Through accurate determination WEBER[1]) found 1886 grams for the brain weight of a fullgrown female specimen of Tursiops tursio, a toothed whale of the Delphinidae family, the body weight being 432 times as much. From this the cephalisation-coefficient 0,981 can be calculated. The Odontocetes, among them especially the Delphinidae, swim with extraordinary dexterity and swiftness, faster than the fastest steamer, they even swim round a steamer at full speed; the Mysticetes, on the contrary, cannot reach the speed of an ordinary steamer. In connection with this the dorsal muscles of the former are much more powerful, which is to be seen by the great thickness of the back part of the body.

Thus the muscle apparatus of Homo neandertalensis was also stronger than that of Homo sapiens, and among the races of modern Man the Mongoloids possess the most powerful muscle apparatus. In agreement with this Homo neandertalensis and the Mongoloids possess also the relatively largest encephalon.

[1]) loc. cit, p. 113. The body weight with the brain ratio 1 : 432 is 815 kg. The value 278 is given, evidently a misprint.

Botany. — *"On the influence of circumstances of culture on the habitus and partial sterility of the pollengrains of Hyacinthus orientalis".* By Dr. W. E. DE MOL. (Communicated by Prof. A. H. BLAAUW.)

(Communicated at the meeting of February 26, 1921).

I. *Introduction.*

When, in the spring of 1919, it had become evident to me that the nuclei of the single-flowered, rose-coloured hyacinth-variety *Nimrod* possessed 19 chromosomes[1]), I thought it advisable to examine the fertility of the pollen and to compare it with that of the Dutch varieties with 24 chromosomes in the somatic cells, which number I at that time still considered as diploid. I chose for that purpose the closed anthers, taken from growing *Nimrod*-plants that belonged to the same grower as those of which I had fixed the root-tops in behalf of my chromosome-examination. To my surprise the pollengrains in these anthers differed greatly from the aspect which hyacinth-pollen had always shown to me. I did not find *one* normal fertile grain. The sterile pollengrains were elliptic, round or triangular in shape and had various dimensions. The wartlike protuberances on the exine, which in normal cases cause the pollengrains, when plunged into a drop of some liquid, to stick together to some extent, were undeveloped, so that the pollen dispersed very easily. Apart from these sterile pollengrains, there appeared in the preparations many that were much larger and globe-shaped, and were full of large starchgrains. If the pollen was put into a diluted solution of jodine in jodide of potassium, one saw at once the abnormal pollengrains lying like intensely blue-black globes among the yellow, shrivelled exines of the sterile pollengrains. In a drop of water the exine usually burst rather soon and the starchgrains

[1]) Over het optreden van heteroploide Hollandsche varieteiten van *Hyacinthus orientalis L.* en de chromosomengarnituur van deze plantensoort.
Verslagen van de Koninklijke Akademie van Wetenschappen te Amsterdam, Wis- en Natuurkundige Afdeeling, Deel XXIX, p. 513.
Nieuwe banen voor het winnen van waardevolle varieteiten van bolgewassen, p. 19.

then floated loose in the preparation causing a bluish spine when the light fell through it. There appeared to be starchgrains among them, reaching the size of a small sterile pollengrain.

But moreover, numerous elliptic pollengrains occurred that had germinated, not with a normal pollen-tube however, but with a tube that had rather the shape of a bubble. This bubble was sometimes smaller than the pollengrain itself, but often it was much larger. It contained 2, 3, 4, 5 or more globe-shaped nuclei.

The closed anthers were slightly shrivelled, and the violet anthocyanin in their walls was slightly discoloured.

This observation stimulated me to try and find out whether in literature any mention was made of phenomena like those observed by me. I then, indeed, found that NĚMEC (1898) had already observed the same thing, also in the hyacinth. He however, had discovered it in the partly petaloid anthers of a variety with double flowers. The anthers were taken by him from young closed flower-buds, fixed, bedded in paraffine, coloured, and made into microtome-series. He also found the small sterile pollengrains without reservesubstance, and the large, globe-shaped ones full of starchgrains. And here, too, many pollengrains had developed in the closed anthers pollen-tubes that often looked like large bubbles. He sometimes saw 8 nuclei in them.

NĚMEC supposed these deviations to be the consequence of the anthers being petaloid from the fact that I found them in the anthers of a single-flowered variety, one could infer that they were due to other causes than the flowers being double. I therefore thought the phenomenon was to be ascribed either to the peculiar bastardlike nature, of the variety *Nimrod* — as the latter is supposed to be a product of cross-fertilization between a French and a Dutch variety! — or to the occurrence of the deviating number of chromosomes in the somatic cells.

I now resolved to examine the pollen of a large number of varieties Carefully I considered in what way this examination was to be performed, in order to derive the most favourable results from it. In the month of April and May 1919 I managed to perform it at Lisse, the centre of the Dutch hyacinth-cultures, in the following way. I chose varieties with the most diverging shapes, dimensions and flowering-times, double-flowered as well as single-flowered ones. Moreover I collected several times many racemes of one and the same variety, cultivated by different growers under greatly diverging circumstances. In this way I was able to come to palpable results. One of these results, in my eys the most important, may be mentioned here.

II. *On the occurrence of pollengrains with 3 and more nuclei.*

SCHÜRHOFF (1919) has drawn our attention to the fact that among *Monocotyledons* as well as *Dicotyledons* pollengrains with 3 nuclei — 1 vegatative and 2 generative — occurs before the germination. He wonders whether this early division of the male sexual nucleus has a biological or a systematical importance and concludes on p. 147, after giving a general view of the orders of plants where pollengrains with 3 nuclei have been noticed: "Es ergibt sich also aus dieser Aufstellung, dass dem Vorkommen von dreikernigen Pollenkörnern keine besondere systematische Bedeutung zukommt. Eine derartige Bedeutung liesze sich zur Not für die *Monokotylen* konstruieren, da bei den ersten Ordnungen das Vorkommen dreikerniger Pollenkörner die Regel bildet, während sie bei den letzten Ordnungen der *Monokotylen* fehlen". Of the *Monocotyledons*, according to him, the *Helobiae*, the *Glumiflorae* and part of the *Spadiciflorae* are characterized by pollengrains with 3 nuclei. The orders of the *Enantioblastae*, the *Liliiflorae*, the *Scitamineae* and the *Gynandrae*, *with the exception of the Juncaceae and other isolated cases*, do not possess them.

If we examine more closely some cases of the *Monocotyledons*, we notice that ELFVING saw, as early as 1878, 3 kernels in the pollengrains of *Andropogon campestris*, and that STRASBURGER (1884) saw that in many cases the generative nucleus was divided in the pollengrain. GOLINSKY (1893) found 2 sperm-nuclei in the pollengrains of *Triticum*, SCHAFFNER (1897) in *Sagittaria variabilis*. "The division of the generative nucleus before pollination", he says on p. 254, "seems to be quite common in monocotyledons, and it is probable that this condition will be found to be the rule rather than the exception in this group". According to the researches of CHAMBERLAIN (1897) the generative nucleus of *Lilium aurantiacum* and of *Lilium tigrinum* was divided in the pollengrain, "a condition not uncommon, in monocotyledons", he says. In 2 cases he also observed in *Lilium aurantiacum*, that the divisions went still further, so that 3 generative nuclei were present. In *Lilium Philadelphicum* the early division of the generative nucleus occured seldom. In *Lilium martagon* it is perhaps out of the question. GUIGNARD (1891) at least notices that the generative nucleus is here only divided in the pollentube. The vegetative nucleus is never divided. In 1899 this naturalist saw 3 nuclei in the pollengrains of *Najas major*. WIEGAND (1899) observed 2 generative nuclei in *Potamageton foliosus Raf.* and gives an enumeration of the cases at that time observed in *Mono-*

cotyledons. MÜRBECK (1902) observed 3 nuclei, 1 vegetative and 2 generative in *Ruppia rostellata Koch.* SCHÜRHOFF (1919) describes explicitly the mechanism of division in the generative nucleus of *Sagittaria sagittifolia.*

In *germinated pollengrains* of *Monocotyledons* more than 2 generative nuclei have sometimes been observed. Thus STRASBURGER (1884) saw 4 of them in the pollen-tubes of *Ornithogalum* and of *Scilla.* THIES (1901) caused ripe pollengrains of *Scilla sibrica* to germinate in a 5 °/₀ solution of cane-sugar and says: "ausnahmsweise wurden in einem gekeimten Pollenkorn 5 Kerne beobachtet".

In hyacinth-varieties, too, one may observe under particular circumstances, that they contain pollengrains with 2 generative nuclei. I found them i.a. in the single-flowered white variety *La Neige.* The vegetative nucleus was large and round. The exine of the pollengrains was very transparent here, the wartlike protuberences were almost entirely absent. This made it possible to observe the nuclei closely, without having to colour them green first in a drop of methylgreen acid of vinegar. Not nearly all pollengrains possessed 2 generative nuclei. That I ascribe the early division of the generative nucleus to external circumstances, may appear later on.

III. *Further particulars concerning the occurrence of pollengrains with several nuclei in Dutch hyacinth-varieties.*

By way of introduction I mentioned that I found pollengrains with several nuclei in the variety *Nimrod.* When composing my extensive tables, I indicated not only the percentage of sterility, but also the origin of the racemes, the latter by indicating each particular category with a capital. Moreover I nearly always gave, with each numeration a short description of the habitus of the pollengrains. In this contribution I think it sufficient to take out of the tables in question those varieties in which I found *in the closed anthers pollengrains, germinated with abnormal pollen-tubes, in which lay several nuclei.* At the same time I mention the other numerations, bearing on the same varieties, but in which no pollengrains with abnormal tubes were found. Because NĚMEC (1898), as I said before, observed before me in the pollen of double-flowered hyacinths the same phenomenon, shall henceforth indicate it, in his honour, by the name: "NĚMEC's phenomenon". In so far as I have fixed the number of chromosomes of the varieties named below, I shall mention this.

A. Single-flowered varieties.

Charles Dickens, single-flowered red.

1. The upper flowers of the raceme are much smaller than the others and have green points at the lobes of the corolla. The pollen of these flowers show NĚMEC's phenomenon. The pollengrains in the lower flowers of the raceme are normally formed, 21 °/₀ are sterile. The pollen of the upper flowers disperse at once in a drop of water; of the lower flowers it sticks together.

2. All flowers contain normal pollengrains, 27 °/₀ of which are sterile. The pollen sticks together.

Général Pélissier, single-flowered red, 16 chromosomes.

1. The upper flowers of the raceme, are small and green coloured, show NĚMEC's phenomenon. The other flowers contain normal pollen, 14 °/₀ of which is sterile.

2. Ibid. The stickiness of the pollen is as in *Charles Dickens.*

3. The sterility amounts to 6 °/₀.

Lady Derby, single-flowered red, 24 chromosomes.

1. The pollen in all flowers of different racemes gives the same impression. The flowerbuds are still quite green and closed. The pollengrains do not stick together. Only a few sterile grains are present. They at once swell very strongly. In most of the pollengrains many starchgrains are present, which are often very large. There occur pollengrains showing NĚMEC's phenomenon. The various nuclei are clearly visible.

2. The pollengrains only swell after a long time; 4 °/₀ are sterile.

3. The sterility is 3½ °/₀.

4. The racemes originate from water-cultures: the sterility is 6 °/₀.

5. The pollen is sterile for 4 °/₀.

Moreno, single-flowered red.

1. The anthers are shrivelled and discoloured and contain very few pollengrains. These do not swell in water. They have a turbid content. Further there are large globe-shaped pollengrains present which soon burst. The preparation is then full of loose starchgrains. Several normally formed pollengrains show NĚMEC's phenomenon. In some normal non-swelling pollengrains 2 globe-shaped nuclei of equal size are clearly visible. I do not find *one* normal fertile grain. Some starchgrains are as large as a small pollengrain.

2. The colour of the flower is orange-red. The dark streak that runs over the middle of the lobes of the corolla is clearly outlined. The sterility is 24 °/₀.

3. The colour of the flower is rose-red. The dark streak is dimly

outlined. The sterility amounts to 40%. (The bulbs of these flowers and those of the former had been subjected to high temperatures).

4. The pollengrains stick together. They swell very soon; 11% are sterile.

5. Like 4, but 15% are sterile.

6. The pollengrains are taken from the flowers of bulbs that have not been planted. The flowers lay shrivelled up in the bulb. The pollengrains are slightly smaller than usual for the rest they look quite normal; 13% are sterile.

7. The pollengrains are taken from a budvariety-in-colour of *Moreno*. The colour of the flower has become dark red from rose-red; 59% of the pollengrains were sterile in the only raceme I had at my disposal.

8. The pollen is not sticky, the sterile pollengrains are ellipsoidical, triangular or globe-shaped; the sterility is 40%.

9. The sterility is 8%.

10. The sterility is 35%.

Nimrod, single-flowered red, 19 chromosomes.

1. The anthers are shrivelled and give the same impression as those of the variety *Moreno* of the same grower (c.f. 1). The pollen does not stick together. I do not find *one* fertile grain. The sterile ones are elleptic, round or triangular.

2. The flowers are taken from a lot that blooms very early. The anthers are badly developed. The pollen shows beautifully NĚMEC's phenomenon.

3. The flowers are taken from a lot that blooms late, coming from the same grower as those under 2. They are not yet open. The pollen shows, as in 2, NĚMEC's phenomenon.

4. All pollengrains, fertile as well as sterile, are normally formed; 26% are sterile.

5. The flowers are taken from a lot that blooms early. The bulbs have been planted medio October, and on April 4th 1919, the date when I cut the racemes, they have long roots. The anthers are normally formed, not shrivelled. The pollengrains at once swell in water, but they are sticky. Among the fertily pollengrains these are some that contain a more or less wide zone of water round a rounded mass of protoplasm. Some pollengrains have developed a short, wide pollen-tube; 36% are sterile.

6. The flowers are taken from a late-flowering lot of the same grower. The bulbs were planted on November 7th, and on April 5th the gemma rises only 2 cm. above the ground. The roots of the bulbs are still very short. The sterile pollengrains are all ellipsoidical, not triangular. Some fertile pollengrains of a normal size contain starchgrains. I find some large globe-shaped pollengrains, full of starchgrains; 29% are sterile. I perform many more enumerations in pollen of flowers from other racemes, out of this same lot. I always find the same phenomenon and a sterility, from 29 to 30%.

7. As in 6.

8. The pollen is not sticky. The nuclei are clearly visible. The sterile pollengrains are all ellipsoidical. In the preparations float some starchgrains, 66% are sterile.

City of Haarlem, single-flowered yellow, 23 chromosomes.

1. The pollen is not sticky. The anthers are large and normally developed, but they contain hardly any pollengrains. The few there are, nearly all have abnormal pollen-tubes with several nuclei or they are large, globe-shaped and filled with starchgrains. I examine several racemes. Always the phenomenon is the same.

King of the Yellows, single-flowered yellow.

1. I examine the pollen in the anthers of green buds. Everywhere the pollen shows NĚMEC's phenomenon.

2. All pollengrains are normally formed. Only 2% are sterile.

Yellow Hammer, single-flowered yellow, 16 chromosomes.

1. The pollengrains are all normal; $17\frac{1}{2}$% are sterile.

2. Id. 14% are sterile.

3. The pollen is sticky; some pollengrains have a wide, abnormal pollen-tube; 87% are sterile.

4. The pollen is not sticky. The various preparations never show a normal fertile pollengrain. The pollen shows perfectly NĚMEC's phenomenon.

5. I examine the pollen in all flowers of *one* raceme.

Undermost flower: the anthers contain only few pollengrains, which are all sterile.

Next flower: there are sterile pollengrains, others with abnormal pollen tubes and others again that are large and globe-shaped, full of starchgrains.

Next flower: pollen as in the preceding flower; besides there are triangular, sterile pollengrains, while the 2 former flowers had only ellipsoidical sterile ones.

Next flower: pollen as in the former, but besides some fertile pollengrains present.

Next flower: as in the former, but more fertile pollengrains present, i.e. $27\frac{1}{2}$%.

Next flower: as in the former, but the fertility is $35\frac{1}{2}$%.

So if we compare the pollen of the various flowers, going from below to the top, we observe a gradual transition from pollen which is sterile or which shows Němec's phenomenon, to pollen which consists of normally formed sterile and fertile pollengrains.

6. The examination again refers to all flowers of *one* raceme.

Undermost flower: very few normal, fertile pollengrains. For the rest: Němec's phenomenon. The anthers are shrivelled and contain only little pollen.

Next flower: like the preceding one; in the abnormal pollen-tubes more than 3 nuclei are clearly visible.

Next 12 flowers: the number of normal fertile pollengrains preponderate.

7. The pollen is not sticky, but it gives a normal impression; 36 °/₀ are sterile.

8. Besides normally formed fertile and sterile pollengrains there occur large, globe-shaped ones and others, of normal size, full of starchgrains; 15 °/₀ are sterile.

Marchioness of Lorne, single-flowered orange, 16 chromosomes.

1. In the great number of preparations only sterile pollengrains occur and others that have developed abnormal pollen-tubes.

2. More than 90 °/₀ of the pollengrains are sterile.

3. Id.

B. Double-flowered varieties.

La Virginité, double flowered white.

1. In a drop of water the pollengrains burst very soon. The grey colour they show in their protoplasm, has then disappeared and the empty, bright yellow coloured exines, on which the wartlike protuberances are clearly visible, are left. I make some preparations and leave the pollengrains in water for half a minute. If I look at them then, it appears that some grains have germinated with an abnormal, wide pollen-tube. The protoplasm is now entirely in the pollen-tube and encloses several nuclei.

Noble par Mérite, double-flowered red.

1. The flowers are doubled to such an extent that I find only few pollengrains. 18 °/₀ of these are sterile.

2. The sterility is difficult to make out, because most of the pollengrains are in a transition-stage from fertile to sterile.

3. Most of the pollengrains are sterile. In the fertile ones 2 nuclei are clearly visible. I observe almost exclusively pollengrains that stick together in groups of four. These tetrads consist generally of 1 fertile and 3 sterile pollengrains or of 4 sterils ones. The sterile ones are fullgrown. Among the sterile as well as among the fertile ones I observe some that are filled with starchgrains. There also occur pollengrains with abnormal pollentubes. Not in all anthers I find germinated pollengrains. The sterility amounts to at least 50 °/₀.

Bloksberg, double-flowered blue.

1. I examine the anthers out of a green bud. The pollen is not sticky and clearly shows Němec's phenomenon. *Van Speijk*, double-flowered blue, 21 chromosomes.

1. The anthers of a green bud are examined. The preparations are entirely in accordance with the drawings Němec has made of the abnormal pollen-tubes with many nuclei, of the large globe-shaped pollengrains full of starch and of the sterile pollengrains.

2. The petaloid anthers contain little pollen, but this normal; 25°/₀ is sterile.

To this I join a table, which renders, in a surveyable form, the content af the descriptions. Under the figures 1° — 10° the result of the numeration is indicated for every variety, in accordance with what stood behind the same figure in the descriptions. These figures indicate the percentages of sterility; by the letter *n* Němec's phenomenon is indicated. The capital letter in parenthesis shows the origin of the raceme from which the pollen was taken.

Further I put the number of chromosomen occuring in the somatic cells, behind the varieties of which I know this number.

The principal conclusions down from the preceding examinations, with a view to the purpose of this publication, are the following:

1°. The pollengrains in *normally formed anthers,* as well as those in *petaloid anthers,* may germinate with abnormal pollentubes with several nuclei. So Němec's opinion that this phenomenon should only occur in double flowers, is inaccurate.

2°. The phenomenon has nothing to do either with the quaestion of the hyacinth-varieties being heteroploid or not. It may be observed in diploids as well as in heteroploids.

3. From the fact that in one and the same raceme or in different racemes of the same variety we now find quite normal pollengrains, now pollen showing Němec's phenomenon, we may infer that the abnormally germinated pollengrains with several nuclei are caused by *external* and not by *internal* influences.

After a more superficial examination one would possibly be inclined to ascribe this kind of deviations simply to *under-* or *overfeeding,* causes that are also so often named to explain the abnormal increase of the number of chromosomes. Němec thought that as the cause of the existence of the abnormal pollentubes with several nuclei was to be considered the *overfeeding* of the petaloid anthers. The finding

Name of the variety.	Number of chromosomes.	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°
A. Single-flowered varieties.											
Charles Dickens		n+21 (C.)	27 (E.)								
Général Pélissier	16	n+14 (C.)	n+14 (C.)								
Lady Derby	24	n (C.)	4 (G.)	$3^1/_2$ (D.)	6 (D.)	4 (D.)					
Moreno		n (B.)	24 (D.)	40 (D.)	11 (G.)	15 (G.)	13	59	48 (A.)	8 (B.)	35 (B.)
Nimrod	19	n (B.)	n (C.)	n (C.)	26 (D.)	n+36 (H.)	29 (H.)	29 (H.)	66 (K.)		
City of Haarlem	23	n (C.)									
King of the Yellows		n (C.)	2 (D.)								
Yellow Hammer	16	$17^1/_2$ (A.)	14 (A.)	n+87 (B.)	n (B.)	n (B.)	n (B.)	36 (C.)	15 (D.)		
Marchioness of Lorne	16	n (C.)	90 (C.)	90 (E.)							
B. Double-flowered varieties.											
La Virginité		n (D.)									
Noble par Mérite		18 (A.)	? (D.)	n+50 (E.)							
Bloksberg		n (C.)									
Van Speijk	21	n (C.)	25 (E.)								

of the abnormal pollengrains in the uppermost flowers of the racemes of *Charles Dickens* (1°) and *Général Pélissier* (1° and 2°) might be an argument in favour of the fact that *underfeeding* is the cause, as the uppermost flowers are always in a far worse condition than the undermost of the raceme. However, what I have observed in *Yellow Hammer* (5° and 6°) is not in accordance with this. For here the *undermost* flowers of the raceme are developed in the same way as the *uppermost* of *Charles Dickens* and *Général Pélisier* though the same rule holds good here as well, that the undermost flowers are in a better condition with regard to the feeding than the uppermost. So at any rate the causes must be considered to be of a more complicated nature; of which presently more.

5°. The abnormal pollen-tubes may developed when the bud is still green. In other cases they do not develop until the flowering-time has set in.

6°. From the descriptions given, as well as from the large tables not published here, we may conclude that between the aspect shown by normal pollen, and Němec's phenomenon, there is as it were a gradual transition, manifesting itself as follows:

a. Normal aspect of the pollen; fertile and sterile grains are present; the latter large and elliptic.

b. Besides the large ellipsoidical pollengrains there occur smaller elliptic ones and others that are round or triangular.

c. the sterile pollengrains of various shapes and sizes get the upper hand, which probable indicates and early dying off, partially; besides these there occur large, round pollengrains, filled with starchgrains.

d. Němec's phenomenon complete.

IV. *On the conditions, under which* Němec's *phenomenon may come to exist.*

I may here remind the reader that all the pollen grains examined originated from plants which, on the ground of the various conditions under which they had been cultivated, were classed by me in 13 different categories, from *A* to *M*. That I owe a considerable part of my results to this arrangement, may appear from a glance at the last table. This table shows clearly, that Němec's phenomenon confined itself almost exclusively to the categories *C* and *B*. Of the 20 times that this aspect was found it occured 11 times in *C*, 6 times in *B* and once in *D*, *E*, in *H*. Besides it immediately struck the eye, that the pollen-aspects which showed one of the transitions outlined above of a normal aspect to NĚMEC's phenomenon likewise manifested themselves most in the categories *C* and *B*.

As I had acquainted myself as carefully as possible with the circumstances under which the plants belonging to the 13 categories, had lived, from the moment when the bulbs were dug up in 1918 till the moment when the pollen was examined by me, it was not difficult for me to decide under what conditions of culture hyacinth-varieties are able to produce pollen that exhibits NĚMEC's phenomenon.

It may be considered as a well-known fact, that the growers dig up their hyacinth-bulbs after the leaves have died off, towards the end of June and in July, then lay the bulbs in artificially heated barns to be dried, and plant them again in September. So, for instance the bulbs, — I mention this in outline only — which were classed by me under category *D*, were dug up in 1918 between July 1 and July 25. The barn was heated from August 1 till November 1, during the first weeks to 65° F., afterwards the temperature was allowed to rise to 75° F. Between September 20 and November 1 the bulbs were planted again.

All bulbs which (1) were treated in this way, be it that duration of heating and degree of heating diverged a little, besides others which (2) were housed in barns where there was no heating; (3) were not dug up, so passed the resting-time outside; (4) were not planted or placed upon glasses; (5) were cultivated on glasses; (6) differed in age or size, never produced flowers the pollen of which showed NĚMEC's phenomenon. It was different with those plants which *partially* had suffered what is called "preparation". The bulbs chosen for that purpose, *are dug up in an unripe state*, heated pretty strongly in the barn, and afterwards planted in pots or placed upon glasses. When the bud begins to rise a little above ground, the plant is exposed to a higher temperature a second time, the consequence of which is that the flowers bloom very early. See for this: A. H. BLAAUW: *On the periodicity of Hyacinthus orientalis p.* 51, *Vol. XVIII of the "Communications of the Agricultural University"*, and my publication: *"On the occurrence of heteroploid varieties of Hyacinthus orientalis L. in the Dutch cultures". Arch. Néerl.* 1921 *and Genetica* 1921.

So the bulbs of the variety *Nimrod* (category B) in the flowers of which I first found pollen-grains which showed me NĚMEC's phenomenon, were dug up on June 10th, *the leaves still being a fresh green not showing a trace of dying off*.

They were exposed for 21 days to a temperature varying on an indented line from 90° F. to 78° F.; afterwards till October 26 to

a temperature fluctuating between 70° F. and 60° F. They were not placed in pots, and afterwards not forced to early florescence, but between October 26 and November 1 planted in the open ground outside. In this way all bulbs had been treated which are grouped under category B and developed abnormal pollen-tubes.

Very remarkable was the phenomenon that I observed in the plants belonging to category C. These were all cultivated by the same grower, of whom I examined 25 varieties (19 single-flowered and 6 double-flowered), with which I effected 31 numerations. Of six varieties 2 numerations were noted. These were varieties which had been grown in 2 lots, under different conditions. In 21 of the 31 cases the pollen diverged more from the normal aspect than that of the same varieties classed under all other categories. In 5 cases I could not compare it with that of other categories because for them I had no racemes at my disposal. In the remaining cases it was found in the same condition or in one a little better than that of any other category.

In a very striking manner it now appeared to me that the racemes with pollen showing NĚMEC's *phenomenon or transitions from the normal aspect to* NĚMEC's *phenomenon, always originated from bulbs dug up in an unripe condition, between July 1 and* 15. Immediately after the digging up artificial heating was started, till September 20, from 75° to 80° F.; afterwards till the planting time, which was in October, from 70° to 75° F. The planting was done in the open ground.

My observations have induced me last sommer to purposely subject several hyacinth-bulbs to various exterior influences. From these

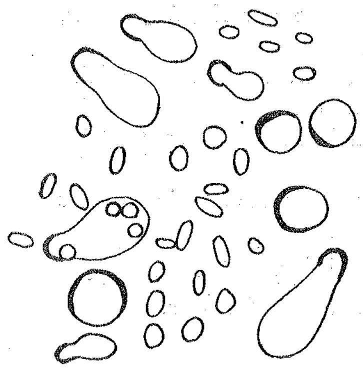

Fig. 1. (Oc. 2, Obj. A. of Zeiss).

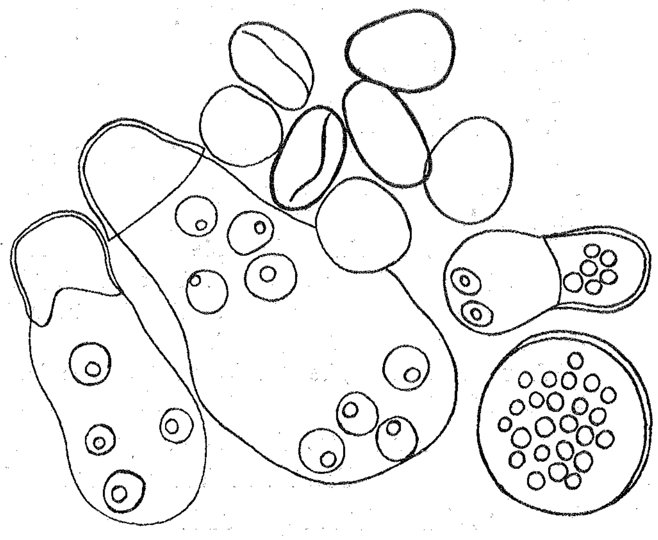

Fig. 2. (Oc. 2, Obj. D. of Zeiss).

experiments it has now, on the 3rd February, become evident to me *that it is possible, to cause the growth of pollen-grains that exhibit* NÊMEC's *phenomenon. To the great importance of deliberately producing pollen-grains with more than one nucleus* — also SAKAMURA (1920, p. 145) by his discovery of several nuclei in the pollen-grains of *Allium Cepa* has come to the opinion that they owe their origin to a modification of the exterior conditions of life — I hope shortly to draw attention.

The diagrams 1 and 2 picture forth the pollen-grains of the variety *Yellow Hammer*, as I found them now in all anthers of the plants which are exposed to the same particular exterior circumstances.

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(Communicated at the meeting of October 30, 1920).

§ 1. *Introduction.*

For organisms which, like the "higher" plants, live as a rule in the (gaseous) atmosphere, the regulation of the gas interchange is an essential point in the organisation. In connection with this the fact must be pointed out, that among the vegetative organs, common to all plants, the only part that is capable of quick response in consequence of its specialised structure, and thus deserves the name of "apparatus", is the very part that has to regulate the gas interchange. This organ is the stoma (Spaltöffnungs*apparat*).

Just as essential as the stomata themselves are for the plant, the study of them is for the plant-physiologist. The finding of methods to get acquainted with the behaviour of stomata by means of experimental researches, has been indeed a subject of constant care in physiology. Much has already been done in this department, but of course there are always improvements to be made and as an attempt in that direction should be regarded the conception of a self-recording type of an existing apparatus treated below.

After the exhaustive discussion, which VAN SLOGTEREN, in the introduction to his dissertation [1]) has devoted to the numerous direct and indirect methods, invented to judge the aperture of stomata — I think it to be superfluous to mention these methods again and I restrict myself to quoting what VAN SLOGTEREN says about the porometer-method of DARWIN and PERTZ and its advantages. [2])

"... it is based on the following principle: a glass chamber is fixed air-tight to a leaf and through a tube connected with this chamber, the air is sucked out, so that the pressure in the chamber is diminished. After the side-tube has been closed, the difference in pressure inside and outside the chamber, can only be annulled, when air is sucked through the leaf. From the time, necessary for making equal the pressure, the degree of aperture of the stomata is judged.

[1]) E v. SLOGTEREN, De gasbeweging door het blad in verband met stomata en intercellulaire ruimten. Groningen 1917, p. 1–13.

[2]) l.c., p. 14.