On the origin of number and arrangement of the places of exit on the surface of pollen-grains
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ments can be inferred view, that number and in pollen-grains necessi-
ty a maximum of areas surface of the grains. The rea
reason I have recorded with the forms
\textit{Alnus} and \textit{Impatiens}. 
omenon which is rather there exists no clearly 
then the grains, which 
size lies just between 
of \textit{Alnus} this would be 
this is indeed the case 
of a single much larger 
\textit{Sultani} represents a 
are formed according 
more of these places of 
developed. This appears in 
variation. Neither \textit{Alnus} 
difficulties to the above 
mentioned which I can not 
The first case are the 
more or less spirally 
\textit{Iris}, \textit{Thunbergia fragrans}, 
s shows a phenomena 
of a few \textit{Ranunculaceae}. 
may show three meridian 
 occurs grains varying in 
early converging grooves, 
and grains with 6 grooves 
expressed differently 
from. This corresponds 
but there also occur 
forms, in which the variation leaps from 3 to 6, without 
observing grains possessing the intermediate number of 
four places of exit.

In connection with the facts accumulated in this publi-
cation, I think I can bring forward some arguments in 
favour of the following view. When in pollen-grains there 
exists a tendency to form places of exit over the whole 
surface or over part of it, the arrangement respectively 
the symmetry and the number follow necessarily from 
the arrangement of a maximum of areas in that part of the 
surface where the formation is possible.

This research was made during the years 1928—1929 
in the Botanical Laboratory of the State University of 
Groningen. I am much indebted to Prof. Dr. J. C. 
Schoute for his suggestions and criticisms.

\textbf{SUMMARY AND CONCLUSIONS.}

Three factors appeared to be very suitable for the research 
into the way in which the number and the arrangement 
of the places of exit in pollen-grains is brought about; 
they are: 1°, the simple form usually to be reduced to two 
types only, which the pollen possessed when the places 
of exit were formed on the surface. 2°, the fact that pollen- 
grains are pre-eminently suitable for statistical ends. 
3°, the occurrence of variations in number and arrangement 
of the places of exit. 

The variation in number of places of exit was statistically 
traced and a typical correlation appeared to exist between 
the size of the pollen and the number of places of exit, 
in that sense that the diameter of a grain was about ex-
pressed by the following formula. 

\[
\text{Diam.} = (a \text{ to } a + 1) \times V \\
\text{when the number of places of exit lay in one plane or as} \\
\text{meridian grooves and } \\
\text{Diam.} = \left(\sqrt{\frac{a}{a+1}}\right) \times V, \text{when} \\
\text{the places of exit are distributed over the whole surface,} \\
\text{Diam. representing the diameter of the grain, } a \text{ the observed}
\]
number of places of exit, and $V$ a constant for pollen-grains of one species being under equal circumstances.

With polyploidy or abnormal reduction-division a great variation in the number of places of exit can often be observed; in these cases it appears that an increase or decrease in the number of chromosomes runs parallel with variations in the size of the grain and the number of places of exit. Yet a variation in the number of places of exit correlated with the size of the grain can also occur without there being any differences in the number of chromosomes or in genetic constitution, which can be observed in the differences in size which can be found in the pollen of heterostylic plants (among others *Lythrum Salicaria*).

To the arrangement of the places of exit in the pollen, however variable it may be, yet a general rule obtains: that equidistance is observed in which the distance from a place of exit to the nearest places of exit is nearly equal in value.

From the equidistance of the places of exit and from the fact that with the correlation between the size of the pollen and the number of places of exit, a place of exit is not observed to appear before a certain space is cleared for it on the surface, we might infer that the arrangement and the number of places of exit only depends on the closest covering of the space occupied by the places of exit over the entire surface or that part of the grain that allows of formation of places of exit.

If this view is correct, the numbers observed and the arrangement of the places of exit of the pollen-grains will have to nearly correspond with the constructions of point-systems on the sphere drawn up on equal theoretical conditions. It appeared that such constructions not only correspond well with the numbers and arrangement observed in nature, but that moreover from such point-systems we could more or less in nature, and facts observe.

Therefore arguments please arrangement geometry of the arrangement on what this fact suggests. In my opinion it is not previously only consequence a number of
for pollen-grains

-division a great it can often be an increase or runs parallel the number number of places which can be found in others Lythrum

it in the pollen, general rule obtains: the distance from of exit is nearly exit and from the size of the place of exit is space is cleared the arrangement depends on the the places of exit grain that allows observed and the pollen-grains will portions of point theoretical con not only cor- ment observed ment-systems we could more or less infer which numbers would be preferred in nature, and which not, which again tallied with the facts observed.

Therefore I think that I possess in the above some arguments pleading for the view that the number and the arrangement of the places of exit and consequently the symmetry of the pollen-grains arises from the closest possible arrangement of a number of areas on that part of the surface where this formation is possible.

In my opinion, therefore, the symmetry of the pollen is not previously extant in the protoplasm, but arises only consequent on the junction of as great as possible a number of equivalent parts.