vand: destilleret Vand, ukogt Ledningsvand (Kjøbenhavn) og filtreret kogt Ledningsvand. Vandets p_H-Værdi blev bestemt ved 5 Prøver af hver Slags og med følgende Resultat (Tab. 4):

Tab. 4. Det til Forsøget i Tab. 5 anvendte Vands p_H-Værdi.

	De enkelte Prøvers p_H-Værdi					Gennemsnitlig p_H-Værdi
Destilleret Vand.....	4,8	4,8	5,0	5,2	5,3	5,02
Ukogt Ledningsvand.	7,6	7,6	7,6	7,6	7,6	7,60
Kogt og filtreret do..	8,2	8,2	8,2	8,2	8,3	8,22

Til Prøvelsen af disse tre forskellige Vandes Virkning blev anvendt en sigtet Lyngtørvsjord, der blev blandet saa godt som muligt. Af denne Jordmasse udtoges 30 Prøver, hvoraf 10 behandledes med destilleret Vand, 10 med ukogt Ledningsvand og 10 med kogt og derpaa filtreret Ledningsvand (cfr. Tab. 4). Bestemmelsen af Ekstrakternes p_H-Værdi gav det i Tab. 5 opførte Resultat.

Det ses heraf, at skønt der var en endog ret stor Forskel paa de anvendte Vandes Brintionkoncentration, viste

Tab. 5. Forskellige Slags Vand som Ekstraheringsvædske.

Lyngtørvjord ekstraheret med	De enkelte Prøvers p_H-Værdi										Gennemsnitlig p_H-Værdi
Destilleret Vand	4,3	4,3	4,3	4,4	4,5	4,6	4,8	4,8	4,8	4,8	4,56
Ukogt Ledningsvand.	4,4	4,4	4,6	4,7	4,7	4,7	4,8	4,8	4,8	4,8	4,67
Kogt og filtreret do..	4,2	4,2	4,3	4,3	4,4	4,4	4,4	4,8	4,8	4,3	4,46

de undersøgte Ekstrakter dog næsten ganske samme p_H-Værdi; navnlig synes det, at man lige saa godt kan anvende kogt og filtreret Ledningsvand som destilleret Vand, idet de med destilleret Vand ekstraherede Jordprøver er 0,1 mindre sure end de, der ekstraheredes med kogt og filtreret Ledningsvand, omtrent den samme Forskel som C. Olsen fandt mellem de med destilleret Vand ekstraherede Jordprøvers p_H-Værdi og selve den udpressede Jordvædskes p_H-Værdi, der gennemsnitlig laa lidt surere end Ekstraktens (l. c., pag. 23).

Det her meddelte Forsøg skal kun tjene til at henlede Opmærksomhed paa Spørgsmaalet og til at vise, at der ikke synes at være Grund til at tvivle om, at man i paakommende Tilfælde kan undvære destilleret Vand ved Undersøgelsen af Jordprøvernes p_H-Værdi; men naturligvis maa man først prøve det anvendte ikke destillerede Vands Forhold i Sammenligning med destilleret Vand ved at anvende begge Slags Vand til Behandling af en Serie af Prøver af samme ensartede Jordblanding.

Om Muligheden af at erstatte de med Indikatorer farvede Standardopløsninger ved Hjælp af Komparatorlinealer. En Sag af endnu større praktisk Betydning end Spørgsmaalet om at kunne undvære destilleret Vand til Ekstrahering af Jordprøverne er Spørgsmaalet om at kunne undvære de ved den kolorimetriske Bestemmelse af Brintionkoncentrationen anvendte Standardopløsninger. Vil man foretage en Jordbundsundersøgelse i en eller anden fra et Laboratorium langt fjernet Egn af Landet, er det forbundet med store Vanskeligheder at medføre den ret betydelige Række at Flasker med de forskellige Standardopløsninger; og gaar der en eller flere Flasker i Stykker, hvilket let sker, er man ilde faren. Jeg har derfor straks fra Begyndelsen at mine Undersøgelser tænkt over, om det ikke var muligt at erstatte de med Indikatorer farvede Standardvædsker med andre Objekter med samme Farvetone, f. Eks. farvet Glas, holdbart farvede Vædsker eller farvet Papir. Ved Tilsætning af forskellige Farvestoffer lader det sig vistnok gøre at fremstille Vædsker med de samme Farvetoner som de med Indikatorer farvede Standardopløsninger; men det vil vistnok være vanskeligt, maaske umuligt, at fremskaffe tilstrækkelig holdbare Farver, og da Fremgangsmaaden ved Anvendelsen af saadanne Vædsker er langt mindre praktisk end ved Anvendelsen af farvet Glas og farvet Papir, har jeg ikke forfulgt denne Sag nærmere. Det er muligt, at farvede Glas vil vise sig at give det bedste Resultat[1], men jeg har ikke haft Lejlighed til at eksperimentere dermed. Jeg skal derfor her udelukkende holde mig til mine Forsøg med at anvende farvet Papir. Disse Forsøg har lært mig, at det lader sig gøre at fremstille farvet Papir, der set gennem et i Komparatoren stillet Reagensglas med Vand giver dette en Farve, der ikke lader sig skelne fra en ved Siden af i Komparatoren stillet Glas med en bestemt Standardoplosning farvet med en bestemt Indikator. Vanskeligheden ligger kun i at

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[1] Cfr. Klas Sondén, Zur Anvendung gefärbter Gläser statt Flüssigkeiten bei kolorimetrischen Untersuchungen. (Arkiv för Kemi, Mineralogi och Geologi. Utgivet av K. Svenska Vetenskapsakademien. Band 8. Nr. 7. 1921).

fremskaffe tilstrækkelig holdbart farvet Papir; vel er det ikke nødvendigt, at Farven er absolut holdbar, da man jo kan forny Papiret; men for at have praktisk Betydning maa Farverne dog være saa holdbare, at de kan benyttes i nogen Tid uden at de forandres mere, end hvad der svarer til f. Eks. 0,2 i p_H.

Fremgangsmaaden er den, at det farvede Papir anbringes vandret foran den under en Vinkel paa c. 45° skraat stillede Komparators Vinduer, ganske tæt ved disse og saaledes mod Lyset, at dette fra Papirfladerne kastes op gennem et i Komparatoren stillet Reagensglas med Vand, ved Siden af hvilket der er stillet et andet Reagensglas med den med Indikator farvede Standardopløsning; det farvede Papir skiftes, indtil man har fundet det farvede Papir, der set gennem Vandet i Reagensglasset giver dette ganske samme Farvetone som den paagældende Standardopløsning, der er farvet med Indikator. Paa denne Maade skaffer man sig det nødvendige Antal forskellig farvede Papirprøver; det er naturligvis ikke nødvendigt at have farvet Papir for hver p_H-Værdi; det er her fuldt tilstrækkeligt at nøjes med en Række med Mellemrum paa f. Eks. 0,4 i p_H; og hvis det skulde vise sig vanskeligt at fremstille en bestemt Farve, f. Eks. en Farve, der svarer til 4,4 i den af C. Olsen anvendte Række, medens det maaske derimod er let at fremstille farvet Papir, der svarer til 4,3 eller 4,5, kan dette sidste meget vel bruges, idet det ikke er absolut nødvendigt at Afstanden mellem Skalaens enkelte Led overalt er den samme.

Har man faaet fremstillet det nødvendige Antal farvede Papirprøver, anbringes de Prøver, der svarer til en bestemt Indikator i 2,5—3 cm lange og c. 2 cm brede Stykker paa en c. 4 cm bred Lineal, ordnet i Række svarende til de fortløbende p_H-Værdier og med en saadan Afstand mellem de enkelte farvede Felter, at der nøjagtig kommer et farvet Felt paa Komparatorlinealen ud for hverandet af Komparatorens Vinduer, naar Linealen anbringes foran disse. Paa denne Maade kan man altid anbringe den med Indikator tilsatte Jordekstrakt, hvis p_H-Værdi skal bestemmes, saaledes at den, idet man forskyder Komparatorlinealen frem og tilbage foran Komparatorens Vinduer, kommer til at staa mellem de to af Komparatorlinealens Farvefelter, der viser de p_H-Tal, mellem hvilke den paagældende Jordekstrakts p_H-Værdi ligger, eller det viser sig, at den er identisk med en af Farverne. Har man først Komparatorlinealerne, een for hver Indikator, tager selve Bestemmelsen af en Vædskes p_H-Værdi kun nogle faa Sekunder; man bliver herved i Stand til at arbejde langt hurtigere end Tilfældet er ved Anvendelsen af de farvede Standardvædsker, der desuden paa Grund af deres Uholdbarhed ofte maa fornyes, for nogles Vedkommende hver Dag. Dette i Forbindelse med det store Besvær med at medføre de mange Flasker med Standardvædsker gør det i høj Grad ønskeligt at faa fremstillet holdbart farvet Papir til Brug ved Fremstillingen af Komparatorlinealer, saa at man ogsaa paa Rejser kan blive i Stand til at foretage nøjagtige Bestemmelser af Jordprøvers p_H-Værdi.

Undersøgelsens Plan og Omfang.

Selv om Forholdet er dette, som C. Olsen har vist, at Jordbundens p_H-Værdi er en af de Faktorer, der betinger, hvilke Arter der kommer til at dække en given Standplads og er medbestemmende for disse Arters Frekvens paa Standpladsen, er det derfor ikke udelukket, at den Vegetation, der indfinder sig paa en Standplads, selv kan komme til, direkte eller indirekte, at betinge Forandring af Jordbundens oprindelige p_H-Værdi og derigennem komme til at forberede sin egen Undergang. Det er dette Spørgsmaal, som jeg i det følgende har undersøgt.

Mest rationelt vilde det være at gaa ud fra en ensartet Lokalitet med overalt væsentlig samme p_H-Værdi, og saa lade en Del af Arealet blive bevokset med een, den anden Del med en væsentlig anden Vegetation, f. Eks. henholdsvis en Urtevegetation og en Skovvegetation; ved saa med flere eller færre Aars Mellemrum at bestemme Jordens p_H-Værdi i de to forskellige Bevoksninger vilde man faa at se, om der foregik nogen paaviselig Forandring med Hensyn til p_H-Værdien, og om de to med forskellig Vegetation bevoksede Partier indbyrdes viste nogen Forskel i denne Henseende. For at opnaa afgørende Resultater ad denne Vej, maatte Forsøget rimeligvis udstrækkes over adskillige Aar, hvilket for mig var upraktisk. Jeg har derfor valgt den Fremgangsmaade, at jeg i Naturen har opsøgt saadanne Steder, hvor der en kortere eller længere Aarrække tilbage i Tiden er sket Forandringer, der svarer til det ovenfor skitserede Forsøg; saadanne Forandringer kan ikke alene ske ved Kulturindgreb men ogsaa ved Omvekslinger, der sker i Naturen uden Menneskets Indgreb.

Det var mig straks fra Begyndelsen af klart, at i visse Henseender egnede Dyrehaven sig særlig godt som Genstand for en saadan Undersøgelse, dels fordi den i Sammenligning med andre Skove af lignende Omfang delvis har haft Lov til i lang Tid at ligge hen uden større Kulturindgreb, dels fordi man her, da Skoven paa Grund af den store Dyrebestand ikke kan forynge sig selv, til forskellige Tider har frembragt indhegnede Nyplantninger paa Dele af Græsarealer, der var opstaaet som Følge af de gamle Træers Død. Der findes saaledes her nu Side om Side, paa oprindelig samme Bund, baade yngre og ældre Skov og Urtevegetation; desuden har man her paa mange Steder Urtevegetation, Græsslette (Ore), hvor der for en kortere eller længere Aarrække siden var gammel Skov, og hvor saaledes de Resultater, der faas ved at følge Udviklingen fra Græsslette til Skov, yderligere kan prøves ved at følge den omvendte Bevægelse nemlig fra Skov til Græsslette. Alle de i denne Afhandling omtalte Undersøgelser angaaende Formationstypers forskellige Indflydelse paa Jordbundens Brintionkoncentration er da ogsaa udelukkende foretaget i Dyrehaven og de tilgrænsende Skove, nemlig Stampeskoven, Chr. IX's Hegn og Jægersborg Hegn. Disse Skoves bekvemme Beliggenhed, saa nær ved Kjøbenhavn, har i høj Grad lettet Undersøgelsen.

Eremitageslettens Nordside. I dens vestlige Del grænser Eremitagesletten mod Nord til Stampeskoven og i dens østlige Del til Chr. IX's Hegn; begge Skove stammer fra Midten af forrige Aarhundrede. Grænsen mod den nuværende Slette blev i 1853 draget som en ganske vilkaarlig lagt Linie tværs over en Græsslette, der var opstaaet ved, at den oprindelige Skovs Træer i Tidens Løb var fældet eller faldet af Ælde; paa denne Slette stod spredt enkelte Træer og smaa Grupper af Træer tilbage; en Del af disse staar endnu, dels paa Eremitagesletten, dels i Stampeskoven og i Chr. IX's Hegn. Der er her Lejlighed til at sammenligne p_H-Værdien i 60—70-aarig Bøge- og Egeskov med p_H-Værdien i den i samme Niveau liggende oprindelige Græsslettes Bund; tillige kan der her drages Sammenligning mellem 60—70-aarig Egeskov og Bøgeskov, og mellem denne sidste og gammel Bøgeskov.

Fortunens Indelukke omfatter Skovpartier af forskellig Art og forskellig Alder. Den sydlige Del indhegnedes 1831, og Tilkultiveringen afsluttedes i Aarene mellem 1840 og 1850 med Undtagelse af enkelte Partier, der er yngre. Baade mod Syd og Øst grænser Skoven paa enkelte Steder til gammel Græsslette, og der er her Lejlighed til at sammenligne denne dels med 70—80-aarig Bøgeskov, dels med Granskov af samme Alder; tillige kan her drages Sammenligning mellem Granskov og Bøgeskov. — Fortun-Indelukkets mellemste Del stammer fra Aarene 1865—70. — Den nordlige Del af Fortun-Indelukket omfatter Arealer, der er kultiveret til meget forskellige Tider. Nogle Partier stammer fra Tiden omkring Midten af forrige Aarhundrede og er saaledes c. 70 Aar gamle; andre er meget yngre. Ogsaa her har vi Skov grænsende op til den oprindelige Græsslette; dog maa det bemærkes, at Sletten ikke allevegne er uberørt; mod Nord er den for Øjeblikket under Dyrkning; og mod Øst har visse Partier været dyrket for en Aarrække siden, hvilket iøvrigt ikke synes at have haft varig Indflydelse paa Jordbundens Brintionkoncentration, og desuden er der Steder, hvor den gamle Græsslette er uberørt, og hvor der er Lejlighed til at sammenligne Granskov og Bøgeskov med den oprindelige Græsslette.

Fortun-Indelukkets mellemste og nordlige Del har særlig Interesse derved, at der her er Lejlighed til at sammenligne p_H-Værdien i Skovens Bund med p_H-Værdien i en ganske ung Græsslette, der er opstaaet som Følge af, at Skoven er fældet, og hvor Bunden har faaet Lov til »at gaa i Græs«. Jeg sigter her til det brede Skovparti tværs gennem Indelukket, som af militære Grunde blev fældet i 1914, og som i Aarene efter Fældningen hurtig blev til Græsslette; denne er begrænset af ganske vilkaarlige Linier, der paa forskellige Steder gaar gennem forskellige Skovtyper, hvis p_H-Værdi nu kan sammenlignes med den unge Græsslettes.

Omtrent fra samme Tid, 1914—15, stammer nogle smalle Græsslettestrimler mellem Granrækkerne i den allernordligste Del af Fortun-Indelukket.

Dernæst er der de smaa Indelukker paa Eremitagesletten frembragte til forskellige Tider for at fremelske Trægrupper paa Sletten. Først er der de fire omkring 1840 tilplantede Grupper: en vest-nordvest og 3 syd og sydvest for Eremitagen; de bestaar fortrinsvis af Bøg; allerede i 1913 er Hegnet omkring dem bleven fjernet. Store Partier af Sletten, der omgiver disse Skovholme, har i Tidernes Løb været dyrket i nogle Aar, men der er dog tilstrækkelig mange Steder, hvor Skovholmene grænser op til Slette, der i hvert Tilfælde ikke har været dyrket, efter at Trægrupperne er plantet.

Videre findes der nordvest og nord for Eremitagen fire ganske smaa Indelukker med Eg med Underskov af Tjørn; de stammer fra 1885—95.

Endelig er der i Aarene mellem 1885 og 1910 oprettet en Del især med Bøg og Eg tilplantede Indelukker rundt omkring i den gamle Skov, hvor der i Tidernes Løb var fremkommet større aabne Pletter, idet de gamle Træer var døde. Her er Lejlighed til at studere den forholdsvis unge Skovs Indflydelse paa Jordbundens p_H-Værdi sammenlignet med p_H-Værdien i den ikke beplantede Del af Lysningen.

I det følgende behandles først de Tilfælde, hvor Partier af gammel Græsslette for en kortere eller længere Aarrække siden er blevet tilkultiveret med Skov, — Granskov, Bøgeskov og Egeskov —, medens ganske tilsvarende og umiddelbart til Skoven grænsende Dele af Græssletten har henligget urørt, og hvor der saaledes er Lejlighed til at se, hvilken Indflydelse de forskellige Skovtyper har haft paa Jordbundens Brintionkoncentration sammenlignet med Brintionkoncentrationen i Græsslettens Bund. Derefter følger nogle Iagttagelser over, hvorledes Forholdet stiller sig med Hensyn til Jordbundens Brintionkoncentration i forskellige Skovtyper af samme Alder og paa oprindelig samme Bund. Tilsidst følger Undersøgelser over Jordbundens Brintionkoncentration i dels gammel dels yngre Skov sammenlignet med den Græsslette, der er fremkommet, efter at Dele af Skoven er forsvunden enten ved Fældning eller ved Fald paa Grund af Ælde, og hvor vi saaledes vender tilbage til det Udgangspunkt, hvorfra vi gik ud: Græssletten.

Paa hver enkelt Lokalitet er Brintionkoncentrationen stedse bleven bestemt i 5 Jordprøver udtaget i 7—10 cm Dybde. — Da der her kun er Tale om at sammenligne forskellige Vegetationstyper og ikke snævert begrænsede Formationer, har jeg ikke foretaget en formationsstatistisk Analyse, men har nøjedes med at give en kort Beskrivelse af Vegetationen i Regelen med Angivelse af de Arter, der iagttages paa det snævre Omraade, indenfor hvilket Jordprøverne udtages.

Græsslette — Skov.

A. Græsslette — Granskov (Tab. 6).

Forholdet mellem Brintionkoncentrationen i Græssletten og den paa Dele af samme Græsslette plantede Granskov er undersøgt paa 6 Lokaliteter, der i 1ste Kolonne i Tab. 6 er betegnet med Tal, der henviser til efterfølgende Lokalitetsbeskrivelse. I Tabellens 2den og 3die Kolonne er opført henholdsvis Græsslettens (a) og Skovens (b) p_H-Værdi. I 4de Kolonne er opført det Tal, med hvilket Græsslettens p_H-Værdi overstiger Granskovens. Paa samme Maade er de følgende Tabeller indrettede og saaledes, at Lokalitetsnumrene er fortløbende.

1. Sydenden af den smalle Græsslette øst for Fortun-Indelukkets sydlige Del sammenlignet med Granskovpartiet syd for Græssletten.
   a. Græsslette: Frodig, mosrig Agrostis tenuis-Cynosurus cristatus-Formation med følgende Arter, der her, som i de efterfølgende Beskrivelser, opføres i alfabetisk Orden: *Cerastium caespitosum, Deschampsia caespitosa, Phleum pratense, Rumex acetosa, Trifolium repens, Veronica chamaedrys*; desuden Hypneer, især *Hylocomium squarrosum.* $p_H = 6{,}76$.
   b. 70—80-aarig Granskov: Bunden delvis dækket af Naale og af tilblæste Blade af Bøg, delvis blottet; paa Grund af Udhugning i de senere Aar er Skoven bleven lysere, hvorfor der nu er en Del spredt *Oxalis acetosella,* ganske enkelte svage *Urtica dioeca* og *Lactuca muralis.* $p_H = 4{,}1$.
2. Samme Sted som Nr. 1, men lidt nordligere.
   a. Græsslette: Frodig Agrostis tenuis-Formation, med *Anthoxanthum odoratum, Carex hirta, Cynosurus cristatus, Poa pratensis, Rumex acetosa, Stellaria graminea, Trifolium repens.* $p_H = 6{,}32$.
   b. 70—80-aarig Granskov med Naalelag og faa Blade af Bøg. Ganske uden Bundflora. $p^H = 4{,}16$.
3. Fortun-Indelukkets-Østside, nord for Vejen Eremitagen-Fortunen.
   a. Græsslette: Agrostis tenuis-Achillea millefolium-Formation med *Anthoxanthum odoratum,*

Phleum pratense, Plantago lanceolata, Poa pratensis, Rumex acetosa, Taraxacum sp., *Trifolium repens.* $p_H = 5{,}76$.

b. 50—55-aarig Granskov med naaledækket Bund og ganske uden Bundflora. $p^H = 3{,}92$.

4. Fortun-Indelukkets nordligste Del; ved Vestsiden af det for faa Aar siden (1914) med Gran beplantede ujævne Parti.

a. Græsslette-Strimmel mellem den unge 0,25—1,5 m høje unge Granplantning og den ældre Granskov vest derfor: Agrostis tenuis-Festuca ovina-Formation med *Agrostis canina, Calluna vulgaris* (meget smaa Individer), *Campanula rotundifolia, Festuca rubra, Hieracium pilosella, Luzula campestris, Plantago lanceolata, Poa pratensis, Sieglingia decumbens, Trifolium repens.* $p_H = 6{,}48$.

b. Granskov, meget tæt og mørk, med tykt Naalelag; begyndende Mordannelse; ganske uden Bundflora. $p_H = 3{,}98$.

5. Samme Sted som Nr. 4, men ved Østsiden af den unge Granplantning.

a. Græsslette-Strimmel mellem den unge Granplantning og den ældre Granskov øst derfor: Mager Agrostis tenuis-Hieracium pilosella-Formation med *Anthoxanthum odoratum, Calluna vulgaris* (meget smaa Individer), *Festuca ovina, Galium verum, Luzula campestris, Leontodon autumnalis, Plantago lanceolata, Poa pratensis, Polygala vulgaris, Sieglingia decumbens, Trifolium repens.* $p_H = 5{,}16$.

b. Granskov med tykt Naalelag. Ingen Bundflora. $p_H = 4{,}04$.

6. Jægersborg Hegn; nordvest for Skodsborg Station.
   a. Græsslette: Agrostis tenuis-Festuca rubra-Formation med *Achillea millefolium, Brunella vulgaris, Campanula rotundifolia, Cynosurus cristatus, Holcus lanatus, Hypericum perforatum, Lathyrus montanus, Leontodon autumnalis, L. hispidus, Potentilla erecta, Ranunculus acer, Rumex acetosa, R. acetosella, Stellaria graminea, Taraxacum* sp., *Trifolium pratense, Veronica chamaedrys.* $p_H = 5{,}8$.
   b. Granskov med 4—6 cm tykt Morlag; ved Udhugning i de senere Aar er Bunden bleven saa lys, at *Oxalis acetosella* er begyndt at vandre ind; ellers ingen Bundflora. $p_H = 3{,}96$.

Tab. 6. Græsslette — Granskov.

Lokalitet	Jordens p_H-Værdi i		Græsslettens p_H-Værdi overstiger Granskovens med
	a Græsslette	b Granskov	
1. Fortun-Indelukkets sydlige Dels Østside: ved Sydenden af den smalle Græsslette	6,76	4,10	2,66
2. Sammest. Ved Vestsiden af Græssletten	6,32	4,16	2,16
3. Fortun-Indelukkets Østside ved Eremitagesletten: nord for Vejen Eremitagen—Fortunen	5,76	3,92	1,84
4. Fortun-Indelukkets nordlige Del: ved Vestsiden af den unge Granplantning	6,48	3,98	2,50
5. Sammest. Ved Østsiden af den unge Granplantning	5,16	4,04	1,12
6. Jægersborg Hegn: nordvest for Skodsborg Station	5,80	3,96	1,84
Gennemsnitlig	6,05	4,03	2,02

Af Oversigten i Tab. 6 ses, at paa alle 6 undersøgte Lokaliteter har Granskoven gjort Bunden meget surere, nemlig 1,16—2,66 udtrykt i p_H, og som Gennemsnit af alle 6 Lokaliteter c. 2 i p_H.

B. Græsslette — Bøgeskov. (Tab. 7).

En Sammenligning mellem p_H-Værdien i Græsslettens og Bøgeskovens Bund er foretaget paa følgende Lokaliteter:

7. Fortun-Indelukkets Sydrands mellemste Del.
   a. Græsslette: Agrostis tenuis-Formation med *Anthoxanthum odoratum, Dactylis glomerata, Deschampsia caespitosa, Festuca rubra, Poa pratensis, Ranunculus acer, Rumex acetosa, Stellaria holostea, Veronica chamaedrys, Viola silvestris.* $p_H = 5{,}48$.
   b. 70—80-aarig Bøgskov: forblæst, næsten nøgen Bund med Knopskæl, Frugtskaale af Bøg etc.; enkelte *Oxalis acetosella.* $p_H = 4{,}8$.
8. Samme Sted som Nr. 7, men østligere, nær »Kjøbenhavns Allé«.
   a. Græsslette: Agrostis tenuis-Formation med *Achillea millefolium, Anthoxanthum odoratum, Campanula rotundifolia, Carex pallescens, Cynosurus cristatus, Dactylis glomerata, Festuca rubra, Hieracium auricula, Luzula campestris, Plantago lanceolata, Potentilla erecta, Ranunculus acer, Rumex acetosa, Trifolium* sp., *Veronica chamaedrys, Viola* sp. $p_H = 6{,}32$.
   b. 70—80-aarig Bøgskov med enkelte *Larix*; Bunden delvis nøgen eller med Knopskæl og Frugtskaale af Bøg, dels løvdækket; enkelte *Oxalis acetosella,* iøvrigt uden Bundflora. $p_H = 5{,}42$.

9. Fortun-Indelukkets Østside, nord for Vejen Eremitagen-Fortunen.
   a. Græsslette (samme Lokalitet som 3a): Agrostis tenuis-Achillea millefolium-Form. $p_H = 5,76$.
   b. 50—55-aarig Bøgeskov uden Bundflora; Bunden delvis nøgen, delvis dækket af Knopskæl, Frugtskaale og Blade af Bøg. $p_H = 4,56$.
10. Fortun-Indelukkets nordøstlige Hjørne.
    a. Græsslette. NB. Denne Del af Sletten har dog ikke ligget ganske uberørt hen siden den tilgrænsende Del omkring 1880 blev tilkultiveret med Bøg, men har i 1895—97 været dyrket; siden da urørt. $p_H = 6,04$.
    b. c. 40-aarig tæt Bøgeskov med løs, muldet Bund med tykt Løvlag. Ingen Bundflora. $p_H = 5,44$.
11. Ved Vestranden af Egegruppen paa Bakkedraget øst for Hjortekær.
    a. Græsslette (Eremitagesletten): Frodig Agrostis tenuis-Formation $p_H = 6,34$.
    b. c. 65-aarig, mørk Bøgeskov umiddelbart nord for Hegnet mellem Stampeskoven og Eremitagesletten, tæt ved Lokalitet a. Bunden er temmelig løs, med godt Løvlag. Uden Bundflora. $p_H = 5,78$.
12. Ved Stenten, der fra Eremitagesletten fører ind i Stampeskoven.
    a. Græsslette: Frodig Agrostis tenuis-Anthoxanthum odoratum-Formation. med *Achillea millefolium, Campanula rotundifolia, Cirsium arvense, Crataegus* sp. (enkelte faa cm. høje Individer), *Dianthus deltoides, Festuca ovina, F. rubra, Holcus lanatus, Leontodon autumnalis, Plantago lanceolata, Poa pratensis, Polygala vulgaris, Potentilla reptans, Veronica chamaedrys, Viola canina.* $p_H = 5,82$.

b. c. 65-aarig Bøgeskov med enkelte *Larix*; godt Løvlag; ingen Bundflora. $p_H = 4,22$.

13. Det sydøstlige Hjørne af Chr. IX's Hegn.
    a. Græsslette (Eremitagesletten): Agrostis tenuis-Formation med *Anthoxanthum odoratum, Campanula rotundifolia, Cynosurus cristatus, Galium verum, Hieracium pilosella, Holcus lanatus, Luzula campestris, Ranunculus bulbosus, Plantago lanceolata, Poa pratensis, Rumex acetosa, Taraxacum* sp., *Trifolium repens*, $p_H = 6,54$.
    b. c. 65-aarig Bøgeskov i haard, næsten nøgen Bnnd med Knopskæl, Frugtskaale af Bøg; faa Blade; næsten uden Bundflora; kun spredte svage Individer af *Dactylis glomerata, Poa nemoralis, Arenaria trinervia*, $p_H = 5,8$.
14. Den nordvestligste Bøgegruppe paa Eremitagesletten.
    a. Græsslette syd for Gruppens Østende: Agrostis tenuis-Formation med *Achillea millefolium, Carex hirta, Cerastium caespitosum, Hieracium pilosella, Lolium perenne, Plantago lanceolata, Poa pratensis, Ranunculus bulbosus, Stellaria graminea, Trifolium repens*. $p_H = 6,1$.
    b. 80-aarig Bøgeskov med en Del Eg: næsten nøgen, stærkt forblæst Bund med Knopskæl, Frugtskaale af Bøg, Smaakviste. Spredt *Poa nemoralis*; iøvrigt uden Bundflora. $p_H = 5,38$.
15. Bøgegruppen tæt syd for Eremitagen.
    a. Græsslette: Cynosurus cristatus-Lolium perenne-Agrostis tenuis-Formation med *Achillea millefolium, Phleum pratense, Plantago lanceolata, Polygonum aviculare, Potentilla reptans, Ranunculus bulbosus, Taraxacum* sp., *Trifolium repens*. $p_H = 6,42$.
    b. 80-aarig Bøgeskov: forblæst Bund med Knopskæl,

Frugtskaale af Bøg, Kviste. Spredt *Dactylis glomerata, Poa annua, P. nemoralis.* $p_H = 5{,}86$.

16. Jægersborg Hegn, nordvest for Skodsborg Station.
  a. Græsslette (samme Lokalitet som 6 a): Agrostis tenuis-Festuca rubra-Formation. $p_H = 5{,}8$.
  b. Bøgeskov med mager Oxalis acetosella-Formation. Bunden delvis bar, delvis dækket af Løv, Knopskæl, Frugtskaale af Bøg, Kviste. $p_H = 5{,}36$.

Tab. 7. Græsslette — Bøgeskov.

Lokalitet	Jordens p_H-Værdi i a Græsslette	Jordens p_H-Værdi i b Bøgeskov	Græsslettens p_H-Værdi overstiger Bøgeskovens med
7. Fortun-Indelukkets Sydrand.....	5,48	4,80	0,68
8. Fortun-Indelukkets sydlige Dels Østside	6,32	5,42	0,90
9. Fortun-Indelukkets Østside nord for Vejen: Eremitagen—Fortunen	5,76	4,56	1,20
10. Fortun-Indelukkets nordøstlige Hjørne (10—15 m høj Bøgeskov).	6,04	5,44	0,60
11. Stampeskovens Sydrand ud for Vestranden af Egegruppen øst for Hjortekær	6,34	5,78	0,56
12. Ved Stenten, der fra Eremitagesletten fører ind til Stampeskovens sydøstlige Hjørne	5,82	4,22	1,60
13. Chr. IX's Hegns sydøstlige Hjørne	6,54	5,80	0,74
14. Den nordvestlige Bøgegruppe paa Eremitagesletten	6,10	5,38	0,72
15. Bøgegruppen tæt syd for Eremitagen	6,42	5,86	0,56
16. Jægersborg Hegn: nordvest for Skodsborg Station	5,80	5,36	0,44
Gennemsnitlig....	6,06	5,26	0,80

Heraf og af Oversigten i Tab. 7 ses, at paa samtlige 10 undersøgte Lokaliteter er Bøgeskovens Bund surere end den tilsvarende Græsslettes Bund, men Forskellen er langt mindre end for Granskovens Vedkommende, nemlig gennemsnitlig 0,8 udtrykt i p_H, medens Granskoven viste en Forskel paa c. 2 i p_H.

C. Græsslette — Egeskov.

Paa tre Steder har jeg haft Lejlighed til at sammenligne Brintionkoncentrationen i Græsslettens Bund og i de paa Græssletten plantede Egeskoves Bund. Disse Egeskove er imidlertid meget forskellige med Hensyn til Lys- og Læforhold; og da de tillige viser kendelig Forskel med Hensyn til Brintionkoncentrationens Størrelse sammenlignet med den oprindelige Græsslettes Brintionkoncentration, skal de her behandles hver for sig.

Ege-Indhegningerne paa Eremitagesletten (Tab. 8). Paa Sletten nord for Eremitagen findes 4 smaa Indhegninger, der i Aarene 1885—1895 blev beplantede med Eg, der nu har en Underskov af Tjørn. Egene staar ret tæt, og da Tjørnene tillige udfylder ethvert Mellemrum, er der ret stærk Skygge under Kronerne; og da Grupperne er ganske smaa og ligger frit paa den aabne Slette, udsatte for alle Vinde, føres de nedfaldne Blade for største Parten bort, og Jordoverfladen bliver udtørret; Betingelserne for en Bundflora er saaledes meget slette.

17. Den vestligste Egeindhegning, nordvest for Eremitagen,
    a. Græssletten umiddelbart vest for Indhegningen: artsrig Agrostis tenuis-Formation. $p_H = 5{,}38$.
    b. Ege-Indhegningens vestlige Del: den forblæste Bund næsten nøgen, hist og her med svag *Holcus mollis* og *Agrostis tenuis*. $p_H = 4{,}74$.
18. Samme Indhegning som Nr. 17.

a. Græssletten umiddelbart øst for Indhegningen: Agrostis tenuis-Formation med *Achillea millefolium, Anthoxanthum odoratum, Cynosurus cristatus, Dactylis glomerata, Leontodon autumnalis, Lolium perenne, Phleum pratense, Plantago lanceolata, Ranunculus bulbosus, Rumex acetosa, Trifolium repens, Veronica chamaedrys.* $p_H = 5,26$.

b. Ege-Indhegningens østlige Del: delvis nøgen Bund; delvis med mager *Holcus mollis, Agrostis tenuis, Urtica dioeca.* $p_H = 4,26$.

19. Den nordvestligste Ege-Indhegning, nord for Eremitagen.

a. Græssletten umiddelbart vest for Indhegningen: *Achillea millefolium, Agrostis tenuis, Anthoxanthum odoratum, Avena pratensis, Cerastium caespitosum, Cirsium arvense, Deschampsia caespitosa, Phleum pratense, Plantago lanceolata, Poa pratensis, Rumex acetosa, Trifolium repens.* $p_H = 6,8$.

b. Indhegningens vestlige Del: Bunden forblæst, delvis nøgen, delvis med lidt Løv; lidt *Agrostis tenuis,* enkelte lave *Urtica dioeca.* $p_H = 5,44$.

20. Samme Indhegning som Nr. 19.

a. Græssletten umiddelbart øst for Indhegningen: Vegetationen væsentlig som i 19 a; dog saa jeg ikke Avena pratensis. $p_H = 6,12$.

b. Indhegningens østlige Del: væsentlig som 19 b. $p_H = 4,88$.

21. Den sydøstligste Ege-Indhegning, nordøst for Eremitagen.

a. Græssletten umiddelbart nord for Indhegningen: Cynosurus cristatus-Agrostis tenuis-Formation. $p_H = 5,88$.

b. Indhegningens nordlige Del: Bunden delvis nøgen, løvdækket, hist og her med temmelig tykt Løvlag. $p_H = 4,92$.

22. Samme Indhegning som Nr. 21.

a. Græssletten umiddelbart syd for Indhegningen. $p_H = 6,02$.

b. Indhegningens sydlige Del i Bunden delvis nøgen, delvis løvdækket; hist og her med svag *Agrostis tenuis*. $p_H = 4,96$.

Tab. 8. Græsslette — Egeskov.
Ege-Indhegningerne paa Eremitagesletten.

Lokalitet	Jordens p_H-Værdi i		Græsslettens p_H-Værdi overstiger Egeskovens med
	a Græsslette	b Egeskov	
17. Den vestligste Indhegnings Vestside	5,38	4,74	0,64
18. Samme Indhegnings Østside	5,26	4,26	1,00
19. Den nordvestligste Indhegnings Vestside	6,80	5,44	1,36
20. Samme Indhegnings Østside	6,12	4,88	1,24
21. Den sydøstligste Indhegnings Nordside	5,88	4,92	0,96
22. Samme Indhegnings Sydside	6,02	4,96	1,06
Gennemsnitlig	5,91	4,87	1,04

Det fremgaar af det foregaaende og af Oversigten i Tab. 8, at Egeskovens Bund her er betydelig surere end Græsslettens, nemlig gennemsnitlig c. 1 udtrykt i p_H; og den er gennemsnitlig baade absolut og forholdsvis surere end de undersøgte, i Tab. 7 fremstillede Bøgeskovlokaliteters Bund. Det afgørende for disse smaa Ege-Indhegningers Bund er den af Skovens Tæthed betingede Skygge i Forbindelse med fuldstændig Mangel paa Læ, saa at Blæsten frit kan stryge ind og hindre Tilstedeværelsen af de skyggetaalende, men mere Læ fordrende Skovbundsplanter; Følgen bliver, at Bundens øverste Jordlag udtørres.

Egesaaten (Tab. 9), Indhegningen umiddelbart øst for Ulvedalenes sydlige Parti er for 20—30 Aar siden blevet tilkultiveret med Eg, hvorimellem der (senere?) er plantet Bøg, i hvert Tilfælde paa de Steder, der her kommer i Betragtning; disse Partier har derfor en ret stærkt skygget Bund. I Indhegningen findes enkelte gamle Bøge og Ege; og umiddelbart udenfor Indhegningen staar ligeledes gamle Træer, der delvis skygger over Indhegningens Bund.

23. Indhegningens nordvestlige Del og Græssletten nord derfor.
    a. Græsslette: Agrostis tenuis-Formation med *Achillea millefolium, Anthoxanthum odoratum, Campanula rotundifolia, Cynosurus cristatus, Deschampsia caespitosa, Festuca ovina, Leontodon autumnalis, Luzula campestris, Plantago lanceolata, Potentilla erecta, Rumex acetosa, Sieglingia decumbens, Trifolium repens, Veronica chamaedrys, Viola canina;* desuden Hypneer, især *Hylocomium squarrosum.* $p_H = 5{,}86$.
    b. Egeskov med lavere Bøg som Underskov: mørk, uden Bundflora; ret godt Løvlag; Jorden sprød; Regnorme tilstede. I Nærheden var *Oxalis acetosella* i Færd med at vandre ind; her tillige *Stellaria media.* $p_H = 5{,}1$.
24. Indhegningens nordøstlige Del og Græssletten og den tilgrænsende Græsslette.
    a. Græsslette: Agrostis tenuis-Deschampsia caespitosa-Formation med *Anthoxanthum odoratum, Carex hirta, Cynosurus cristatus, Festuca rubra, Juncus conglomeratus, Lotus corniculatus, Plantago*

lanceolata, Ranunculus acer, Rumex acetosa, Veronica chamaedrys. $p_H = 6,4$.

b. Egeskov med lave Bøge som Underskov: Løvlag. Ingen Bundflora. $p_H = 5,26$.

25. Indhegningens Østside og Græssletten øst for samme.

a. Græsslette paa en Lysning mellem gamle Bøge: dels 1) skyggepræget, mosrig Agrostis tenuis-Formation med *Anthoxanthum odoratum, Dactylis glomerata, Deschampsia caespitosa, Ranunculus acer;* af Mosser især *Hylocomium squarrosum;* dels 2) Urtica dioeca-Carex remota-Formation med *Dactylis glomerata, Deschampsia caespitosa, Juncus effusus, Melica uniflora, Oxalis acetosella, Rumex nemorosus.* (Agrostis tenuis-Formation: $p_H = 6,5, 6,2$; Urtica-Carex-Form: p_H 6,6, 6,3; Grænseomraadet mellem begge: $p_H = 6,5$) $p_H = 6,42$.

b. Egeskov med lavere Bøg som Underskov, omgivet af gamle Bøge: meget mørk; godt Løvlag; Regnorme tilstede; enkelte *Anemone nemorosa* og *Oxalis acetosella* men ellers ingen Bundflora. I Nærheden begynder enkelte Arter at vandre ind fra den lysere, rene Egeskov vest derfor, nemlig *Carex remota, Deschampsia caespitosa, Melica uniflora, Urtica dioeca.* $p_H = 5,58$.

26. Indhegningens sydøstlige Del og Græssletten syd derfor.

a. Græssletten paa en Lysning mellem gamle Bøge: dels 1) skyggepræget Agrostis tenuis-Formation med *Dactylis glomerata, Deschampsia caespitosa, Melica uniflora, Oxalis acetosella, Ranunculus acer*; dels 2) Urtica dioeca-Melica uniflora-Formation med *Deschampsia caespitosa, Festuca gigantea, Geranium robertianum, Juncus effusus, Rumex nemorosus.* $p_H = 5,66$.

b. Egeskov med lavere Bøg som Underskov: tykt Løvlag; meget mørk; ingen Bundflora. $p_H = 5{,}1$.

Tab. 9. Græsslette — Egeskov.
Egesaaten (øst for Ulvedalene).

Lokalitet	Jordens p_H-Værdi i a Græsslette	Jordens p_H-Værdi i b Egeskov	Græsslettens p_H-Værdi overstiger Egeskovens med
23. Egesaatens nordvestlige Del.....	5,86	5,10	0,76
24. » nordøstlige Del	6,40	5,26	1,14
25. » Østside.............	6,42	5,58	0,84
26. » sydøstlige Hjørne ...	5,66	5,10	0,56
Gennemsnitlig....	6,09	5,26	0,83

Ligesom i Egeindhegningerne paa Eremitagesletten er de undersøgte Partier af Egesaaten saa godt som uden Bundflora; men i Egesaaten er Læforholdene langt gunstigere og Bunden for største Delen dækket af et Løvlag; i Overensstemmelse hermed er Forskellen mellem Egeskovens og Græsslettens Surhedsgrad ikke saa stor for Egesaatens (Tab. 9) som for Eremitageslettens Egeindhegningers Vedkommende. Paa Grund af de under Egene plantede Bøge og de store, skyggende Bøge ved Siden af forholder de undersøgte Partier af Egesaaten sig, hvad Skyggeforholdene angaar, ganske som en temmelig ung Bøgeskov; og Forholdet mellem p_H-Værdien i Skovens Bund og p_H-Værdien i den tilsvarende Græsslettes Bund viser sig da ogsaa her at være væsentlig den samme som for Bøgeskovens og den til samme svarende Græsslettes Vedkommende; Bøgeskovens Bund var, udtrykt i p_H, 0,8 surere end Græsslettens, medens det tilsvarende Tal for Egesaatens Vedkommende er 0,83.

Stampeskoven (Tab. 10). Den sydlige, mod Eremitagesletten grænsende Del af Stampeskoven bestaar for største Delen af en c. 65-aarig Egeskov. Paa flere Steder er der for en Del Aar siden plantet Bøg mellem Egene i Skovens Yderkant; men disse Bøge er kun mandshøje og har endnu ikke formaaet at bortskygge den i Forvejen tilstedeværende Bundflora. Skoven er lys; Krontaget er saa aabent, at Skovbunden naaes af talrige Solstrejf, her til een Tid, hist til en anden Tid, hvorved der skabes Betingelser for en ret frodig, navnlig ret høj Bundflora, der i Almindelighed ikke er saa tæt, at den helt udelukker Lyset fra selve Bunden, men snarere lægger et let skyggende Slør over denne. Denne Bundflora bestaar de fleste Steder først og fremmest af *Rubus idaeus*, mellem hvilken der findes spredt en Række andre Arter, især: *Avena elatior, Dactylis glomerata, Deschampsia caespitosa, Fragaria vesca, Hypericum perforatum, Lampsana communis, Mercurialis perennis, Oxalis acetosella, Stachys silvatica, Stellaria holostea.*

De gunstige Lys- og Læforhold betinger et mangfoldigt og rigt Dyreliv baade over Jorden og i Jorden; og paa Grund af at en Del Sollys naar Jorden, bliver denne varmere end i den tilsvarende, stærkt skyggede Bund i Bøgeskoven, hvilket formodentlig er til Gavn for Trivselen af den Mikroflora, der medvirker ved de døde organiske Stoffers hurtige Omsætning og Nyttegørelse; i hvert Tilfælde er Forholdet det, at der i Sommertiden, til Trods for at en stor Mængde Løv tilbageholdes af Bundfloraen, kun ligger et tyndt Lag af Blade og døde Dele af Urter i Sammenligning med det tykke Løvlag i den tilgrænsende, mørke Bøgeskov. Hist og her, delvis paa Grund af rodende Dyrs Virksomhed, ses den blottede Jord; paa disse Pletter kommer ofte *Catharinea undulata*. Paa Grund af det rige Dyreliv er Jorden løs og sprød i langt højere Grad end Jorden under Løvdækket i den Bøgeskov, der er saa mørk, at ingen Sommer-Bundflora kan trives.

Langs Grænsen mellem denne Egeskov og Eremitagesletten har jeg paa 6 Steder bestemt Forholdet mellem Jordbundens Surhedsgrad i Egeskoven og i den tilsvarende Del af Græssletten.

27. Det lavere Terræn nær Hjortekær.

a. Græsslette: *Achillea millefolium, Agrostis tenuis, Anthoxanthum odoratum, Calluna vulgaris, Campanula rotundifolia, Dianthus deltoides, Festuca ovina, Galium verum, Hieracium pilosella, Leontodon autumnalis, Lotus corniculatus, Plantago lanceolata, Potentilla erecta, Polygala vulgaris, Sieglingia decumbens, Thymus serpyllum, Trifolium repens, Viola canina.* NB. Frekvensprocenten for *Calluna vulgaris* er her 100, men Individernes overjordiske Dele er meget smaa. $p_H = 6{,}5$.

b. Egeskoven: her har vist oprindelig været Bøg mellem Egene, men nu var Skoven paa det undersøgte Sted en ren Egeskov. Her var saa godt som ingen Hindbær; Bundfloraen bestod især af *Anthriscus silvester, Avena elatior, Carex hirta, Dactylis glomerata, Deschampsia caespitosa, Oxalis acetosella, Stellaria holostea.* $p_H = 5{,}68$.

28. Den vestlige Del af Bakkedraget øst for Nr. 27.

a. Græsslette: Agrostis tenuis-Formation med *Achillea millefolium, Anthoxanthum odoratum, Calluna vulgaris* (faa og lave Individer), *Campanula rotundifolia, Festuca ovina, Galium verum, Hieracium pilosella, Holcus lanatus, Lathyrus montanus, Luzula campestris, Poa pratensis, Potentilla erecta, Rumex acetosa, R. ace-*

tosella, Trifolium repens, Veronica chamaedrys, Viola canina. $p_H = 5{,}42$.

b. Egeskov: med unge, mandshøje Bøge, der ikke dækker Bunden: Løvlag. *Agrostis tenuis, Avena elatior, Dactylis glomerata, Deschampsia caespitosa, Hypericum perforatum, Oxalis acetosella, Rubus idaeus* (svag), *Stellaria holostea*; af Mosser: *Catharinea undulata* og en Del *Hypnum (purum?).* $p_H = 4{,}74$.

29. Lidt østligere end No. 28, ved Vestranden af Gruppen af gamle Ege paa Eremitagesletten øst for Hjortekær.

a. Græsslette: frodig, artsrig Agrostis tenuis-Formation. $p_H = 6{,}34$.

b. Egeskov med indtil mandshøje Bøge, der dog ikke dækker Bunden; Hindbærkrat med de Pag. 40 nævnte Arter. $p_H = 5{,}86$.

30. Lidt østligere end Nr. 29, ud for Mellemrummet mellem de vestlige og de østlige Ege i Egegruppen øst for Hjortekær.

a. Græsslette: Frodig Agrostis tenuis-Formation med *Agrostis canina, Anthoxanthum odoratum, Campanula rotundifolia, Carex muricata, Deschampsia caespitosa, Galium verum, Hieracium pilosella, Holcus lanatus, Hypericum perforatum, Leontodon autumnalis, Lotus corniculatus, Phleum pratense, Plantago lanceolata, Poa pratensis, Potentilla erecta, Ranunculus acer, Rumex acetosa, R. acetosella, Veronica chamaedrys.* $p_H = 6{,}42$.

b. Egeskov: Hindbærkrat med de Pag. 40 nævnte Arter. $p_H = 6{,}3$.

31. Øst for den i No. 29—30 nævnte Egegruppe.

a. Græsslette: Frodig Agrostis tenuis-Anthoxanthum odoratum-Formation (= 12 a). $p_H = 5{,}82$.

b. Egeskov mellem Hegnet og Vejen fra Raavad til Hjortekær. $p_H = 5{,}92$.

32. Samme Sted som Nr. 31.
  a. Græsslette (= 31 a). $p_H = 5,82$.
  b. Egeskov umiddelbart nord for Vejen Raavad-Hjortekær. Bundflora: de Pag. 40 opførte Arter. $p_H = 5,46$.

Tab. 10. Græsslette — Egeskov.
Stampeskoven.

Lokalitet	Jordens p_H-Værdi i		Græsslettens p_H-Værdi overstiger Egeskovens med
	a Græsslette	b Egeskov	
27. Det lave Terræn nær Hjortekær	6,50	5,68	0,82
28. Den vestlige Del af Bakkedraget øst for 27	5,42	4,74	0,68
29. Lidt østligere end 28, ved Vestranden af Gruppen af gamle Ege øst for Hjortekær	6,34	5,86	0,48
30. Lidt østligere end 29, ud for Mellemrummet mellem de vestlige og de østlige Ege i Egegruppen øst for Hjortekær	6,42	6,30	0,12
31. Øst for ovennævnte Egegruppe	5,82	5,92	÷0,10
32. Samme Sted som Nr. 31 (se Teksten)	5,82	5,46	0,36
Gennemsnitlig	6,05	5,66	0,39

I Tabel 10 er Resultatet af Undersøgelserne af de lyse Egeskovslokaliteter og de tilsvarende Græsslettepartier sammenstillet; ved Sammenligningen af denne Tabel med de foregaaende ses det, at af de undersøgte Skovtyper er den lyse Egeskov den Skovtype, der i lavest Grad har gjort den oprindelige Græssletles Bund surere, nemlig — som Gennemsnit af de 6 Lokaliteter — kun 0,39 udtrykt i p_H: dette er jo kun en ringe Forskel; det er derfor ikke paafaldende, at paa en af de 6 undersøgte Lokaliteter (No. 31) er det Egeskovens Bund, der er lidt mindre sur end Græsslettens.

Ved at sammenligne Tabellerne 6—10 ses det, at indenfor det behandlede Omraade er Resultatet af Undersøgelsen dette, at Skoven gør den oprindelige Græsslettes Bund surere, men i forskellig Grad, idet Jorden bliver surere i tilsvarende Grad, som Skoven er skyggegivende: den lyse Egeskov gør Jorden mindst sur; den mørke Bøgeskov gør Jorden ret stærk sur; ligesaa den ved Tilstedeværelse af Underskov af Bøg, Tjørn, etc. stærkt skyggende Egeskov; men den tætte, mørke Granskov gør Bunden mest sur, idet Forskellen mellem denne Skovs Bund og Bunden i den oprindelige Græsslette, paa hvilken Granskoven er plantet, endog overstiger 2 udtrykt i p_H.

I god Overensstemmelse hermed er Resultatet af efterfølgende Undersøgelse over Jordbundens p_H-Værdi i forskellige Skovtyper af samme Alder og paa oprindelig ganske samme Bund.

Forskellige Skovtyper paa samme Bund og af samme Alder.

A. Granskov og Bøgeskov paa oprindelig samme Bund og af samme Alder (Tab. 11).

33. Østsiden af Fortun-Indelukkets sydlige Del: 70—80-aarig Skov.
    a. Granskov (= 2b). $p_H = 4{,}16$.
    b. Bøgeskov (= 8b). $p_H = 5{,}42$.
34. Fortun-Indelukkets Østside nord for Vejen Eremitagen—Fortunen: 50—55-aarig Skov.
    a. Granskov (= 3b). $p_H = 3{,}92$.
    b. Bøgeskov (= 9b). $p_H = 4{,}56$.
35. Jægersborg Hegn: nordvest for Skodsborg Station.
    a. Granskov (= 6b). $p_H = 3{,}96$.
    b. Bøgeskov (= 16b). $p_H — 5{,}36$.

Tab. 11. Granskov og Bøgeskov paa oprindelig samme Bund og af samme Alder.

Lokalitet	Jordens p_H-Værdi i		Bøgeskovens p_H-Værdi overstiger Granskovens med
	a Granskov	b Bøgeskov	
33. Fortun-Indelukkets Østsides sydlige Del	4,16	5,42	1,26
34. Fortun-Indelukkets Østside nord for Vejen Eremitagen — Fortunen.	3,92	4,56	0,64
35. Jægersborg Hegn: nordvest for Skodsborg Station	3,96	5,36	1,40
Gennemsnitlig	4,01	5,11	1,10

Alle tre Lokaliteter viser, at Granskovens Bund er betydelig surere end Bøgeskovens — i Gennemsnit 1,1 udtrykt i p_H.

B. Bøgeskov og Egeskov paa oprindelig samme Bund (Tab. 12).

Alle herhen hørende Lokaliteter er beliggende i Stampeskovens Sydside. Egeskov Lokaliteterne er delvis de samme som i Tab. 10, og med den Pag. 40 skildrede Bundflora.

36. Ved Vestranden af Gruppen af gamle Ege paa Bakken øst for Hjortekær.
    a. Bøgeskov (= 11 b). $p_H = 5{,}78$.
    b. Egeskov (= 29 b); unge Bøge plantede mellem Egene. $p_H = 5{,}86$.
37. Sydøst for Skovsumpen i Sydsiden af Stampeskoven.
    a. Bøgeskov, plantet omkring en Gruppe af gamle Ege og vistnok noget yngre end Egeskoven ved Siden af: godt Løvlag; temmelig løs Jord; stærk Skygge; uden Bundflora. $p_H = 5{,}82$.
    b. Egeskov: cfr. Pag. 40. $p_H = 6{,}22$.

38. Midt for Egeskovens Nordside.
   a. Bøgeskov: godt Løvlag; Jorden temmelig løs; stærk Skygge; ingen Bundflora. $p_H = 5{,}56$.
   b. Egeskov: cfr. Pag. 40. $p_H = 6{,}32$.

39. Lidt østligere end Nr. 38.
   a. Bøgeskov: godt Løvlag; temmelig løs Jord; ingen Bundflora. $p_H = 5{,}06$.
   b. Egeskov: cfr. Pag. 40. $p_H = 5{,}9$.

40. I Egeskovens østlige Del.
   a. Bøgeskov: lille Bøgegruppe, 10—12 m i Diameter, plantet omkring en gammel Eg. Godt Løvlag; ganske enkelte *Oxalis acetosella* og *Anemone nemorosa* — iøvrigt uden Bundflora. $p_H = 5{,}28$.
   b. Egeskov: cfr. Pag. 40. $p_H = 6{,}06$.

41. Ved Egeskovens Østrand.
   a. Bøgeskov: godt Løvlag; uden Bundflora. $p_H = 4{,}22$.
   b. Egeskov: cfr. Pag. 40. $p_H = 5{,}46$.

Tab. 12. Bøgeskov og Egeskov paa oprindelig samme Bund og af samme Alder (Stampeskoven).

Lokalitet	Jordens p_H-Værdi i		Egeskovens p_H-Værdi overstiger Bøgeskovens med
	a Bøgeskov	b Egeskov	
36. Ved Vestranden af Gruppen af gamle Ege paa Bakken øst for Hjortekær	5,78	5,86	0,08
37. Sydøst for Skovsumpen i Sydsiden af Stampeskoven	5,82	6,22	0,40
38. Midt for Egeskovens Nordside	5,56	6,32	0,76
39. Lidt østligere end Nr. 38	5,06	5,90	0,84
40. I Egeskovens østlige Del	5,28	6,06	0,78
41. Ved Egeskovens Østrand	4,22	5,46	1,24
Gennemsnitlig	5,29	5,97	0,68

Ogsaa heraf og af Oversigten i Tab. 12 fremgaar det, at Bøgeskovens Bund er betydelig surere end Egeskovens; udtrykt i p_H er Forkellen gennemsnitlig 0,68.

Skov—Græsslette.

De i det foregaaende meddelte Undersøgelser over Surhedsgraden i en Række forskellige Skovtypers Jord viser, at Skoven gør Jorden surere, og at det er den tætte, stærkt skyggende Skov, der betinger den største Surhed, hvad enten vi har at gøre med Granskov, Bøgeskov eller med Egeskov, der er bleven stærkt skyggende paa Grund af tæt Underskov eller ved Skygge fra tilgrænsende Bogeskov. Dette Resultat er vi kommet til ved paa en Række forskellige Steder at undersøge flade Pletter af — saa vidt det kan ses — oprindelig samme Beskaffenhed og dækket af Græsslette, hvoraf en Del for en kortere eller længere Aarrække siden er blevet tilkultiveret med Skov, medens en anden Del er vedblevet at ligge hen som Græsslette til den Dag i Dag.

Det laa nu nær at undersøge, hvorvidt der til den tiltagende Surhedsgrad, der følger med, at Græssletten bliver skovbevokset, kunde paavises en modsat Bevægelse, altsaa fra stærkere til mindre stærk sur Reaktion, naar Skoven fjernedes og Terrænet fik Lov til »at gaa i Græs« og ligge hen som Græsslette. Ogsaa til en saadan Undersøgelse giver Dyrehaven, som allerede foran nævnt, god Lejlighed, nemlig dels hvor enkelte Træer i den gamle Skov falder og Bunden bliver til Græsslette, dels langs Randene af det store Parti af yngre forskelligartet Skov, der i 1914 af militære Grunde blev fældet i Fortun-Indelukkets nordlige Del ud for Fortunfortet. Jeg skal nu meddele mine Undersøgelser over de Forandringer i Jordbundens Surhedsgrad, der indtræder, naar Skov forvandles til Græsslette.

A. Granskov—Græsslette (Tab. 13).

42. Fortun-Indelukket: ved den østlige Ende af Sydsiden af det i 1914 afskovede Parti ud for Fortunfortet.
    a. 50—55-aarig tæt, mørk Granskov uden Bundflora. $p_H = 3{,}92$.
    b. 7-aarig Græsslette paa oprindelig samme Bund som a. $p_H = 4{,}96$.
43. Samme Sted som 42, men ved Nordsiden af det afskovede Parti.
    a. 50—55-aarig Granskov med tykt Naalelag og uden Bundflora. $p_H = 4{,}18$.
    b. 7-aarig Græsslette: Agrostis tenuis-Formation. $p_H = 5{,}3$.
44. Nord for Østenden af det afskovede Parti.
    a. 50—55-aarig Granskov med tykt Naalelag; uden Bundflora. $p_H = 4{,}08$.
    b. 7-aarig Græsslette: i 1914—15 fældedes visse Granrækker, hvorved der er fremkommet smalle Partier af Græsslette; disse Græsslettestrimler, der løber Vest—Øst, er kun c. 7 m brede, bevoksede med en mosrig Agrostis tenuis-Formation, der er tydelig paavirket af Skyggen mellem de høje Granrækker. Artsliste: *Achillea millefolium, Agrostis canina, A. tenuis, Anthoxanthum odoratum, Calluna vulgaris, Campanula rotundifolia, Cerastium caespitosum, Cirsium arvense, Dactylis glomerata, Deschampsia caespitosa, Festuca rubra, Fragaria vesca, Galeopsis tetrahit, Galium harcynicum, Gnaphalium silvaticum, Holcus lanatus, Hypericum perforatum, Knautia arvensis, Leontodon au-*

tumnalis, Plantago lanceolata, Poa pratensis, Ranunculus repens, Rumex acetosella, Stellaria graminea, Taraxacum sp., *Urtica dioeca, Veronica chamaedrys, V. officinalis, Vicia cracca, Viola canina, V. silvestris.* $p_H = 5,42$.

Tab. 13. Granskov — Græsslette.
Fortun-Indelukkets nordlige Del i det i 1914 afskovede Parti ud for Fortunfortet.

Lokalitet	Jordens pH-Værdi i		Græsslettens p_H-Værdi overstiger Granskovens med
	a Granskov	b Græsslette	
42. Ved Østenden af Sydranden af det afskovede Parti	3,92	4,96	1,04
43. Ved Nordsiden af det afskovede Parti	4,18	5,30	1,12
44. Nord for Østenden af det afskovede Parti (cfr. Teksten)	4,08	5,42	1,34
Gennemsnitlig	4,06	5,23	1,17

Af Oversigten i Tab. 13 ses, at Græsslettens Surhedsgrad er betydelig lavere end Granskovens; i de 7 Aar, der er forløbet, efter at Granskoven er fældet, er Bundens Surhedsgrad formindsket gennemsnitlig 1,17 med udtrykt i p_H.

B. Yngre og ældre Bøgeskov—Græsslette (Tab. 14).

45. Fortun-Indelukket: nær Vestenden af Nordsiden af det i 1914 afskovede Parti ud for Fortunfortet.
    a. 50—60-aarig Bøgeskov med Eg og Lærk: mange Kviste- og Knopskæl, men kun lidt Løv; enkelte svage *Agrostis tenuis.* $p_H = 4,44$.
    b. 7-aarig Græsslette: Agrostis tenuis-Formation med *Anthoxanthum odoratum, Campanula rotundi-*

folia, Holcus mollis, Hypericum perforatum, Potentilla erecta, Rumex acetosa, R. acetosella; af Mosser især *Hylocomium squarrosum.* $p_H = 5{,}5$.

46. Samme Sted som Nr. 45, men østligere.
    a. 50—60-aarig Bøgeskov med begyndende Indvandring af *Agrostis tenuis* paa Grund at lidt Sidelys. Mange Knopskæl, Frugtskaale af Bøg, Kviste; kun lidt Løv, mest fanget af Agrostis tenuis. $p_H = 4{,}92$.
    b. 7-aarig Græsslette med Agrostis tenuis-Formation med *Achillea millefolium, Anthoxanthum odoratum, Campanula rotundifolia, Carex muricata, Cirsium arvense, Hypericum perforatum, Juncus effusus, Linaria vulgaris, Rumex acetosella, Stellaria graminea, Taraxacum* sp., *Veronica chamaedrys, Viola canina.* $p_H = 5{,}44$.
47. Samme Sted som No. 45 og 46, men ved Østenden af det afskovede Partis Sydside.
    a. 50-60-aarig Bøgeskov uden Bundvegetation. Knopskæl, Frugtskaale af Bøg, Kviste, ganske lidt Løv. $p_H = 4{,}56$.
    b. 7-aarig Græsslette: Agrostis tenuis-Formation med *Agrostis canina, Campanula rotundifolia, Carex muricata, Cirsium arvense, C. lanceolatum, Deschampsia caespitosa, Galium harcynicum, Holcus lanatus, Juncus conglomeratus, J. effusus, Linaria vulgaris, Luzula campestris, Rumex acetosella, Stellaria graminea, Taraxacum* sp., *Veronica chamaedrys.* $p_H = 5{,}38$.
48. Ved Stenten ved Stampeskovens sydøstlige Hjørne.
    a. 60—70-aarig Bøgeskov: godt Løvlag; ingen Bundflora. $p_H = 4{,}22$.
    b. 8-aarig Græsslette: et ganske lille, i 1913 afskovet Parti, nu dækket af Agrostis tenuis-Formation

med *Campanula rotundifolia, Carex muricata, Dactylis glomerata, Dianthus deltoides, Gnaphalium silvaticum* (svag), *Hieracium auricula, Juncus effusus* (svag), *Rubus idaeus* (meget lille og svag), *Trifolium* (*medium?*), *Urtica dioeca* (svag), *Veronica chamaedrys*. $p_H = 5{,}36$.

49. Jægersborg Hegn, syd for Bøllemosen.

a. Bøgeskov med en fattig aaben Bundflora af *Asperula odorata, Carex pilulifera, Luzula pilosa, Melica uniflora, Oxalis acetosella, Veronica chamaedrys, Viola silvestris*. $p_H = 5{,}24$.

b. Græsslette, vistnok c. 10 Aar gammel, med frodig Juncus effusus-Agrostis tenuis-Formation, bl. a. med *Chamaenerium angustifolium, Cirsium arvense, Deschampsia caespitosa, Digraphis arundinacea, Holcus lanatus, Plantago lanceolata, Rubus idaeus*. $p_H = 6{,}12$.

Tab. 14. Yngre og ældre Bøgeskov — Græsslette.

Lokalitet	Jordens p_H-Værdi i		Græsslettens p_H-Værdi overstiger Bøgeskovens med
	a Bøgeskov	b Græsslette	
45. Ved Vestenden af Nordsiden af det i 1914 afskovede Parti ud for Fortunfortet	4,44	5,50	1,06
46. Samme Sted som Nr. 45, men østligere	4,92	5,44	0,52
47. Ved Østenden af det afskovede Partis Sydside	4,56	5,38	0,82
48. Ved Stenten ved Stampeskovens sydøstlige Hjørne	4,22	5,36	1,14
49. Jægersborg Hegn: syd for Bøllemosen	5,24	6,12	0,88
Gennemsnitlig	4,68	5,56	0,88

Ogsaa her er Jordbundens Surhedsgrad saaledes aftaget, efter at Skoven er fældet og Terrænet har faaet Lov til at ligge hen som Græsslette (NB. Arealet er nu tilplantet med Gran). Den gennemsnitlige Forskel i p_H-Værdi er, som det ses af Tab. 14, 0,88, omtrent den samme som den, vi tidligere fandt mellem Bøgeskovens og den oprindelige Græsslettes Bund. (Cfr. Tab. 7).

C. Gammel Bøgeskov—Nældelysning (Tab. 15).

Hvert Aar falder der flere eller færre af de store ærværdige Dyrehave-Bøge; hvor der ved et saadant Træs Fald fremkommer en Lysning i Skoven, bliver Bunden, selv hvor den i Forvejen er uden Bundflora, meget ofte efterhaanden dækket af en Vegetation af Nælder (*Urtica dioeca*). Mellem Nældernes Stængler fanges en Mængde Løv, hvorved der skabes Betingelser for et rigere Dyreliv og en anden og rigere Mikroflora end den, der trivedes i den sure, stærkt skyggede og ofte forblæste Bund under de gamle Bøge. Under passende Belysnings- og Fugtighedsforhold kan Nælderne i lang Tid være saa godt som eneherskende og fuldstændig dække Bunden om Sommeren, selv om de ikke bliver ret høje. Bliver Lyset stærkere, f. Eks. ved flere Træers Fald, kan imidlertid en Række andre Urter faa Fodfæste, f. Eks. *Mercurialis perennis* og bredbladede Græsser som *Festuca gigantea* og *Dactylis glomerata*; endvidere *Deschampsia caespitosa* o. a.; Nældevegetationen trænges tilbage, og hvis Jorden ikke er for fugtig, vil Terrænet efterhaanden blive erobret af Græsslettens sædvanlige Agrostis tenuis-Formation med dens efter de forskellige Forhold vekslende Sum af Arter; denne nye Græsslettes Forhold vil blive omtalt i næste Afsnit; her skal blot Nældelysningerne omtales.

50. Nordvest for »Første Tøjreslag«.

a. Under gamle Bøge: Bunden næsten uden Løv, med Knopskæl, Frugtskaale af Bøg og Kviste; intet Mos, men det øverste 1—2 cm tykke Lag stærkt humøst. Spredt *Oxalis acetosella,* enkelte *Melica uniflora* og nogle svage Individer af *Deschampsia caespitosa* og *Dactylis glomerata.* $p_H = 4,96$.

b. Nældelysning med temmelig godt Løvlag; mange Regnorme; foruden *Urtica dioeca* fandtes *Aspidium filix foemina, Dactylis glomerata, Deschampsia caespitosa, Nepeta glechoma, Ranunculus repens.* $p_H = 6,12$.

51. Syd for »Første Tøjreslag«.

a. Under gamle Bøge: Bunden hist og her med lidt Løv; mange Knopskæl, Kviste og Frugtskaale af Bøg; det øverste Jordlag stærkt humøst. Ingen Bundflora. $p_H = 4,84$.

b. Nældelysning, med *Festuca gigantea* og enkelte andre Arter. Temmelig godt Løvlag. $p_H = 5,9$.

52. Ørnekuldsbakken vest for Kildesøen.

a. Under en gammel Bøg: Uden Løvlag, men med Knopskæl, Kviste og Frugtskaale af Bøg, det øverste 1—2 cm. tykke Lag stærkt humøst. Enkelte svage *Dactylis glomerata* og *Deschampsia caespitosa,* iovrigt uden Bundflora. $p_H = 4,42$.

b. Nældelysning: meget tæt, næsten ren, knæhøj Nældevegation med godt Løvlag. $p_H = 6,56$.

53. Ved Stenten ved Stampeskovens sydøstlige Hjørne.

a. Under gamle Bøge: Lidt Løv; desuden Knopskæl og Frugtskaale af Bøg. Lidt Sidelys; spredt *Oxalis acetosella, Stellaria holostea* og *Viola silvestris.* $p_H = 4,26$.

b. Temmelig ny Lysning, især med *Rubus idaeus* og *Urtica dioeca*; desuden *Anemone nemorosa, Cirsium arvense, Festuca gigantea* og *Oxalis acetosella*. $p_H = 4,7$.

Tab. 15. Gammel Bøgeskov — Nældelysning.

Lokalitet	Jordens p_H-Værdi i a Bøgeskov	Jordens p_H-Værdi i b Nældelysning	Jordens p_H-Værdi i Nældelysningen overstiger Bøgeskovens p_H-Værdi med
50. Nordvest for »Første Tøjreslag«..	4,96	6,12	1,16
51. Syd for »Første Tøjreslag«	4,84	5,90	1,06
52. Ørnekuldsbakken	4,42	6,56	2,14
53. Ved Stenten ved Stampeskovens sydøstlige Hjørne	4,26	4,70	0,44
Gennemsnitlig....	4,62	5,82	1,20

Heraf (cfr. Tab. 15) ses, at Nældelysningernes Bund er mindre sur end Bunden under Bøgene, gennemsnitlig 1,2 udtrykt i p_H; men medens de fire Bøgeskov-Lokaliteters Surhedsgrad kun er temmelig lidt forskellige, — varierer fra 4,26 til 4,96 i p_H —, er Forskellen i p_H langt større for de tilsvarende Nældelysningers Vedkommende, idet p_H-Værdien her svinger fra 4,7 til 6,56, altsaa en Forskel 1,86 i p_H, medens Bøgeskov-Lokaliteterne kun viser en Forskel paa 0,7. Aarsagen hertil ligger sikkert nok væsentlig deri, at disse Nældelysninger er af meget forskellig Alder; Lysningen paa Lokalitet Nr. 53 er i hvert Tilfælde den yngste, og her har vi ogsaa den mindste Forskel mellem Bøgeskovens og Nældelysningens p_H-Værdi; Nældelysningen paa Lokalitet Nr. 52 er, saa vidt jeg ved, den ældste og viser i Overensstemmelse hermed ogsaa den største Afvigelse fra den tilsvarende Bøgeskovs p_H-Værdi.

D. Gammel Bøgeskov—Græsslette (Tab. 16).

54. Ørnekuldsbakken vest for Kildesøen.

a, Under en gammel Bøg (samme Lokalitet som Nr. 52 a). $p_H = 4{,}42$.

b. Græsslette ved Siden af Nældebevoksningen paa Lokalitet Nr. 52 b: Agrostis tenuis-Formation med *Cynosurus cristatus, Deschampsia caespitosa* (enkelte), *Poa pratensis, Ranunculus acer, Rumex acetosa, Trifolium repens* (rigelig), *Veronica chamaedrys*. $p_H = 5{,}98$.

55. Umiddelbart nord for Egesaaten.

a. Under gamle Bøges Kronrand: en Del Løv; paa Grund af Sidelys har enkelte Planter indfundet sig, saaledes faa Individer af *Carex hirta, Dactylis glomerata, Oxalis acetosella*. $p_H = 4{,}88$.

b. Græsslette med Agrostis tenuis-Deschampsia caespitosa-Formation. $p_H = 6{,}4$.

56. Ved Vestsiden af Sletten syd for Schimmelmanns Vildthus.

a. Under gamle Bøge: Knopskæl, Kviste og Frugtskaale af Bøg, men kun ganske lidt Løv. Ingen Bundflora. $p_H = 5{,}22$.

b. Græsslette lige udenfor de gamle Bøges Kronrand; det er længe siden, at de Bøge, der har staaet her, er faldet. Festuca rubra-Cynosurus cristatus-Agrostis tenuis-Formation med *Achillea millefolium, Dactylis glomerata, Galium verum, Leontodon autumnalis, Plantago lanceolata, Rumex acetosa, Trifolium* sp., forskellige Mosser. $p_H = 6{,}32$.

57. Sydvest for Schimmelmanns Vildthus.

a. Under gamle Bøge: Knopskæl, Kviste og Frugtskaale af Bøg; lidt Løv. Nær Kronranden begynder enkelte Planter at vandre ind. $p_H = 5{,}31$.

b. Græsslette udenfor Kronranden: Agrostis tenuis-Formation med *Achillea millefolium, Brunella vulgaris, Cerastium caespitosum, Cynosurus cristatus, Dactylis glomerata, Festuca rubra, Juncus conglomeratus* (enkelte svage Individer), *Plantago lanceolata, Poa pratensis, Rumex acetosa, Stellaria graminea, Trifolium repens, Veronica chamaedrys.* $p_H = 5{,}82$.

58. Ved det nordvestlige Hjørne af Rødelyngen.

a. Under gamle Bøge: Knopskæl og Frugtskaale af Bøg, og ganske lidt Løv; enkelte spinkle, skyggeprægede *Dactylis glomerata.* $p_H = 4{,}82$.

b. Græsslette umiddelbart udenfor Kronranden: frodig, artsrig Agrostis tenuis-Formation. $p_H = 5{,}82$.

Tab. 16. Gammel Bøgeskov — Græsslette.

Lokalitet	Jordens p_H-Værdi i		Græsslettens p_H-Værdi overstiger Bøgeskovens med
	a Bøgeskov	b Græsslette	
54. Ørnekuldsbakken	4,42	5,98	1,56
55. Umiddelbart Nord for Egesaaten .	4,88	6,40	1,52
56. Ved Vestsiden af Sletten Syd for Schimmelmanns Vildthus	5,22	6,32	1,10
57. Sydvest for Schimmelmanns Vildthus	5,31	5,82	0,51
58. Ved det nordvestlige Hjørne af Rødelyngen	4,82	5,82	1,00
Gennemsnitlig....	4,93	6,07	1,14

Det er sikkert længe siden, at de i Tab. 16 opførte Græsslettepartier har været dækket af gammel Bøgeskov, og deres Vegetation gør da ogsaa Indtryk af at være i høj Grad stabiliseret. Jordbundens Surhedsgrad er naturligvis ikke ens paa de undersøgte Græsslette-Lokaliteter; men ved en Sammenligning af Tab. 16 med Tab. 7 ses det, at den gennemsnitlige Surhedsgrad er den samme for den relativt oprindelige Græsslette (Tab. 7) og den Græsslette (Tab. 16), der i Tidens Løb er opstaaet paa den gamle faldne Bøgeskovs Bund. Derimod er den gamle Bøgeskovs Bund (Tab. 16) betydelig surere end den unge og midaldrende Bøgeskovs Bund (Tab. 7).

Tages alle de i det foregaaende meddelte Undersøgelser under eet, ses det, at der deraf fremgaar det Resultat, at i Sammenligning med Græssletten gør Skoven Jordbunden surere og desto surere, jo mere skyggegivende Skoven er; og at Bunden vender tilbage til den oprindelige Surhedsgrad, naar Skoven atter viger for Græssletten og denne faar Lov til i længere Tid at beholde Pladsen.

Forudsat at Naturen overlades til sig selv, vil Skov i en eller anden Form være Slutvegetation paa vel Hovedparten af Jordens Overflade, og kun pletvis og kun midlertidig vil Skoven her komme til at vige for Græsslette. Hvorledes de varmere Jordstrøgs Skovtypers Jordbund forholder sig til Græssletter, hvad Surhedsgraden angaar, maa nærmere undersøges. I de tempererede Zoner hører Skovene til de Hovedtyper, der er omtalt i det foregaaende og som har vist sig at gøre Jorden surere; og da Skoven her, forudsat at Naturen overlades til sig selv, er Slutvegetation, synes det at ligge nær at slutte, at Verden her bliver surere og surere — hvor Kulturen ikke griber mildnende ind.

Om Aarsagerne til, at Skovens Bund bliver surere end Græsslettens Bund.

Der kan næppe være Tvivl om, at vi her staar overfor et meget kompliceret Problem. For om muligt at nærme os til en Forstaaelse maa vi først søge at opløse Spørgsmaalet i dets enkelte Led og undersøge disse hver for sig. Paa Basis af de Resultater, der derigennem vindes, lader der sig maaske saa en Gang opbygge en fyldestgørende Forklaring.

Det nærmest liggende Spørgsmaal er dette: forandrer de fanerogame Planter direkte Jordens Surhedsgrad, eller sker denne Forandring kun indirekte derved, at de forandrer de Betingelser, der bestemmer Surhedsgradens Forandring, eller finder begge disse Forhold Sted.

At Planterne kan forandre en Kulturvædskes Surhedsgrad er sikkert nok; og det ligger nær at formode, at de ogsaa, i det mindste i nogen Grad, kan paavirke Surhedsgraden i den Jord, hvori de vokser. Og da det meget vel er muligt, at forskellige Plantearter forholder sig forskelligt, og at endog samme Art forholder sig forskelligt under forskellige Jorbundsforhold, vil det være meget ønskeligt at faa anstillet Forsøg. Men da Brintionkoncentrationen ikke blot kan være ret forskellig paa forskellige Punkter indenfor samme snævre Omraade, men endog kan være forskellig i forskellige Prøver af samme godt blandede Jordmasse, er det klart, at man ved saadanne Forsøg ikke kan bygge paa Bestemmelsen af p_H-Værdien i en enkelt Prøve, men maa foretage Bestemmelsen i en Række Prøver af den til de enkelte Forsøg anvendte Jord. Med Hensyn til Forsøg, der tilfredsstiller denne Fordring, disponerer jeg i Øjeblikket kun over Resultatet af en enkelt lille Forsøgsrække. Skønt denne Forsøgsrække ikke strakte sig over mere end to Maaneder og saaledes ikke kan ventes at vise store Udslag, skal den dog omtales her.

I Begyndelsen af Oktober 1921 blev der saaet Havre, Byg, Rug og Hvede i to forskellige Slags Jord, nemlig en Græstørvjord fra Nørrefælled ved Kjøbenhavn og en Lyngtørvjord. Hver af disse to Slags Jord blev omhyggelig sigtet og blandet, og af hver blev der udtaget to Sæt Prøver, hver paa 5, hvis Brintionkoncentration blev bestemt og med det i Tab. 17 givne Resultat.

Tab. 17.

	Gennemsnitlig p_H-Værdi af		
	5 Prøver	5 Prøver	alle 10 Prøver
Lyngtørvjord	4,48	4,56	4,52
Græstørvjord	4,76	4,8	4,78

Den 6te Oktober blev 20 lige store Urtepotter fyldt med Jord, 10 med Lyngtørvjord og 10 med Græstørvjord; to Potter af hver Slags blev besaaet med Havre, altsaa 4 ialt; paa samme Maade blev 4 besaaet med Byg, 4 med Rug og 4 med Hvede; af alle 4 Arter blev der saaet 100 udsøgte Korn i hver Potte. De 4 tiloversblevne Potter, to med Lyngtørvjord og to med Græstørvjord, forblev ubesaaet, men behandledes i hele Forsøgstiden iøvrigt ganske som de besaaede, blev ligesom disse holdt i passende fugtig Tilstand ved Vanding med destilleret Vand.

Alle 4 Arter spirede i Tidsrummet $^{9}/_{10}$—$^{12}/_{10}$, og de spirede alle godt; først Rug, derpaa Hvede, derefter Byg, sidst Havre; hos alle begyndte Spiringen først i Lyngtørvjorden. De stod alle omtrent lige kraftige i hele Forsøgstiden, og der var ingen kendelig Forskel paa Trivselen i de to Slags Jord.

I Tidsrummet $^{6}/_{12}$—$^{11}/_{12}$ blev Jordens p_H-Værdi bestemt i hver af det ene Sæt Forsøgs 10 Urtepotter. Hver enkelt af de 8 med Planter bevoksede Potters Jord blev saa vidt muligt befriet for Rødder og derpaa godt blandet; ligeledes blev Jorden fra hver af de to ubevoksede Potter godt blandet. I hver af de 10 Potters Jord blev p_H-Værdien bestemt i 10 Prøver, tilsammen c. $^2/_3$ af hele Jordmassen. Resultatet ses af Oversigten i Tab. 18, hvor desuden er vedføjet den p_H-Værdi de paagældende Jorder viste ved Forsøgenes Begyndelse d. 6te Oktober.

Tab. 18.

	Den ubevoksede Jords p_H-Værdi		Den bevoksede Jords p_H-Værdi December 1921			
	Okt. 1921	Dec. 1921	Havre	Byg	Rug	Hvede
Lyngtørvjord . .	4,52	4,61	4,72	4,84	4,97	4,7
Græstørvjord . .	4,78	4,88	4,93	5,03	4,95	4,92
Gennemsnitlig	4,65	4,75	4,83	4,94	4,96	4,81

Det ses heraf, at i Sammenligning med den ubevoksede Jords p_H-Værdi er den med Planter bevoksede Jords p_H-Værdi steget med de i Tab. 19 anførte Tal.

Tab. 19.

	Havre	Byg	Rug	Hvede
Lyngtørvjord	0,11	0,23	0,36	0,09
Græstørvjord	0,05	0,15	0,07	0,04
Gennemsnitlig...	0,08	0,19	0,22	0,07

Det drejer sig saaledes kun om meget smaa Forskelligheder, saa smaa, at det er tvivlsomt, hvorvidt de vidner om en Forandring af Jordens p_H-Værdi eller ikke; det Forhold, at Forandringen i samtlige Urtepotter gaar i samme Retning, tyder dog paa, at der virkelig her har fundet en Forandring Sted. Gaar vi ud fra, at de fundne Tal er et korrekt Udtryk for Forholdene, viser de, 1) at saavel Lyngtørvjorden som Græstørvjorden er, uden at være bevokset med Planter, blevet lidt mindre sur i Løbet af Forsøgstiden, nemlig c. 0,1 i p_H, 2) at p_H-Værdien ligeledes er steget i den med Planter bevoksede Jord, og at den her er steget stærkere end i den ubevoksede Jord, og at den er steget stærkere i Lyngtørvjorden end i Græstørvjorden, navnlig for Bygs og Rugs Vedkommende.

Det er klart, at da de fundne Forandringer i Jordens p_H-Værdi er saa smaa, maa Forsøgene gentages og med længere Forsøgstid og tillige udstrækkes til at omfatte flere Plantearter og forskellige Slags Jorder, før man kan faa Sikkerhed for, hvorvidt de grønne Planter direkte kan forandre Jordens Surhedsgrad eller ikke.

Men selv om Forholdet maatte være dette, at de enkelte Plantearter i nogen Grad er i Stand til direkte at ændre Jordens p_H-Værdi, synes det dog at være vanskeligt heri at finde fyldestgørende Forklaring paa de f. Eks. Side 57 omtalte Kendsgerninger. Og i alle Tilfælde vil det være nødvendigt at efterforske Betydningen af de forskellige Formationstypers forskellige Indflydelse paa Standpladsens enkelte Kaarled som Lys, Varme og Fugtighed, hvad enten disse betinger de fanerogame Planters Evne til at ændre p_H-Værdien eller deres væsentligste Betydning bestaar i at betinge Mikroorganismernes Indflydelse paa p_H-Værdien, eller i at indvirke paa rent kemiske Processers Forløb.

Paa Forhaand er der maaske ikke noget i Vejen for at antage, at Granen i højere Grad end Bøgen, og denne igen i højere Grad end Egen er i Stand til direkte at gøre Jorden surere. Men naar man lægger Mærke til, at den forskellige Størrelse af Surhedsgraden gaar jævnsides med de paagældende Arters Evne til at give Skygge, og at Surhedsgraden i Egeskoven er kendelig højere ikke alene der, hvor Egeskoven er stærkt skyggende paa Grund af større Tæthed, men ogsaa der hvor den stærke Skygge ikke skyldes Egen selv men høje stærkt skyggende Bøge i Nærheden, kan man vanskeligt undlade at formode, at Surhedsgraden ikke saa meget skyldes de paagældende Træarters direkte Virkning, men derimod staar i Forbindelse med de Forskelligheder i Kaar, som de forskellige Træarter betinger.

I den meget tætte Granskov er der ingen Bundflora af grønne Planter; først naar der ved Udhugning kommer lidt Lys til Bunden, vandrer grønne Skovbundsplanter ind; Jorden er da vist allerede for længe siden bleven saa sur, som den overhovedet bliver.

I den unge tætte Bøgeskov, navnlig saa længe de visne Blade bliver siddende til det følgende Foraar, er der paa Grund af Løvmangel heller ingen Bundflora af grønne Planter. Senere, naar Bladene ikke længere bliver siddende Vinteren over, er Skovbunden om Foraaret saa lys, at der kan trives en Foraarsflora, hvis overjordiske Organer dog dør bort lidt efter, at Skoven er sprunget ud, efter hvilket Tidspunkt Skovbunden ligger hen som en planteløs Ørken. Først senere, naar Træerne er blevet højere og Udhugningen er skredet frem, bliver Bunden saa lys, at der ogsaa kan trives en Sommerflora; men fra dette Tidspunkt bliver Bunden næppe heller her surere, end den allerede er, forudsat at Kaarene, navnlig Læforholdene, ikke af anden Grund forandres.

I Modsætning til Gran- og Bøgeskoven er Egeskoven allerede fra Begyndelsen af saa lys, at der saavel i Foraar som Sommer kan trives en Bundflora; saa længe Skoven er sluttet, bestaar denne Bundflora mest af forholdsvis høje Proto-Hemikryptofyter, der ikke helt udelukker Lyset fra

Bunden, men danner et gennemskinneligt Slør over denne. Vel findes der ogsaa en Del Roset-Hemikryptofyter, men dels staar de spredt, dels er de paa Grund af Bladenes Form og Retning kun forholdsvis lidet skyggegivende. Det synes paa Forhaand givet, at paa Grund af det milde Lys i Egeskoven og paa Grund af, at den forskelligartede Bundflora baade kan give Læ og Næring, maa Egeskoven afgive langt gunstigere Betingelser for Dyrelivet end de mørke Gran- og Bøgeskove; der er næppe heller Tvivl om, at baade det underjordiske og det overjordiske Dyreliv er langt rigere i Egeskoven, hvis Bund derfor ogsaa er løsere, mere gennemrodet af Dyr. Omsætningen af de organiske Stoffer foregaar derfor ogsaa her hurtigere og mere fuldstændig end i de Gran- og Bøgeskove, hvor der endnu ingen Sommer-Bundflora kan trives, hvilket vel er i det mindste en af Aarsagerne til, at disses Bund bliver surere end Egeskovens. Desværre kender vi endnu saa lidt til Mikrofloraen og dens Betydning for Surhedsgraden; men vi kan i hvert Tilfælde se, at der for de øverste Jordlags Mikroflora maa være ret forskellige Betingelser i Egeskoven i Sammenligning med Gran- og Bøgeskoven; og det er meget sandsynligt, at disse to Lokaliteter af den Grund har en forskellig Mikroflora, der maaske atter betinger eller er med til at betinge Forskellen i Surhedsgrad. Jeg tænker her især paa Forskellen med Hensyn til Betingelserne for Fordampning fra de øverste Jordlag paa de to Lokaliteter. Bundfloraen i Egeskoven — og naturligvis i enhver anden Skov, der er saa lys, at en Bundflora kan trives der — berøver naturligvis Jorden en vis Mængde Fugtighed, og Fordampningen fra Bundfloraens Blade kan jo være betydelig større end Fordampningen fra den ikke plantedækkede Bund; men der er her det væsentlige Forhold, at den Fugtighed, der fordamper fra

Bundfloraens Blade, hovedsagelig er hentet op fra en vis større eller mindre Dybde, hvor der i Regelen er Vand nok, medens Bundfloraen ved at give Læ beskytter de øverste Jordlag mod Udtørring. I de mørke Gran- og Bøgeskove er der derimod ingen Bundflora til at give Læ, hvorfor Betingelserne for Fordampning fra de øverste Jordlag her bliver større, saa at dette Jordlag tilligemed de der beroende døde Plantedele udtørres af de Trækvinde, der frit kan stryge hen over Bunden.

Jeg skal give et Par Eksempler paa, hvor stor Forskellen i Fordampningen kan være paa to tæt ved hinanden liggende Punkter i samme Skov, hvor den ene Lokalitet er uden Bundflora, den anden derimod med Bundflora. Først maa jeg dog give en kort Beskrivelse af det ved disse Undersøgelser benyttede Atmometer.

Det kan naturligvis have stor Interesse at følge og sammenligne forskellige Lokaliteters Fordampningsbetingelser gennem hele Vækstperioden eller endnu længere Tidsrum; men størst Betydning har det dog, forekommer det mig, at kende Forholdene i de særlig kritiske Perioder, i hvilke Fordampningen nærmer sig til at blive skæbnesvanger for Planternes Eksistens; det er saadanne Perioders Kaar, der er bestemmende for, hvilken Bestand af Arter en given Lokalitet kommer til at huse. Det var derfor mit Maal at faa konstrueret et Atmometer, der var saa fint mærkende, at det selv i ganske kort Forsøgstid gav et tilstrækkelig nøjagtigt Udtryk for de sammenlignende Lokaliteters Fordampningsbetingelser i den givne Tid. Ligesom Mitscherlich og Livingston har jeg ved Maalingen benyttet Fordampningen fra Overfladen af en vandfyldt porøs Beholder; og da Maalingens Nøjagtighed kun krævede en lille fordampende Flade, har jeg kunnet benytte Chamberlands Porcellænsfiltre med et kun c. 4,5 cm langt porøst Parti. Efter at være fyldt med destilleret Vand bliver Filtret (Fig. 1, *f*) sat i Forbindelse med Maaleapparatet ved Hjælp af et c. 4 cm langt Stykke Gummislange (*g*), hvis ene Ende omfatter Filtrets glacerede Munding, medens den anden Ende omfatter et paa Maaleapparatet siddende Glasrør (*a*). Som Billedet (Fig. 1) viser, bestaar Apparatet af en Tregangshane, til hvis opadrettede Gren (*a*) det fordampende Chamberland-Filter (*f*) er forbundet paa den angivne Maade. Den ene af de to andre Grene (*b*) er forbunden med en Tragt (*t*) til Paafyldning af Vand. Den 3die Gren er forbunden med en inddelt Maalepipette (*c*). Hele Apparatet kan ved Hjælp af en Elastik let anbringes i en Udskæring i Spidsen af et tyndt Stativ eller paa anden Maade fæstes til dette.

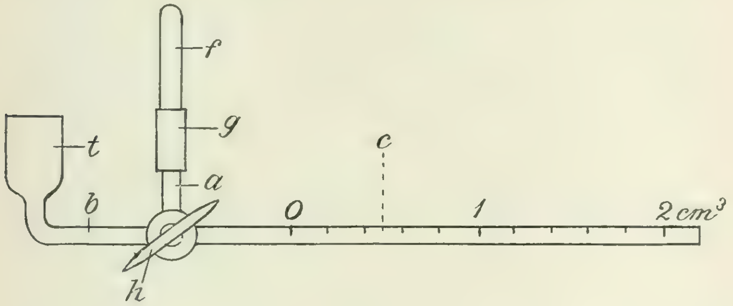

Fig. 1.

Det maa naturligvis nøje iagttages, at der ikke kommer Luft ind i Filterkerten; før denne forbindes med Apparatet stilles Hanen (*h*) først saaledes, at der er Forbindelse fra Tragten til Grenen *a*, medens der er lukket til Maalepipetten; derpaa hældes der Vand i Tragten, og Apparatet holdes saaledes, at Grenen *a* bliver fyldt med Vand lige til Randen.

hvorpaa Hanen drejes saa meget, at der bliver lukket for Vandet i Grenen *a*; dernæst forbindes Filterkerten, der tilligemed den paa samme paasatte Gummislange i Forvejen er suget fuld af Vand, med Grenen *a*, hvorved det maa passes, at dette sker uden at der kommer Luft ind, hvilket ved lidt Øvelse let undgaas. Derpaa stilles Hanen saaledes, at der kommer Forbindelse mellem *b* og *c*, saa at Maalepipetten kan fyldes med Vand fra Tragten; hvis der kommer Luftblærer i Maalepipetten, maa man ved at dreje Apparatet faa Vandet til at stige og synke i Røret, indtil man har faaet Luftblærerne fjernet. Naar saa Pipetten er fyldt med Vand, lukkes der ved en Drejning af Hanen af for Forbindelsen med *b*, saa at der nu kun er Forbindelse mellem Filterkerten og Maalepipetten. Det Vandtab Filterkerten nu lider ved Fordampning fra dens Overflade erstattes ved Sugning fra Maalepipetten, hvor Vandet derfor efterhaanden trækker sig længere og længere tilbage fra Pipettens Spids, hvorved Fordampningens Størrelse i en given Tid direkte kan aflæses. Naturligvis maa Aflæsningen ikke begynde, før vedhængende Vand er dampet bort og Apparatet er kommet i Ligevægt. Naar dette er sket, og Apparatet er bragt paa Plads, noteres Tiden og det Punkt, til hvilket Vædsken i Pipetten i Øjeblikket naar; ved Forsøgets Slutning og, om man vil, tillige med bestemte Mellemrum under Forsøget, aflæses og noteres, hvormange Kubikmillimeter Vand der er fordampet i den paagældende Tid.

Hvor Fordampningen er meget stor, kan Pipetten tømmes i Løbet af c. 2 Timer; Forsøget kan alligevel godt strækkes over længere Tid, idet man paa et Øjeblik til enhver Tid atter kan fylde Pipetten, helt eller delvis, med Vand fra Tragten.

Vil man paa samme Tid sammenligne Fordampningsbetingelserne paa flere Steder, og det er jo i Regelen det, man har Brug for —, maa man naturligvis anvende et tilsvarende Antal Apparater. Da man imidlertid ikke kan gaa ud fra, at Filterkerterne er ens, og Resultaterne saaledes ikke uden videre kan sammenlignes, maa Apparaterne standardiseres før Forsøgene derved, at de sættes i Virksomhed i samme Tidsrum og under ganske ens Betingelser, hvorved deres indbyrdes Forhold let bestemmes; ved Hjælp heraf lader de senere ved Forsøg med forskellige Apparater paa forskellige Lokaliteter fundne Resultaters sande indbyrdes Forhold sig hurtig udregne.

Ønsker man at kende ikke alene det relative Forhold mellem de enkelte Lokaliteters Fordampning, men tillige dennes absolute Størrelse maalt ved Fordampningen fra en fri Vandoverflade i samme Tid, kan dette lade sig gøre derved, at Apparaterne under Standardiseringen anbringes sammen med en Skaal med Vand med kendt Overflademaal; Skaalen med Vandet vejes ved Forsøgets Begyndelse og Slutning, og af Vægttabet, Vandfladens Størrelse og den paa de enkelte Apparater aflæste Fordampning i Forsøgstiden lader det sig let beregne, hvorledes Fordampningen fra hver enkelt Maaleapparats Filterkerter forholder sig til Fordampningen fra en fri Vandoverflade under samme Betingelser.

I Tidens Løb kan der foregaa nogen Forandring i Filterkerternes Fordampningsevne; og da det ikke er givet, at disse Forandringer er ens for alle de anvendte Filterkerter, maa Apparaterne med visse Mellemrum sammenlignes ved Standardisering.

Med det foran beskrevne Atmometer[1] har jeg anstillet

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[1] Af EDUARD RÜBEL's i dette Aar udkomne Bog »Geobotanische Untersuchungsmethoden«, Pag. 81, ser jeg, at S. JOHNSTON og B. E. LIVING-

en Del Forsøg til Belysning af Fordampningsbetingelserne paa forskellige Lokaliteter. Et Par af disse Forsøg, der vedrører Spørgsmaalet om Bundfloraens Betydning for Fordampningen fra Jordoverfladen, skal meddeles her. Disse Forsøg blev anstillet i Allindelille Fredskov i Begyndelsen af August 1920. I det første Forsøg blev Fordampningen maalt samtidig paa de nedenfor nævnte fire forskellige Lokaliteter indenfor samme snevert begrænsede Terræn ved en lille Mose, Thomaspark, omtrent midt i Skoven.

A. Solaaben Haardbund ved Mosens Nordrand: tæt, artsrig Urtevegetation, i hvilken bl. a. *Selinum carvifolium* var meget fremherskende.

B. Høj Bogeskov syd for Mosen: Bunden, der har Fald mod Nord, var dels ganske nøgen, dels dækket af et tyndt Lag Blade og Knopskæl; uden Vegetation eller meget spredt bevokset med mager *Asperula odorata*, enkelte Individer af *Viola silvestris*, *Oxalis acetosella*, *Anemone hepatica*, *Poa nemoralis* og *Vicia sepium*. Jorden var sur; fra c. 5 cm Dybde og nedefter bestod den af haardt, sandblandet Ler.

C. Faa Meter vest for B, med Bøg af samme Alder som ved B, og paa samme mod Nord jævnt skraanende Flade; men Bunden er her stærkt kalkholdig. Frodig Bundflora af *Actaea spicata*, *Brachypodium silvaticum*, *Hordeum europaeum*, *Asperula odorata*, *Convallaria ma-*

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ston allerede i 1916 har foretaget en Ændring af Livingstons Atmometer saaledes, at Fordampningens Størrelse i korte Tidsrum kan bestemmes med dette Apparat. Forskellen mellem det foran beskrevne, af mig anvendte Atmometer og det af Johnston og Livingston konstruerede Apparat vil let ses ved en Sammenligning af foranstaaende Figur af mit Apparat og Figuren hos Rübel (l. c., Pag. 81). Johnston og Livingstons Afhandling (Plant World 19, 1916) har jeg desværre ikke haft Adgang til.

jalis, Mercurialis perennis, Bromus ramosus, Hedera helix, Rubus saxatilis, Fragaria vesca, Viola silvestris, Pulmonaria officinalis; desuden lidt Underskov bl. a. af *Viburnum opulus*.

D. Tæt Pilekrat ved Sydsiden af Mosen.

Forsøget varede fra Kl. 1^{40} til Kl. 4^{5} den 5te August; det var i Forsøgstiden Solskin; dog var Solen en Gang imellem dækket af hvide Skyer. Kl. 2 blev Lysstyrken bestemt paa alle fire Lokaliteter ved Hjælp af den af Dr. Boysen Jensen konstruerede Lysmaaler[1] paa to Maader: dels saaledes, at Lysmaaleren var skærmet mod direkte Sollys ved Hjælp af en i passende Afstand anbragt Skærm, dels saaledes, at Lysmaaleren førtes (i vandret Stilling) frem og tilbage over Terrænet og uden at være direkte skygget, saa at den altsaa ved A var i Sollyset hele Tiden, medens den paa de øvrige Lokaliteter kun blev truffet af de Solstrejf, som den tilfældigvis passerede igennem. Saavel Lysprocenten som Fordampningens Størrelse er opført i Tab. 20. Fordampningen var naturligvis størst paa den solaabne Eng; fra det der opstillede Apparats Kerte fordampede der i de $2^{1}/_{4}$ Time, Forsøget varede, 900 Kubikmillimeter Vand; dette Tal er i Tabellen sat lig 100, hvorpaa For-

Tab. 20.

Lokalitet	Fordampningsprocenten	Lysprocenten	
		Lysmaaleren ikke skærmet mod direkte Sollys	Lysmaaleren skærmet mod direkte Sollys
A	100	100	100
B	82,7	2,3	6,9
C	39,2	3,8	11,4
D	16,9	2,1	6,3

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[1] P. Boysen Jensen: Studies on the production of matter in Light- and Shadow-Plants, Botanisk Tidsskrift, 36. Bind, 1918, (p. 233).

dampningens Størrelse paa de øvrige Lokaliteter er omregnet i Forhold dertil.

Den Del af Forsøget, som det i foreliggende Sammenhæng særlig kommer an paa, og som her skal sammenlignes, er Tallene for Lokaliteterne B og C. Disse Lokaliteter ligger kun faa Meter fra hinanden i samme Bøgeskov og paa samme Skraaning, kun med den af Jordbundens forskellige Beskaffenhed betingede Forskel, at der ved B saa godt som ingen Bundflora findes, i hvert Tilfælde ingen Bundflora, der kan afgive nævneværdig Læ, medens der ved C findes en rig lægivende Bundflora. Forholdene var iøvrigt ikke særlig gunstige for Lokaliteten C den paagældende Dag, idet Vinden, der ganske vist var ret svag, kom fra Sydøst og blæste skraat ind mod Grænsen mellem B og C. Atmometret ved C stod kun faa Meter fra den aabne, næsten vegetationsløse Skovbund omkring B, henover hvilken Vinden blæste mod C. Som det ses af Tabellens Tal, er Forholdet alligevel dette, at Fordampningen ved C er kun halvt saa stor som ved B. Der kan ikke være Tvivl om, at det er den rige lægivende Bundflora ved C, der har bevirket, at Fordampningen ved Jordfladen her er saa stærkt nedstemt; som det ses af Tabellen, kan Forskellen ikke bero paa Forskellen i Belysning paa de to Steder; thi vel er der en lille Forskel i Belysning, men denne gaar i Retning af at betinge en stærkere Fordampning ved C end ved B, idet Lysprocenten ved C er noget højere end ved B.

For yderligere at oplyse den Betydning, som Bundfloraen har for Nedstemningen af Fordampningen fra Jordens Overflade og derved modvirke dennes Udtørring, anstillede jeg (6te Maj) følgende Forsøg paa de i Tab. 20 med B og C betegnede Lokaliteter. Dette Forsøg varede kun en Time (Kl. 2—3); for at undgaa Forskelligheder, der kunde tænkes at hidrøre fra Forskel med Hensyn til de Solstrejf, der eventuelt traf Fordampningskerten, blev denne paa alle Apparater skygget ved en i passende Afstand stillet Skyggegiver. Ved B, altsaa paa Lokaliteten uden lægivende Bundflora, anbragtes umiddelbart ved Jordfladen to Apparater, det ene uden Læ, det andet i Læ af en Lægiver, hvortil der i Mangel af bedre anvendtes en flad, 65 cm lang og 40 cm høj Rejsekuffert. Ved C blev der ogsaa anvendt to Apparater, men kun det ene opstilledes paa Jorden, i Læ af Bundfloraen, medens det andet anbragtes i ca. 40 cm Højde umiddelbart over Bundfloraens Hovedmasse, idet kun spredte Straa ragede højere op. Resultatet af Forsøget, der er gengivet i Tab. 21, viser paa slaaende Maade Bundfloraens store Betydning som Middel til at nedstemme Fordampningen fra Jordfladen. Ved C er Fordampningen fra det umiddelbart over Bundfloraen anbragte Apparat over dobbelt saa stor som Fordampningen fra det ved Jordfladen i Læ af Vegetationen anbragte Apparat. Og ved B er Fordampningen fra det ved Jordfladen men uden Læ opstillede Apparat dobbelt saa stor som Fordampningen fra det ligeledes ved Jordfladen, men i Læ af en Lægiver anbragte Apparat.

Tab. 21.

Lokalitet	Atmometer	Fordampningsprocent	
B	a. Tæt ved Jorden uden Læ	100	
	b. Tæt ved Jorden i Læ af en Lægiver	49,3	
C	c. Tæt ved Jorden i Læ af Bundvegetationen	37,7	46
	d. I ca. 40 cm Højde umiddelbart over Bundvegetationen	81,9	100

I Tab. 22 har jeg sammenstillet Resultaterne af begge paa Lokaliteterne B og C anstillede Forsøg med Atmometre anbragte ved Jordfladen og uden kunstigt Læ. Som det erindres, var de to Forsøgsrækker forskellige deri, at i det første Forsøg, den 5te August, var Fordampningskerten ikke skærmet mod Solstrejf, der sandsynligvis havde forskellig Styrke paa de to Lokaliteter og saaledes kunde tænkes at paavirke Fordampningens Størrelse i forskellig Grad. I Forsøget den 6te August blev derimod samtlige Apparaters Fordampningskerte skærmet mod Solstrejf. Af Oversigten i Tab. 22 ses, at naar den Forskel, at Lyset er stærkere ved C end ved B, delvis afsvækkes ved paa begge Steder at udelukke det direkte Sollys, synker Fordampningen ved C endnu mere i Sammenligning med Fordampningen ved B.

Tab. 22.

Lokalitet	Fordampningsprocent	
	5te August	6te August
B	100	100
C	47,4	37,4

Den Pag. 40 beskrevne Bundflora i Stampeskovens Egeskov er vel i floristisk Henseende meget forskellig fra den ovenfor, paa Lokalitet C, omtalte Flora; men med Hensyn til Evnen til at beskytte Jordoverfladen mod Udtørring er der næppe stor Forskel mellem de to Lokaliteters Bundflora. Gennemgaar man Fortegnelsen over de to Lokaliteters Arter, finder man begge Steder, at de stærkt skyggende og lægivende Organer, Bladene, findes i forskellig Højde over Jorden hos de forskellige Arter; vi kan her nøjes med at skelne mellem to Lag: 1) Bundlaget, fortrinsvis Roset-

Hemikryptofyter, hos hvilke Hovedmassen af Bladene findes lige ved Jordfladen, og 2) Overlaget, hvis Arters Blade hæves højere op over Jordfladen enten ved lange Bladstilke eller ved strakte Stængler.

Holder vi os til den Skov, der er saa lys, at en skærmende Sommer-Bundflora kan trives, og begynder vi med den Skovtype, der har den stærkest skyggede Bund, vil man, naar man ser bort fra de for Blæst udsatte Skovpartier, i Almindelighed finde, at de Arter, der danner Overlaget, er fremherskende, og at de, sammen med Bundlagets faa Arter, er i Stand til at beskytte Jordoverfladen mod for stærk Udtorring. Overlagets Arter er imidlertid mere eller mindre mesofile, temmelig bredbladede Planter, der trænges tilbage, hvis Fordampningsbetingelserne stiger; hvor derfor Skovbunden bliver lysere, viger efterhaanden Overlagets Arter; men samtidig indvandrer flere og flere nye Rosetplanter i Bundlaget, der tilsidst bliver et ganske sammenhængende Tæppe, som ligger tæt paa Jorden og beskytter dennes øverste Lag mod Udtørring ved Vind og Sol: vi faar en Græsslette-Vegetation.

Som foran omtalt er Brintionkoncentrationen i Græsslettens Bund lavere end i de mere eller mindre skyggende Skovtypers Bund; hvis en lav Brintionkoncentration, en lav Surhedsgrad, er en Fordel, maa det derfor, hvad Jordbundens Reaktion angaar, betragtes som heldigt, at Skoven bliver saa lys, at Bundfloraen kan udvikles som et tæt, sammenhængende Bundlag. Imidlertid er der jo andre vigtige Faktorer end Surhedsgraden. Den meget lyse Skovs tætte Bundfloras Arter lægger saaledes sikkert nok stærkt Beslag paa Jordbundens Indhold af Livsgoder, bl. a. berøver disse Planter de næstøverste og dybere Jordlag store Vandmængder, der saaledes unddrages Skovens Træer. Det er derfor sandsynligt, at den heldigste Skovtype i vort Klima er den, der er saa lys eller, om man vil, saa skyggende, at der kan trives en Sommer-Bundflora, væsentlig bestaaende af et Overlag af mere eller mindre bredbladede Arter, der ikke helt udelukker Lyset fra Bunden og dog yder denne saa meget Læ, at det øverste Jordlag ikke udtørres, men holdes i en for en hurtig og fuldstændig Stofomsætning passende Fugtighedstilstand, samtidig med, at den skaber Betingelser for en rig Mikroflora og et rigt Dyreliv.

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