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Autor: Paclt, Jii

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Synopsis of the genus Catalpa (Bignoniaceae) II[1]

Chapters on physiology and biochemistry

by

Jiří Paclt, Bratislava, Czechoslovakia

1. Growth

The influence of certain physical factors and chemicals on the germination of *Catalpa* has been studied by Montemartini (1914), who used seeds of two *Catalpa* species. According to this author, ether and chloroform, as well as increasing gravity have a stimulating effect on the germination of *Catalpa.* In addition, one seed was observed by Montemartini which contained two embryos.

The stimulation of the growth of *Catalpa* planted in association with black locust *(Robinia pseudo-acacia),* has been treated by Ferguson (1922) and McIntyre and Jeffries (1932). However, it appears to have been W. F. Cook (cp. Garman, 1912, p. 209), who first drew attention to that effect. The black locust increases soil fertility through the nitrifying bacteria of the root nodules. On the other hand, it is well known to European botanists, how many herbs, with the possible exception of *Leguminosae,* are destroyed when growing in the neighbourhood of *Robinia.*

2. Movements

The phenomenon of thigmonasty in the stigmatic lobes of *Catalpa* was observed by authors in the second half of the last century; e.g., Clos (1869), Heckel (1874) and Meehan (1874). Because of the presence of only one vascular cylinder in the stigmata, the movements, being due to a change in turgescence, are relatively shortlived (c. 60 seconds per reaction). They are characterized by the approach and then the separation of the lobes of the stigma.

3. Chemical Substances

a) Inorganic Constituents

An analysis of the leaf of *Catalpa speciosa* shows (McHargue and Roy, 1932) :

[1] The main part, Part I, dealing with morphology and taxonomy, appears in « Blumea » (1951).

Weight of dry substance used for the analysis

. . . .	1000,0 gm	Mg	5,1 gm
N	24,7 gm	Fe	0,56 gm
Ash	73,0 gm	P	3,1 gm
K	14,5 gm	S	2,2 gm
Na	1,2 gm	Si	3,9 gm
Ca	18,5 gm	Mn	0,1 gm

b) Organic Constituents

Sardo (1884) described in his paper a new acid, catalpic acid. The substance, however, was later proven to be nonhomogenous by Piutti and Comanducci (1902). According to these authors it comprises a mixture of two acids, namely: the *p*-oxybenzoic [I] and *p*-oxybenzoic + protocatechuic acids [II].

$$(OH)\ C_6H_4\ CO_2H\ (4,1) \qquad [I]$$

$$(OH)\ C_6H_4\ CO_2H\ (4,1) + (OH_2)\ C_6H_3\ CO_2H\ (1, 2, 4) + 2H_2O \qquad [II]$$

These acids may arise chemically by hydrolysis of the heteroside catalposide (the "catalpin" of Claassen), which was first described in 1888. They represent, no doubt, the principal constituents of the aglycone of that heteroside. In addition, Plouvier (1947) discovered another heteroside which he called catalpinoside.

The components above mentioned occur more or less specifically in certain parts of *Catalpa.* There exist, however, a number of constituents which cannot be considered as specific in regard to *Catalpa.* According to Hiramoto and Watanabe (1939), these are sitosterol, *p*-coumaric acid and isoferulic acid and, according to Chollet (1946 a), stachyose.

It may be of further interest to note that no antibiotic principle has been found in *Catalpa* (Cannizzaro, 1946). On the other hand, it may be mentioned, that *Catalpa,* containing catalposide in various parts, shows some therapeutic characteristics such as the tonic, stimulating, antipyretic and diuretic properties, which were ascribed to it long ago by some of the earlier authors; e.g., Thunberg (1784), Descourtilz (1833) and Nuttall (1855). Whether tannin may occur in the bark of *Catalpa,* especially *C. longissima,* has yet to be determined.

Another phenomenon is the toxicity of the pollen of *Catalpa.* Bureau (1894) questioned this as he wrote: « D'après Nuttall [1855], le miel recueilli sur les fleurs de ce *Catalpa [C. bignonioides]* serait vénéneux. C'est peu probable. » Now, it is well known that the pollen of *Catalpa* can cause allergic hay fever. Swineford and Pipes tested 87 patients, who exhibited their major symptoms during April or May, with *Catalpa* pollen extract. Of these, 64 were negative, 13 reacted "weakly but definitely", and 10 had strongly positive reactions (S w i n e f o r d , 1940). The *dermatitis venenata* of W h i t e (1887) was also described as being due to *Catalpa* pollen.

c) Anthocyanins and other Pigments

As is known, the anthocyanins are chemically related to the heterosides. They may have their origin in the oxidized chromogens which probably arise from the latter :

$$\text{Heteroside} + H_2O \text{ (hydr.)} + \text{Hydrolase} \rightarrow$$
$$\rightarrow \text{Chromogen} + \text{Monosaccharide (6)} + \text{Energy}$$

Since the chromogens and anthocyanins are easily oxidized and reduced, respectively, they may both act as oxygen carriers in the life of the plant. The oxidation of chromogens, is often due to an injury, resulting in an increased penetration of oxygen into the plant tissues. It was C o m b e s (1912) who experimented in this connection with *Catalpa bignonioides.* According to his observations, the petioles of that species become reddish beyond the trauma, but the respective blades do not. However, it must be noted that this is only a special case of the reaction which, generally, results in the typical change in colour of the leaves when the plant is injured.

The anthocyanins may also occur in apparently undamaged specimens. According to my observations, these pigments are often abundant in the young leaves of *Catalpa ovata, C. ovata* × *C. bignonioides,* and are present sometimes also in those of *C. bignonioides.* On reaching maturity, such leaves lose anthocyanins. It seems that the red colouring matter serves to make the energy from sunlight available to the immature leaves, as a result of which their internal temperature may rise by several degrees.

There exists a horticultural form, *C. erubescens* f. *purpurea,* the leaves of which conserve their dark purple colouration during a much longer period of development than those of typical forms of the species.

In order to determine the group of the colouring matters of flowers of *Catalpa,* I tested both the purple and yellow (orange) pigments occurring in the corolla tube, with the conclusion that the former belong to the anthocyanins, and the latter to the carotinoids.

4. Metabolism

The excess of sugars usually existing in leaves when anthocyanins are abundant may favour the metabolism of the respective plant. Also, in *Catalpa,* it is known that the form with anthocyanins *(C. erubescens* f. *purpurea),* exhibits higher values in assimilation than the normally green forms (P l e s t e r , 1912). On the other hand, the value of assimilation of the yellow-leaved ("chlorina-blättrig") *C. bignonioides* f. *aurea* was estimated to be about one half of that of *C. ovata*. However, it is impossible to interpret these data properly, since the process of respiration was disregarded in Plester's experiments.

5. Biophysical Data

The osmotic pressure (P) of the cell sap of leaves of *Catalpa* (collected August 30th (was measured cryoscopically by Dixon (cp. Grafe, 1925):

C. bignonioides . . $\triangle = 1{,}905$; $P = 22{,}92$ atm.
C. speciosa . . . $\triangle = 1{,}724$; $P = 20{,}73$ atm.

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