# DEVELOPMENT OF APHIDINEA VECTOR OF VIROSES BY THE SEED POTATO WITHIN THE AGRO-ECO SYSTEM

# DEZVOLTAREA AFIDELOR VECTOARE DE VIROZE LA CARTOFUL PENTRU SĂMÂNȚĂ ÎN CADRUL AGROECOSISTEMULUI

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***Abstract:*** *Plants and animals associated in biocenosis live within the biotope and develop directly influenced by effective or useful temperatures. The speed with which biochemical processes are carried out ($t_n$-$t_o$) is dependent on the air temperature ($t_n$) and is limited by the biological threshold ($t_o$). Between reaction speed of biochemical processes characteristic of each species and temperature (processes underlying growth, development and multiplication of species) there is a close correlation, which allowed the formulation of mathematical equations very different from one species to another. Among these, the thermal constant equation can contribute fully to explain the processes of growth, development, propagation, biological spreading of species.*

***Rezumat:*** *Plantele şi animalele asociate în biocenoze trăiesc-viețuiesc în cadrul biotopului şi se dezvoltă influențate direct de temperaturile efective sau utile. Viteza cu care se desfăşoară procesele biochimice ($t_n$-$t_o$) este dependentă de temperatura aerului ($t_n$) şi este limitată de pragul biologic ($t_o$). Între viteza de reacție a proceselor biochimice caracteristice fiecărei specii şi temperaturi (procesele care stau la baza creşterii, dezvoltării şi înmulțirii speciilor) există o strânsă corelație, care a permis formularea unor ecuații matematice foarte diferite de la o specie la alta. Dintre acestea, ecuația constantei termice poate contribui din plin la explicarea proceselor de creştere, dezvoltare, înmulțire, răspândire biologică a speciilor.*

***Keywords***: *potato, seed, potentially productive, aphide, development, biological propagation*
***Cuvinte cheie***: *cartof, sămânță, potențial productiv, afide, dezvoltare, răspândire biologică*

## INTRODUCTION

**The thermal constant equation** has been developed since 1914 by BLUNCK (1914, 1923) and was developed and completed in Romania by A. SĂVESCU during 1955-1976 (SĂVESCU, 1972) and by SĂVESCU and RAFAILĂ (1978).

BLUNCK (1914, 1923) has developed the equation of **thermal constant** (K), which he defines as the product between the time of development ($X_n$) and the effective temperature ($t_n$-$t_0$), which is the same regardless on the place of experimentation:

$$K = X_n(t_n - t_o) \qquad \text{(A)}$$

Starting from accurate experimental measurements, using the equation (A) one can mathematically model: the **biological lower threshold** ($t_o$) specific to species and the thermal constant (K). The thermal constant equation may be represented by an equilateral hyperbola.

## MATERIALS AND METHODS

Based on the thermal equation for each species of Aphids were determined:
- The threshold of the prolific (O); the optimum thermal threshold ($O_1$);
- The higher thermal threshold (T); the constant of regression line (C);
- The tropics constant (X); the multiplication equation ($\gamma$)

The multiplication equation is:

$$\gamma = \frac{X(t_n - t_o}{K} \qquad \text{(B)}$$

The calculation of development constants is based on the constant equation of development (A).

The equation's analysis (1) shows that the three elements K, $x_n$ and $t_n$-$t_o$ meet the physical basic notions of space (S), time (T) and speed (V). The physical equation S = T * V corresponds in this particular case to:

$K = x_n (t_n - t_o)$ set by BLUNCK (1914, 1923), equation in which:

K = biological space

$x_n$ = biological time;

$t_n$-$t_o$ = speed of development

According to this equation, the *biological space* is the three-dimensional size of bodies and their prolificacies, the *biological time* is defined as the duration of development of a stage or of a generation, both varying in terms of *biological motion's speed* (the reaction speed of internal processes which lead to the speed of growth and development).

**The thermal constant equation** allows by derivation the calculation of **lower biological threshold (**$t_o$**)** and **thermal constant (K).**

**The conditions for development of complex species *Aphis frangulae* Kalt and *Aphis nasturtii* Kalt during the experimental cycle:**

The presented algorithm for calculation features the following constants for complex species: *Aphis frangulae* Kalt and *Aphis nasturtii* Kalt.

l. The equation for development; 13 (14- $t_0$) = 7 (22.8- $t_0$)

2. Biological threshold $t_0$ = 3.7

3. Thermal constant K = 134

4. The prolificacy threshold 0 = 7.1 ° C

5. The threshold of thermal optimum $O_1$ = 13.6 ° C

6. Upper limit of thermal optimum O = 14.7

7. The superior thermal threshold T = 15.3 ° C with $X_n$ = 1.6 days

8. Multiplication constant C - $t_n$ = 10.7 ° C, $x_n$ = 15.2 days

9. Multiplication equation: y = 2.724

10. Time of multiplication: X = 230 days

11. The length of time as winter egg: 135 days

12. The propagation speed (v) directly proportional V = ($t_n$ - 3.7 °)

## RESULTS AND DISCUSSION

Given the conditions in the Sibiu basin, the complex of *Aphis frangulae* Kalt and *Aphis nasturtii* Kalt winters as winter egg on the primary hosts *Rhamnus catharticus L-verigariul* ("spinul cerbului" and *Frangula alnus* Mill (formerly *Rhamnus frangula* L)-the way thorn, shrubs that are commonly found on river valleys in the county, and *Frangula alnus* is found as well in the Păltiniş mountain area.

On the primary hosts mentioned above, after the winter egg hatching occurs the "fundatrix". The average date for occurrence of the "fundatrix" during the study is 12th of April, oscillating between 27th of March 2001 and 26th of April 2003.

The early appearance of the "fundatrix", as is the case of the year 2001 (27.03), exposes the "fundatrix" to the last late frosts, such as the frost on 5th of April 2001 when the minimum temperature dropped to -2.2 ° C and the "fundatrix" has mostly frozen.

In this situation during 2001 at the captures made with yellow traps (MÖERICKE) we have found few winged individuals of the species complex: *Aphis frangulae* Kalt and *Aphis* *nasturtii* Kalt.

The "fundatrix" gives rise to wingless "fundatrigene". The first "fundatrigene" appear on average in 30.04 and their appearance may oscillate between 23.04 in 2001 and 7.05 in 2003.

In the experimental period 1999-2003, both the appearance of the "fundatrix" and the first "fundatrigene" occurred earlier by 7-9 days compared to multi-annual average values, as can be seen in Table 1.

| Last frost with t°min<-2°C | | Year (period) | Primary host | | | | | Secondary host | | | | | | | | | | | | Primary host | | First frost with t°min<-2°C | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Value | Date | | F | F I | Fg II | Fg III | Fg IV | V I | V II | V III | V IV | V V | V VI | V VII | V VIII | V IX | V X | V XI | V XII | S | Depot winter | Value | Date |
| -2,1° | 25.03 | 1999 | 13.04 | 2.05 | 19.05 | 30.05 | 8.06 | 16.06 | 27.06 | 5.07 | 12.07 | 21.07 | 29.07 | 7.08 | 15.08 | 24.08 | 5.09 | 17.09 | - | 28.09 | 8.10 | -4,9° | 17.10 |
| -4,5° | 10.04 | 2000 | 15.04 | 27.04 | 10.05 | 21.05 | 1.06 | 10.06 | 19.06 | 28.06 | 6.07 | 15.07 | 25.07 | 2.08 | 10.08 | 18.08 | 25.08 | 5.09 | 18.09 | 3.10 | 13.10 | -4,7° | 20.10 |
| -2,2° | 5.04 | 2001 | 27.03 | 23.04 | 7.05 | 21.05 | 1.06 | 12.06 | 23.06 | 4.07 | 13.07 | 20.07 | 29.07 | 6.08 | 15.08 | 24.08 | 4.09 | 12.09 | 24.09 | 2.10 | 12.10 | -2,0° | 25.10 |
| -3,7° | 9.04 | 2002 | 12.04 | 30.04 | 11.05 | 22.05 | 1.06 | 12.06 | 20.06 | 28.06 | 6.07 | 14.07 | 22.07 | 31.07 | 9.08 | 19.08 | 29.08 | 9.09 | 21.09 | 15.10 | 25.10 | -3,0° | 20.10 |
| -3,7° | 9.04 | 2003 | 26.04 | 7.05 | 16.05 | 26.05 | 5.06 | 12.06 | 21.06 | 30.06 | 8.07 | 18.07 | 26.07 | 3.08 | 11.08 | 19.08 | 27.08 | 7.09 | 21.09 | 4.10 | 14.10 | -5,5° | 19.10 |
| -3,2° | 4.04 | Mean 1999-2003 | 12.04 | 30.04 | 13.05 | 24.05 | 3.06 | 12.06 | 22.06 | 1.07 | 9.07 | 18.07 | 26.07 | 4.08 | 12.08 | 21.08 | 30.08 | 11.09 | 21.09 | 4.10 | 14.10 | -4,0° | 20.10 |
| -2,4° | 14.03 | Multiannul mean | 21.04 | 7.05 | 20.05 | 31.05 | 10.06 | 20.06 | 30.06 | 9.07 | 18.07 | 27.07 | 5.08 | 14.08 | 23.08 | 2.09 | 13.09 | 26.09 | - | 12.10 | 22.10 | -2,0° | 15.11 |

Migration flight data

Retro migration flight data

**NOTE:**
F = Fundatrix
Fg = Fundatrigene
V = Winged Virginogene
Vs = Virginogene sexupare
S = Sexed ♂ winged
♀ wingless

On the primary hosts *Rhamnus catharticus* L. and *Frangula alnus* Mill are developing four generations of "fundatrigene" until early June, when the mass effect is achieved and the sprouts are lignifying, thus appearing the winged forms which perform the migration flight to secondary hosts.

The migration flight occurs on average (1999-20003) in 3.06 and can oscillate between 1.06 in 2000-2002 and 8.06 in 1999. The migration flight during 1999-2003 occurred 6 days earlier than the multi-annual average (10.06) (IAGĂRU , 2005).

On secondary hosts the complex species: *Aphis frangulae* Kalt and *Aphis nasturtii* Kalt are proliferating powerfully by having in most of the years 12 generations of winged "virginogene". This lowering of the minimum temperature below -2 ° C resulted in the emergence of winged males' sterility that could not perform the fecundation of winged sexed females and thus the drastic reduction winter eggs fecundation, a fact that is experienced in 2003, in the accumulations of Aphidinea appearing a strong decrease of individuals in the complex *Aphis frangulae* Kalt and *Aphis nasturtii* Kalt (Figure 1).

The depositing of winter egg occurs in the experimental period on average in 14.10, oscillating between 8.10 in 1999 and 2002. On average multi-annual values, the depositing of winter egg is signaled in 22.10, although it occurs 8 days later than in the experimental period 1999-2003. Examining the minimum daily temperatures during the occurrence of sexed generation is found that minimum temperatures <-2°C occur in autumn 2002 between the occurrence of sexed generation (15.10) and the depositing of the winter egg, which must occur in 25.10.2002, by signaling the decrease of minimum temperature, which in 20.10 2002 recorded values of - 3°C.

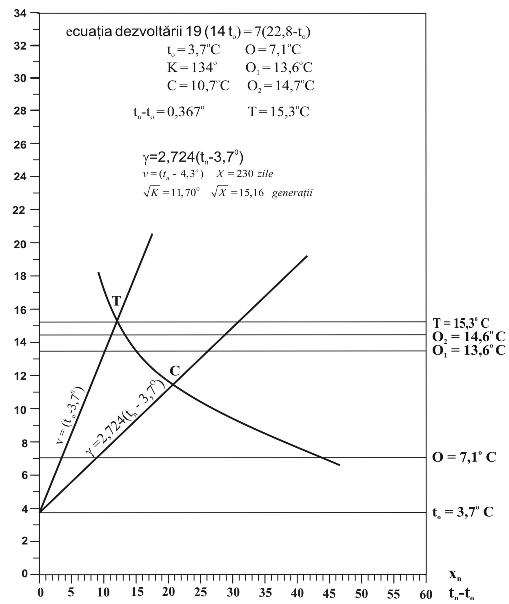


Figure 1. Chart of the growth, development and multiplication of complex species *Aphis frangulae* Kalt and *Aphis nasturtii* Kalt (according to BUIUC and DONESCU, 1992)

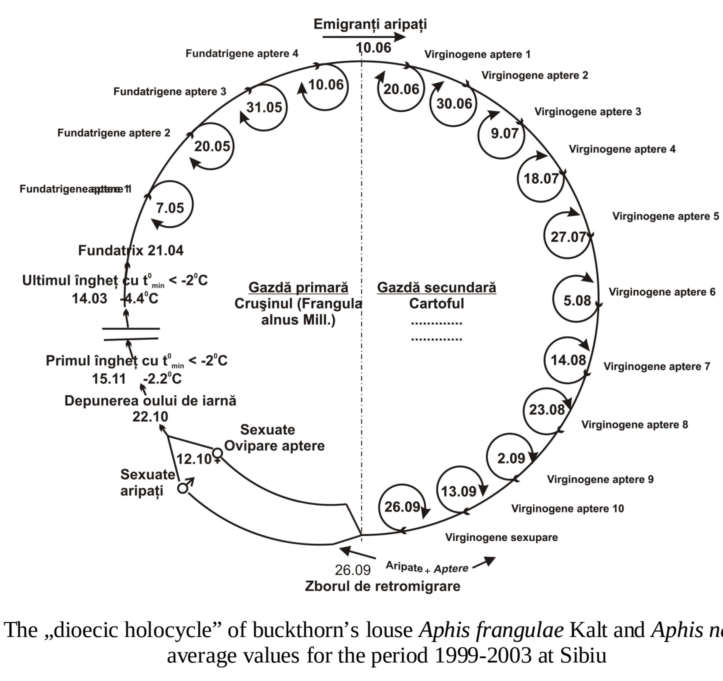


Figure 2. The „dioecic holocycle" of buckthorn's louse *Aphis frangulae* Kalt and *Aphis nasturtii* Kalt on average values for the period 1999-2003 at Sibiu

## CONCLUSIONS

On fields of potato's cultivation from Păltiniş, the appearance of Aphidinea occurs because of the flight at long distance and passive flight (wind transport of Aphidinea) with a delay of 40-45 days against the Sibiu Basin.

The maximum flight of Aphidinea vector of viruses in the Păltiniş area occurs in the first and second decade of August, so with 10-20 days before the destruction of potato haulms, which prevents the migration of viruses from haulms to tubers.

In these circumstances, the production of potato seed in the high area of Păltiniş provides planting material free of viroses, which then multiplied in the cold sub-mountain area, ensures the necessary seed for Sibiu County, avoiding the lengthy and costly transportations in the closed areas for the production of potato planting material.

Knowing the biology of Aphids species specific of Sibiu county, species with low virulence, but with high biologic pressure and in continuing growth, contributes to a more effective control and leads to the appropriate setting of the moment for discontinuation of seed potato vegetation.

It is necessary to study the flight of retro-migration in autumn, knowing that the intensity of this flight depends on the amount of Aphids that will attack potatoes the following year.

It is necessary to study the occurrence of the sexed generation on primary hosts and the first frost in autumn with minimum temperatures <-20C, to see the conditions in which winter eggs are deposited, which may have a prognostic significance regarding the abundance of Aphids the following year.

Through the coordinates of growth, development and propagation of different species of Aphids vector of viroses can be predicted (modeled) with great precision the holo-cycle of different species to indicate the moment of migration and propagation flight on the potato.

The study of retro-migration flight, combined with tracking of Aphids colonies on primary hosts, allows the establishment of forecasting and warning system of Aphids control.

The effective combat of Aphids should be made both on potato crops, and possibly on primary hosts.

The results presented in this work show that through the application of technical and organizational measures under certain conditions can be obtained outside closed areas, planting material of biological category class A and B, in accordance with current rules for the certification of seed potato with a production capacity comparable to that of the closed areas.

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