

Citation:

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In order to show how decidedly heterogene cell-formation is still considered as impossible, so that it is not superfluous to afford a new evidence for its existence, I refer to the well-known book of O. HERTWIG "Die Zelle und die Gewebe", p. 64 Bd. 2, Ed. 1898, where we read as follows: „Die Theorie der heterogenen Zeugung, wo sie aufgestellt wurde, ist als grober Irthum bald beseitigt worden. So gilt als ein allgemeines Grundgesetz in der Biologie der Ausspruch „Gleiches erzeugt nur Gleiches“ oder besser „Art erzeugt stets seine Art“ Bei allen einzelligen Lebewesen ist erbgleiche Theilung ihres Zellenorganismus die einzige die vorkommt und vorkommen kann. Auf ihr beruht die Constanz der Art. Wenn es möglich wäre, dass bei irgend einem einzelligen Organismus die Erbmasse (Idioplasma) durch Theilung in zwei ungleiche Componenten zerlegt und auf die Tochterzellen ungleich übertragen werden könnte, dann hätten wir den Fall einer heterogenen Zeugung, den Fall der Entstehung zweier neuer Arten aus einer Art. Wie indessen alle Beobachtungen lehren, werden auch bei den Einzelligen die Arteigenschaften so streng und bis ins Kleinste überliefert, dass einzellige Pilze, Algen, Infusoriën auch noch im millionsten Gliede, ihren weit entfernten Vorfahren genau gleichen. Der Theilungsprocess als solcher erscheint daher auch bei den einzelligen Organismen nie und nirgends als Mittel um neue Arten ins Leben zu rufen.“

The preceding pages prove that this view is erroneous, so that the far reaching conclusions, drawn from it in relation to ontogeny vanish at the same time.

So far there is thus no reason in contradiction with observation, which forbids admitting, that the ontogeny of the higher organisms consists in a regular course of variation processes, and that full-grown plants and animals are built up of as many cell-variants of the embryonal cells, as they contain different tissues composed of identic cells.

Botanics. -- "*On the development of Buds and Bud-variations in Cytisus adami*". By Prof. M. W. BEIJERINCK.

Cytisus adami is a hybrid between the common laburnum, *Cytisus laburnum*, and a little shrub from Styria, *Cytisus purpureus*, with purple flowers. Now and then are found on *Cytisus adami* buds

of both species as bud-variants¹⁾. The experience that these buds appear in particular on older parts, and have, probably without exception, passed one or more years in dormant condition before budding and changing into the primitive forms²⁾, induced me to cut down all the branches and the main stem of four specimens of *C. adami* in order in this way to excite the development of the very old buds which were, since years, in dormant condition on the old trunk. My expectation, that by these means I should obtain a great number of bud-variants, proved right: in few years I saw, together with earlier observations, appear more than a hundred buds of *laburnum* and about twenty of *purpureus*. I was thereby enabled to establish a few particularities about buds and bud-variations which follow here:

1. The ordinary axillary buds of *Cytisus adami* spring not from single cells but from cell-groups. They grow on by means of a pluricellular meristem, and not by means of one terminal cell. The latter fact was long known already and is here anew confirmed.

2. The bud-variants, also, originate from cell-groups and not from single cells, so that the cause which is active here in producing variability, must extend over many cells at a time.

That this cause is in some or other way related to unfavorable conditions of nutrition cannot be doubted.

Of course the possibility is not excluded that for *C. adami* buds and bud-variants can spring from single cells. I think this even probable as regards some of the many buds which develop from the "bud-crown"³⁾. Herewith is meant the sheath of vigorously vegetating cambium-cells which is found in the callus and the bark, just in the prolongation of the procambium- or cambium-cells of truncated or thrown off buds or branches, which sheath is an active centrum for the originating of new buds. For the rest, it is not the springing forth of a bud or new individual from a single cell which is remarkable, but the fact that this can take place from an already constituted cell-group. That this really occurs, and also, that a meristem

1) The word "variant" is here used in a sense somewhat different from that in the preceding paper on the variants of microbes, "component" might perhaps be more precise in this case. But I keep to the usage, as the meaning is clear.

2) This does not hold good for the flowers, which have no dormant period but constantly develop in the 2^d year, and of which the different parts are still more subject to return to the components than the vegetative buds. But the flower may, even unreckoned the process of fertilisation, be called the organ of variability.

3) Translated from the German "Knospenkronne".

constituted of many cells may be subject to the process of variation, is proved by the following observations.

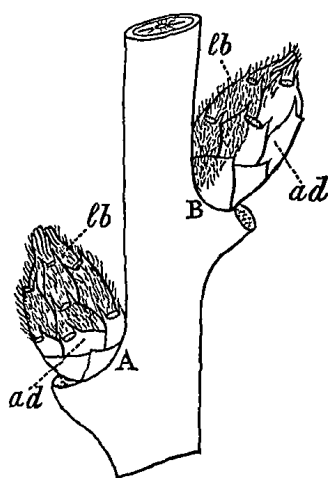


Fig. 1.

Two *laburnum* bud-variants on a branch of *Cytisus adami*; the lower bud *A* bears at its base *adami* bud-scales, but is in the higher portion pure *laburnum*; the upper bud *B* is precisely for one half *adami*, for the other *laburnum*.

At about ninety *laburnum*-buds which had developed as variants, nothing particular was to be seen, but at eight or nine were found at the base a greater or smaller number of bud-scales which could with certainty be recognised as bud-scales of *adami* (*ad* Fig. 1 A).

This observation is easy and convincing, as all parts of *laburnum*, hence the bud-scales too, are covered with silverwhite hairs, especially at the under- or back-side, while the full-grown portions of *adami* are always devoid of hairs. In all the cases, which I examined more minutely, the line of demarcation between the *adami*- and *laburnum*-portion ran in an oblique direction, so that the whole meristem belonged evidently to *laburnum*. This was constantly confirmed by the experience at the budding, as always pure *laburnum*-shoots grew from these buds.

In 1898 an extraordinarily great number of *laburnum*-variants were formed on my *adami*-trees. In consequence of the early pruning all the buds were situated low enough to be easily examined with the magnifying-glass. Two of them presented themselves as in Fig. 1 B. The line of demarcation went precisely over the middle of the bud-scales and not obliquely as in the eight cases above. The supposition that the said demarcation would also continue precisely over the middle of the meristem, proved right at the budding, for both the branches which sprung from these buds in 1899, were exactly for one half, lengthwise, *adami*, for the other half *laburnum*.

One of these "mixed branches" has attained a length of about 1 Metre, and produced more than 30 leaves with axillary lateral buds, of which about 15 belonged to *laburnum*, the other 15 to *adami*. At its extremity was in the autumn of 1899 an open "summer-bud", still for one half *adami*, for the other half *laburnum*; this summer-bud was not closed with bud-scales, and died in the winter of 1899—1900.

The second branch has become about $\frac{1}{2}$ M. long, and bore more

than 12 leaves with axillary buds, again belonging for one half to *laburnum*, for the other to *adami*. In the autumn of 1899 a closed „winter-bud” with bud-scales was formed at the extremity. Though the line of demarcation seemed also to go over the middle of this terminal bud, a *laburnum*-branch developed from it in the summer of 1900, which only at the base bore some *adami*-leaves, so that the separation within the bud must have run obliquely and divided the meristem into a larger *laburnum*- and a smaller *adami*-portion.

This description proves that the two halves of the „mixed branches” have each grown from an independent half of the meristem, which half cannot consist of less than one cell, so that the continued growing of the branches with one terminal cell is out of question, accordingly it is certain that the branches of *Cytisus adami* grow with at least 2, and probably many more meristem cells.

The two separating lines between *laburnum* and *adami*-which are seen over the full length of the „mixed branches”, easily discernible on the bark as the confines between a portion set with hairs and another without, ran in 1899 for the greater part of course between the leaves, but in some places also through the leaves themselves. Some of these „mixed leaves” were situated exactly for one half on the *laburnum*- for the other on the *adami*-portion of the branch. In this case the trifoliate leaf was as exactly for one half an *adami*- and for the other a *laburnum*-leaf, and over the whole length of the petiole and the midrib of the terminal leaflet the line of demarcation was distinctly discernible. This would, if necessary, be sufficient to prove that also each leaf takes birth from at least two, and probably more meristem cells. But the pluricellular origin of the leaves of the higher plants has, so far as I know, never been called in question, though this has been the case concerning the origin of the lateral buds.

So, it was of importance to establish whether the axillary buds of these „mixed leaves”, exactly placed on the confine, would likewise produce „mixed branches”, by which the question would be answered if one bud might spring forth from two or more cells at a time. The answer was not dubious: all the buds, placed in the axils of the leaves, which were for one half *laburnum*, for the other *adami*, produced, in the summer of 1900, as well *laburnum*- as *adami*-leaves, and in this case, too, some leaves again were mixed, namely partly *adami*- partly *laburnum*-leaves.

In most cases the line of demarcation went very obliquely through the “mixed buds” of this second generation, so that the whole meristem early in the year consisted of only *adami* or only

laburnum. In one of these buds however the boundary line went precisely through the middle, but this bud contained an inflorescence of which the summit had died off in the winter of 1899—1900. At the base were however pure *laburnum*- and pure *adami*-flowers, and one flower was precisely for one half *laburnum*, for the other *adami*, so that also flowers evidently spring not from one cell, but from a cell-group.

The preceding description proves that in the springing forth of the *laburnum*-variant from *Cytisus adami*, as well a whole meristem may be concerned as half of it, and that the cause which gives rise to the appearance of a bud-variant is active when the meristem is completely formed, and not in the far-back moment when the cell-group, which later manifests itself as a meristem, was still a single cell. For if this were the case it could not be possible that a portion of the bud, which produces the variant, continued to belong to *C. adami* itself.

Hence it follows that the bud-variant is not produced by variation of a single cell but by that of a cell-group.



FIG. 2.

One year's *purpureus*, *ps*, sprung as a bud-variant, from a dormant *adami*-bud, at the extremity of a "short-shoot" *ad*. On the left a "long-shoot" of *adami*, at the extremity of a "short-shoot",

To show that also the *purpureus*-variant is produced by the variation of an already constituted *adami*-meristem, and not of a single cell, far-back in the evolution of that meristem, I refer to Fig. 2.

Here we see a one year's *purpureus*-shrub (*ps*) placed at the extremity of a "short-shoot" of *Cytisus adami*¹⁾. Commonly the *purpureus*-variants, quite like those of *laburnum*, spring from common buds, whence the exact moment of their birth is not clear. But the peculiarity of the case figured here is that the "short-shoot", terminating in *purpureus*, had already grown for a number of years as *adami*, and that consequently it is not possible to doubt, that *purpureus* has come forth from the whole *adami*-meristem. As this meristem is pluricellular, the cause, which led to produce the *purpureus*-variant, must thus also have affected a cell-group and not have been confined to a single cell.

In a few cases the *purpureus*-bud was not found alone, but also some *adami*-buds of the nearest surrounding were changed into *purpureus*. So, this summer, in my garden, of six quite independent, dormant, three years' buds at the summit of a "long shoot" of *Cytisus adami*, separated from each other by relatively short internodes of the long-shoot, no less than four are changed into *purpureus*, and besides, the two unchanged *adami*-buds are placed between the higher and lower situated *purpureus* branchlets. Accordingly the influence which caused the variation must have been active simultaneously in four meristems, the distances between which, at the time of the variation, must certainly have amounted to some tenth parts of millimeters.

Herewith I think to have made good the two statements expressed at the beginning of this paper, and I only wish to add that already before, but at quite another occasion (*Cécidiogénèse du Cynips calicis*. Archives Néerlandaises, Sér 2, T. 2, 1897, pag. 436), I came to the opinion that variability, though habitually going out from a single cell, is not necessarily always bound to it, but sometimes has a cell-group as starting point, so that there can be question of uni- and pluri-cellular variability.

The relatively great number of bud-variants of *adami*, which I have examined, consisted, as usually, only of pure *laburnum*- and pure *purpureus*-branches. Hybrids, in which both factors occur, but one preponderant as compared to its part in *adami*, seem never to be produced. Still I believe that in the cell-layers of the bud-

¹⁾ A "short-shoot" consists of a closely crowded succession of nodes, between which the internodes are not developed; they grow very slowly and point to unfavorable conditions of nutrition.

meristem, which form the separation between *adami* and one of the variants, there must occur transitory cells, which, could they be independently developed and cultivated into new individuals, would produce such derivated hybrids. Perhaps the "supplanting" of these transitory cells by the completely varied cells, may be compared to the rarity (discussed in the preceding paper on the variants of microbes) of the sub-variants as compared to the normal form and the main variants, by which it seems possible to explain, on the one hand the existence of distinctly marked bounds between the species, on the other hand, the not less marked bounds between the different organs and tissues of the higher organisms.

Physiology. — "*On the permeability of the red bloodcorpuscles for NO_3^- and SO_4^- ions*". By Dr. H. J. HAMBURGER.

The question whether cells are permeable for certain substances and if so, to what extent, is not only important for our knowledge about metabolic and other vital processes, but is also of great importance from a pharmacological point of view. Here again the red bloodcorpuscles are found to be the favourable test-objects to study this question accurately. It is only natural that these cells are in this case equally serviceable as in many other problems of a general scope. In the first place they are met with in the isolated condition (in contrast with most other cells) and they can therefore be procured without being injured; in the second place the influence of different agencies can in them be better traced than in other cells, thanks to their change of form and dimension as well as to the extrusion of red colouring matter, and in the third place the reciprocal influence between the contents of the cell and its natural surroundings can be studied in detail by chemical analysis.

It is through the study of the laws of the isotonic coefficients (HUGO DE VRIES) of the red blood-corpuscles that the problem of permeability was first brought into the foreground ¹⁾.

I will not here enlarge on what has hitherto been investigated and written on this subject. I only wish to point out that it has been agreed that there are: 1°. substances which penetrate through the bloodcorpuscles and destroy them (for instance NH_4Cl); 2° sub-

¹⁾ HAMBURGER, De permeabiliteit der roode bloedlichaampjes in verband met de isotonische coëfficiënten. Versl. en Meded. d. Kon. Akad. v. Wetensch., 1890, bl. 15.