ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume 63 166 Number 5, 2015
http://dx.doi.org/10.11118/actaun201563051513

SYNPHENOLOGY OF HERB LAYER OF *CARPINION BETULI* COMMUNITY IN THE BÁB FOREST

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Abstract

PILKOVÁ IVANA. 2015. Synphenology of Herb Layer of *Carpinion betuli* Community in the Báb Forest. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 63(5): 1513–1521.

The submitted paper presents the results of a phenological research of herb layer of *Carpinion betuli* community which was realized on the locality of the Báb forest in 2012 and 2013. During 2012, there were 25 species recorded in an herbal layer and for a phenological research in 2013, I was able to document 24 taxa. In 2012, the highest number of present species in a phenological spectrum occurred. Especially, it was during March and October. In 2013, the highest number of species in a phenological spectrum was found on March and April and also later from September to October which is a period when forest species start to grow because of a temperature increase and it also occurred in the autumn period when a repeated growth of forest species took place. In 2012, species in generative phases occurred from 11th March until 1st September and after that, taxa in vegetative phases were found only. In 2013, because of low March temperatures, it was possible to observe generative phases only since 22nd March until the last date of a phenological observation – 11th December. A change in the onset, interphase duration and ending of the monitored phenophases between the years 2012 and 2013 was observed. Specifically, a shift in the onset of the vegetative and generative phenophases was noted. This distinction was caused by a different average week temperature measured in 2012 and 2013. In March 2013 a significant temperature decrease and even ground frost occurred.

Keywords: Báb forest, synphenology, clearcuts, forest community, *Carpinion betuli*

INTRODUCTION

The submitted paper shows results of the phenological research which was realized on the locality of the Báb forest in 2012 and 2013. There are three groups of forest types in the Báb forest which are mentioned by Kubíček and Brechtl (1970). A forest type called *Fageto-Quercetum* is associated with a *Carpinion betuli* aliance (Mayer, 1937) Oberdorfer 1953. The given type is assigned to associations such as *Primulo veris-Carpinetum* Neuhäusl, Neuhäuslová-Novotná 1964 and *Carici pilosae-Carpinetum* Neuhäusl, Neuhäuslová-Novotná 1964 which does not correspond with my results. My dissertation thesis includes phytosociological relevés (64 relevés) of 2013 which were divided by a numeric classification of the Twinspan programme (Hill, 1979) into four clusters.

That is the reason why the thesis deals and assesses a phenology at the level of *Carpinion betuli* union. The given report's aim is to evaluate an onset, development and ending of vegetative and generative phases in the case of the community *Carpinion betuli*. Specifically, I will be dealing with a seasonal dynamics of an herbal layer and with its comparison during 2012 and 2013. I will also focus on how to compare it with a thesis from the 60's Kubíček, Šimonovič (1975).

MATERIALS AND METHODS

The research was conducted in the Báb forest. Administratively the Báb forest area belongs to cadastre of village Veľký Báb, district Nitra and to Nitra Region. It is situated on Nitra loess upland. Two reserve areas can be found here – National

Nature Reserve Báb forest and the Protected Area Báb Park. This forest is remnant of original native forest complexes. Its total area is 66 ha. In the past it was marked by anthropogenic impacts especially short rotation management. Its surrounding were mainly turned into wide-area fields and vineyards (Kubíček, Brechtl, 1970). The Báb forest represents a climax stage of forest succession on loess (Eliáš, 2010).

I assign the phytosociologic relevés of all forestry PRP into *Querco-Fagetea* Braun-Blanquet et Vlieger in Vlieger 1937 class, into *Carpinion betuli* Issler 1931 em. Meyer 1937 union and into *Querco petraeae-Carpinetum* Soó et Pócs (1931) 1957 association. After forestry communities complex classification for Slovakia territory, the relevés classification into the association of *Querco petraeae-Carpinetum* Soó et Pócs (1931) 1957 will be re-evaluated.

The phenological research is taking place on 3 permanent research plots (PRP) which were chosen in the way that the highest possible species diversity would be included. The plots are permanently marked, phenological observations are done on 1m wide transects on the perimeter of PRP.

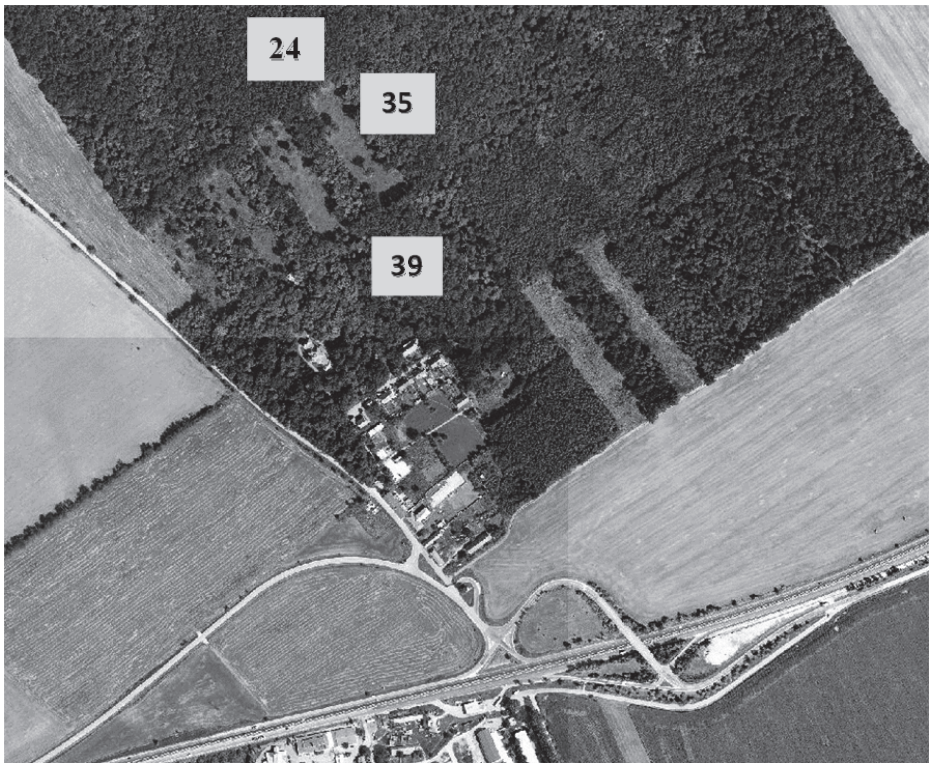
The forest permanent plot no 24 (GPS coordinates of PRP are N 48° 18' 13.74" and E 17° 53' 22.57") is in the National nature reserve Báb forest. NNR is anthropically least influenced and it has an indigenous structure of the upper tree, shrub and herb layer. PRP no 35 (GPS coordinates of PRP are N 48° 18' 14.19" and E 17° 53' 33.09") is situated in the part of the forest where shelterwood cutting was done in November 2006. The last PRP no 39 (GPS coordinates of PRP are N 48° 18' 11.19" and E 17° 53' 35. 8") is situated in the unlogged part of forest vegetation where logging is expected in the future (Fig. 1).

Terrain observations were realized every 4 (spring season) to 12 days (autumn season). On 3 PRP the following vegetative (VP) and generative (GP) phenological phases which were chosen according to the work by Moravec (1994) were observed:

- VP – young folded leaves, completely unfolded leaves, yellowing, withered, overwintering leaves,
- GP – buds formation, flower closed buds, flower poured buds, flower buds formation, young flower, fully developed flower, fading away, total fading away, fruit formation, unripe fruit, ripe fruit, seeded fruit.

Into a phenological phase, I also included not completely developed individuals of herbs, grasses. Into a phase of completely unfolded leaves, I included completely developed plants of herbs and grasses. Into a phase of yellowing, yellowed leaves and withering I put not only yellowed or withered leaves but also yellowed and withered shoots, generative organs of individual taxa. Based on percentage terms (a number of species in a given vegetative or generative phase in a given date), I created phenological spectra for a species community on PRP in forestry covers.

Under the term taxa optimum, I understood the highest number of species in a particular phase and under the term missed species in a phonologic



1: *The area of interest Báb forest with marked permanent plots*
Source: ILE SAS, branch Nitra

spectrum I understand such taxa the absence of which was found out during the phenological research.

To help with phenological assessment, the weather characteristics such as average daily temperature and average daily rainfall of the years 2012 and 2013 were used. Moreover, long-term averages for the period of 1991–2010 were used there. Out of all given monthly averages, it was climate diagrams which were processed in MS Excel programme.

All the characteristics of weather were provided by Slovak hydrometeorological institute (SHMÚ). A critical temperature for an onset of individual phenological phases of observed taxa was expressed by the sum of all effective air temperatures. I calculated the temperature sums out of average daily air temperatures which were higher than 0 °C (TS0), 5 °C (TS5), 10 °C (TS10), 15 °C (TS15). This temperature value was assigned to the beginning of a calendar year.

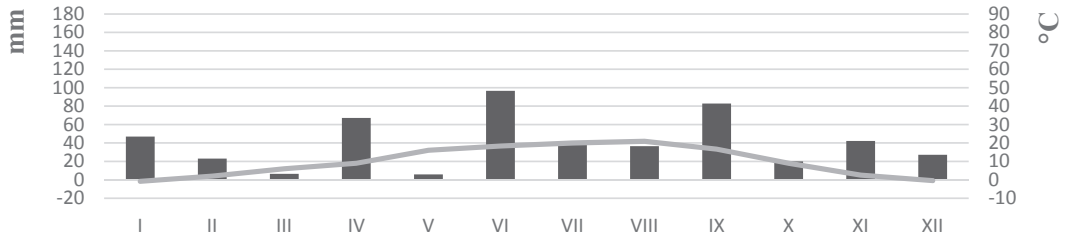
The significance tests I investigated the program Statistica. The nomenclature of the determined taxa was adjusted according to the work by Marhold, Hindák *et al*. (1998).

RESULTS AND DISCUSSION

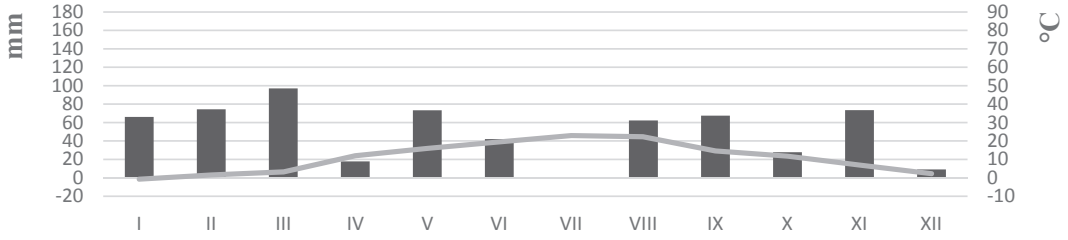
In 2012, phenological research took place from 11th March until 10th December and in 2013 it was from 18th February until 11th December. Individual phenophases may last even after the final date of a phenological monitoring. In the thesis however, I mention them only until the final date which is on 10th (2012), eventually on 11th December (2013).

Weather Conditionality

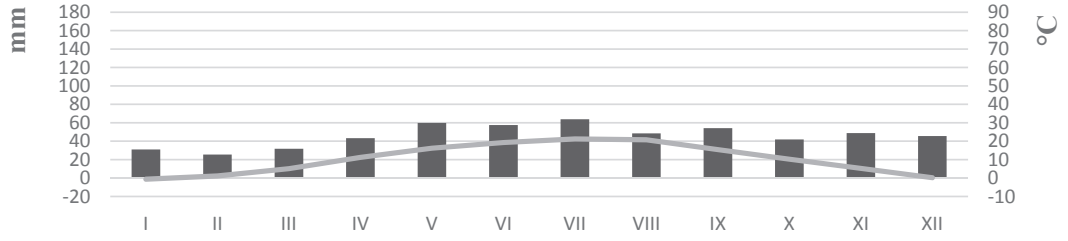
When I compare the monthly average temperatures and the amount of precipitation of 2012 and 2013 (Figs. 2 and 3), it is possible to observe significant differences compared to a long-term average of the period 1991–2010 (Fig. 4). There were no dry periods during those 20 years however in the spring of 2012 (March, May) and at the end of the summer (August, September), I was able to observe severe dry periods. Dry periods were recorded in 2013 as well, and it was during the spring and summer months, specifically in April and June. During those years, temperature considerably differed from the long-term average. The average monthly summer temperatures of both years (2012, 2013) were up to 23 degrees Celsius, while in a period of the previous 20-years, the highest averages reached to 21 degrees Celsius only. The temperature in August 2013 reached up to 40 degrees Celsius. Then, I monitored many damaged herbs. After the temperature decrease, a re-growth of observed taxa has occurred.



2: *Klimadiagram – 2012*



3: *Klimadiagram – 2013*



4: *Klimadiagram – a long-term average 1991–2010*

Species of Phenological Spectrum

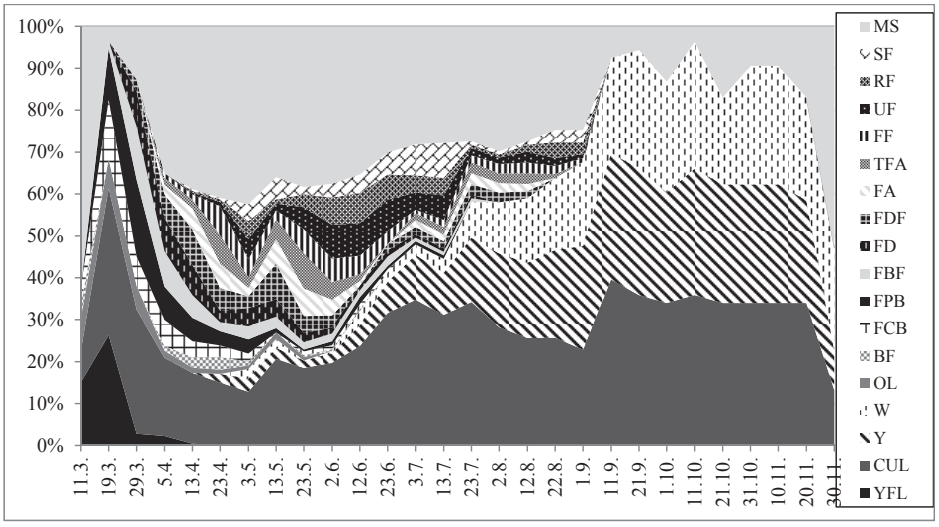
The Fig. 5 and Fig. 6 depict a phenological spectrum of an herbal layer in a forest undergrowth in 2012 and 2013. During 2012, there were 25 species recorded in an herbal layer and I included not only herbs and grasses there but also two evergreens *Hedera helix* a *Vinca minor*. For a phenological research in 2013, I was able to document 24 taxa and previously mentioned woody plants were classified as well.

Common taxa (22) for both years include: *Anemone ranunculoides, Convallaria majalis, Corydalis solida, Dentaria bulbifera, Ficaria bulbifera, Gagea lutea, Galeobdolon luteum, Galium odoratum, Geum urbanum, Glechoma hirsuta, Hedera helix, Impatiens parviflora, Isopyrum thalictroides, Lamium maculatum, Melica uniflora, Merculiaris perennis, Polygonatum latifolium, P. multiflorum, Pulmonaria officinalis, Roegneria canina, Vinca minor, Viola mirabilis.*

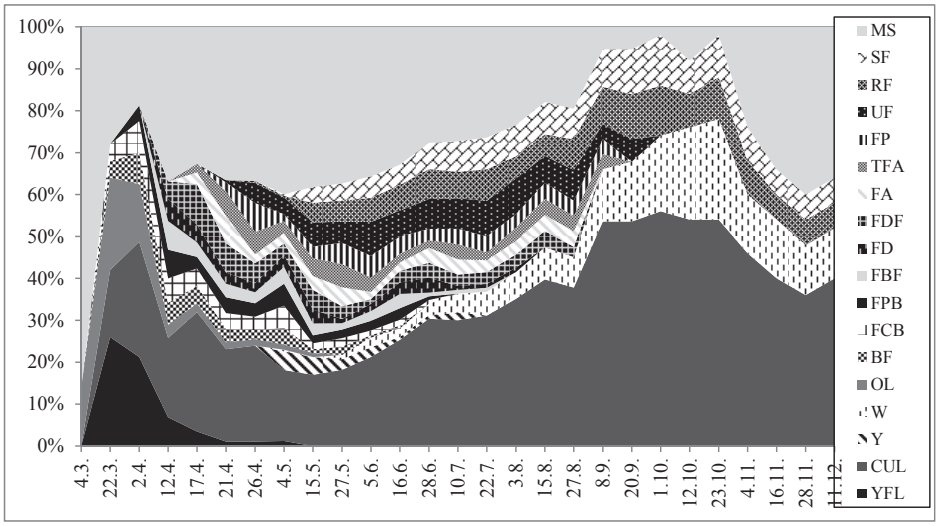
Taxa *Geranium robertianum*, *Viola hirta* and *V. reichenbachiana* could be observed only in 2012 and unique observations of *Alliaria petiolata* and *Lathyrus vernus* were made.

Development of Vegetative Phase

The first observed vegetative phase is called a phase of young folded leaves and it started from 11th March until 3rd May in 2012. The phase's optimum was reached on 19th March (26%). In 2013, the same phase started started from 22nd March until 4th May and it reached its optimum on 2nd April



5: *Synphenology of herb layer of Carpinion betuli in year 2012*



6: *Synphenology of herb layer of Carpinion betuli in year 2013*
Explanations: IFL – young folded leaves, CFL – completely unfolded leaves, Y – yellowing, W – withered, OL – overwintering leaves, BF – buds formation, FCB – flower closed buds, FPB – flower poured buds, FBF – flower buds formation, FD – flower development, FDF – fully developed flower, FA – fading away, TFA – total fading away, FP – fruit formation, UF – unripe fruit, RF – ripe fruit, SF – seeded fruit, MS – missing species druhy in the spectrum

(21% of species). The second phase of completely unfolded leaves was also noticed in 2012 for the first time on 11th March and it lasted until 30th November. When the second phenological observation of 2012 occurred, all of the monitored species had already been under the snow. The phenophase reached its maximum during two dates. Firstly, it was on 23th April, secondly on 3rd May and the maximum was documented in the case of 12–15% of species. In 2013, it was possible to observe a phase of completely unfolded leaves since 22th March until the end of phenological research, which was on 11th December. In 2013, a minimal snow cover was documented as well. The optimum of that phase was reached on 26th April and it was documented in the case of 23% of species.

I claim that growth and development of observed individual plants take place in different year periods. The reason for this includes a very low temperature and an occurrence of ground frost in March of 2013. The low temperature caused eleven days shift of vegetative phases for later period in 2013. The temperature sum TS0 has shown different values but TS5 has shown an identical value (TS5 = 60) through the years and that proves that temperature higher than 5 degrees Celsius represents a very important influence for a growth of observed taxa individuals. The thesis by Havlíček (1986) claims that a beginning of vegetative period was set to the day which reached temperature higher than 5 degrees Celsius in three consecutive days. Onset and ending of 5 degree temperature represent borders of a big vegetative period because this temperature can activate physiological processes in herbal organs. This fact was confirmed when a temperature higher than 5 degrees Celsius occurred a week before a phenological observation.

A phase of young folded leaves reaches its maximum in different periods of both years when a temperature is around 10 degrees Celsius. A phase of completely unfolded leaves reaches the maximum in different year period as well but that time a temperature reaches 10 up to 20 degrees Celsius. I state that the highest number of species in phases of complete and young folded leaves was found in situations with a temperature higher than 10 degrees Celsius. This average daily temperature $T > 10$ °C represents borders of a main vegetative stage (Kurpelová *et al.*, 1975).

It was possible to observe a yellowing phase from 23th April until 30th November. A period in which the most yellowed leaves or all plants yellowing was documented, occurred on 1st September (25% of species). In 2013 this phenophase observed from 4th May until 10th June and its maximum was reached on 4th May (only 4% if species). There is a great difference in the case of observed years and the difference is visible when the Figs. 5 and 6 are compared. A period of 3rd May to 30th November represented a withering stage. The highest number of withered plants was documented on 1st September too and it was 20%. The particular phase was being observed from 4th May until the end of phenological research (11th December). On 23rd October, the phenophase reached its optimum when 24% of species reached it too.

The reason for such significant yellowing and withering of species in 2012 is a combination of and high air temperature during April. During a field observation it was possible to monitor a very dry soil and there was not enough time for April's rainfall to soak into the soil in a required quantity. It was possible to observe the same situation on 1st September in 2012. A high temperature and a low amount of rainfall was typical for August too. The taxa yellowing in 2013 was documented mainly on 4th May, but it did not occur in a large extent because of April's low rainfall amount. In 2013, withering occurred in the highest number of species on 23rd October which resulted from a temperature decrease and a preparation of species for a winter rest period. Šiška, Špánik (1999) consider a temperature of $T < 10$ °C as a period of a vegetative rest. This situation has been confirmed in forest cover of the Báb forest as well, when the final phenological calendar phases (Y and W) began to occur. Especially, it was in the case of temperatures lower than 10 degrees Celsius (it is mentioned by the authors Šiška, Špánik (1999) but also in the case of temperatures lower than 5 degrees (mentioned by Havlíček (1986).

The next observation phase was a phase of overwintering leaves and in 2012 it occurred since the beginning of observation on 11th March until 23rd May. The highest number of species with an overwintering leaves was observed in March and it represented 7 to 8%. In 2013, the given phenophase occurred from 4th March until 15th May and there were two dates when it reached the maximum. It was on 22th March and on 2nd April. In 2013, the highest number of species was documented in periods of an intensive snow melting. In those periods, it was possible to observe the given phase in the case of 13 dash 22% of species. It was possible to observe the particular phase mainly in the case of species such as: *Ajuga reptans, Galeobdolon luteum, Geum urbanum, Hedera helix, Vinca minor.* The particular taxa are capable of creating new shoots and leaves in the autumn and this way they will overwinter to the next year. In the spring, shoots and leaves will die and with a temperature rising plants will create new aerial organs.

Development of Generative Phase

Buds Formation

The first observed generative phase is a phase of buds formation and in 2012, it started to occur since 11th March until 12th June. The maximum was reached on 23rd April (3% of species). In 2013, it was possible to monitor the phase since 22th March until 16th June. The optimum of the phase was reached on 12th April and on 4th May (4, 5% of species). Within this phase, I could observe 11 days shift

to a later period of 2013. The reason why this shift has occurred includes a low March temperature as I mentioned in the case of the first vegetative phases (IFL, CFL). The species optimum in a given phase was possible to observe in different year periods. Not only temperature influenced the highest occurrence of species in that phase which has been proven by different temperature sums through the years. The reason why the shift of the phase to 23rd April in 2012 occurred was probably an influence of a low rainfall in March. In 2013, the same phase occurred in April (after a sufficient amount of rainfall), in March and in May (after a rainfall at the beginning of that month).

The second observed phase is a phase of flower closed buds. In 2012, it occurred since the date of 11th March until 23rd June and its maximum was reached on 5th April (6% of species). In 2013, it was possible observed the given phase since 22nd March until 28th June and it reached its maximum on 4th May (5%). In the case of that phase, I observed a shift to a later period of 2013 and the reasons for that shift matches previously mentioned reasons.

A phase of flower poured buds which are closed however was being observed since 19th March until 13th July in 2012 and it reached the optimum on 5th April (8% of species). In 2013, the given phenophase was being monitored since 2nd April until 28th June. Within this phase, we observed 14 days shift to the later period of 2013. The shift was caused by a low March temperature as well. A temperature sum which was needed for that particular phase onset was TS5 > 85. The remaining temperature sums reached various values (the temperature sum not amount), which means that they have no influence on the phase's onset.

The highest number of species was always collected after a higher amount of precipitation. All of the temperature sums were different which proves that temperature has no influence on optimum of the given phases. Ending of those phenophases takes place in the case of an intensive temperature increase in June and July.

Development of Flowers

The taxa blooming was documented with a help of the first phase of flower buds formation and it was being monitored since 19th March until 23rd July in 2012. The phenophase reached its maximum on 5th April (9% of species). In 2013, it was possible to observe the same phase since 12th April until 22nd July and the maximum was reached on 12th April too (7% of species). A phase of young flower started to be observed on 29th March until 23rd July in 2012. The most taxa of the given phase was collected on 13th April (7% of species). In 2013, the phase was being observed since 12th April until 3rd August and the phenophase's optimum was reached on 12sd April (5%). A phase of fully developed flower started to be observed on 29th March until 12sd August in 2012. The most taxa of the given phase was collected on 13th April (8% of species). In 2013, the phase was being observed since 12th April until 27th August and the phenophase's optimum was reached on 17th April when 10% of flowers were blossoming.

A temperature sum TS10 > 85 has an influence on the onset of the flower buds development phase and the onset of the last two blossoming phenophases is influenced by TS10 > 120. The given temperature sums TS10 has reached the most homogenous values through the years. Not only temperature may influence an optimum of the phenophases but an amount of rainfall is a very important factor too. In March of 2012, there was a minimum of rainfall monitored. An onset of all blossoming phases in 2012 occurred quite sooner than in 2013 but the development was slowed down by a low amount of rainfall. And that is the reason why the dates of the phenophases of those years ended almost at the same moment.

A start of a fading away phase was possible to observe from 5th April until 12th August and the phase's optimum was reached on 23rd April (14% of species). In 2013, the species started to fade away on 17th April and this phase lasted until 27th August. A maximum of that phase was reached on 21st April (7% of species). A phase of a total fading away could be observed since 5th April until 22nd August in 2012 and its optimum was reached on 23rd April (7% of species). Monitoring of this phase in 2013 started on 17th April and it finished on 8th September and it reached the maximum on 21st April and 27th May (6–11% of species).

All the temperature sums were showing very different numbers which means that the phases' onset was not influenced by a temperature factor only. A low March's amount of precipitation represents another factor influencing an earlier onset of phases and since the beginning of April, a significant drought and an intensive fading away. Optimum of both phases has occurred almost in the same periods (April to May) which is given by a natural life cycle of the particular forest species.

Fruiting

A phase of fruit formation could be observed from 5th April until 1st September in 2012 and its optimum was reached on 23rd April (7% of species). In 2013, the same phenophase occurred since 21st April until 8th September and it reached its maximum during 26th April (7% of species). In 2013, a shift of onset and optimum occurred because of low March temperatures which has stopped development in few taxa phenophases. However, not only temperature could influence that phase and that idea was proven by dissimilar temperature sums. In 2012, a higher amount of rainfall fell down and that might be the reason which could speed up fruit formation.

The next observed phase called a phase of the unripe fruit started to occur on 13th April and it lasted until 1st September in 2012. The phase has reached its optimum in two dates, on 3rd May and

2nd June (8 to 11% of species). In 2013, this phase occurred since 21st April until 20th September and the given phenophase reached its optimum on 5th June (8% of species). The phenophase of the ripe fruit in 2012 occurred since 13th April until 1st September and it reached its optimum on 3rd May (4% of species). In 2013, the same phase started to occur on 26th April and it lasted until the end of phenological observation which represents the date of 11th December. The observed phase reached its optimum on 15th, 27th May and 5th June (5% of species). A phase of seeded fruit appeared since 13th April until 1st September in 2012 and it reached its optimum on 3rd May (4% of species). In 2013, this observed phase started do be monitored on 4th May and it lasted until the end of phenological observation (11th December). Its optimum was monitored on 5th June (5% of species).

The given phenophases' onset concerning fruit maturing (ageing) and dissemination occurred in the early 2012. One of the reasons was a higher temperature which could activate fruit maturing but all the temperature sums has showed different numbers through the years. This fact proves that it was not only temperature which had an influence on the phenophases' onset. At the beginning of 2012, a higher amount of rainfall fell down and I could observe a very fast fruit maturing in the field. Dissemination has appeared mainly after an intensive rainfall because fallen raindrops helped to speed up the process of fruit seeding. I observed such situation at the beginning of April but also at the beginning of May in 2012 and 2013 as well. Optimum of all phases took place in conditions of high temperatures and a higher amount of precipitation. In 2013, phases of the ripe fruit and that of dissemination lasted until the end of phenological observation. This situation was caused by a more adequate temperature occurring in 2013. During 2013, less days with frost and an inconsistent snow cover occurred and compared to 2012, it lasted only few days.

The dates of onset and optimum of the seeded fruit phase took place in an earlier period of the year when we compare it with 1973. That fact is mentioned in the work by Kubíček, Šimonovič (1975). The authors claim that species which are seeding start to appear in July and August mainly. The reason for the phase's earlier onset is a significantly higher temperature and more intensive rainfall in 2012 and 2013. The authors also claim that species which form seeds last until the end of September. The given fact agrees with our results.

Optimum of Phenological Spectrum

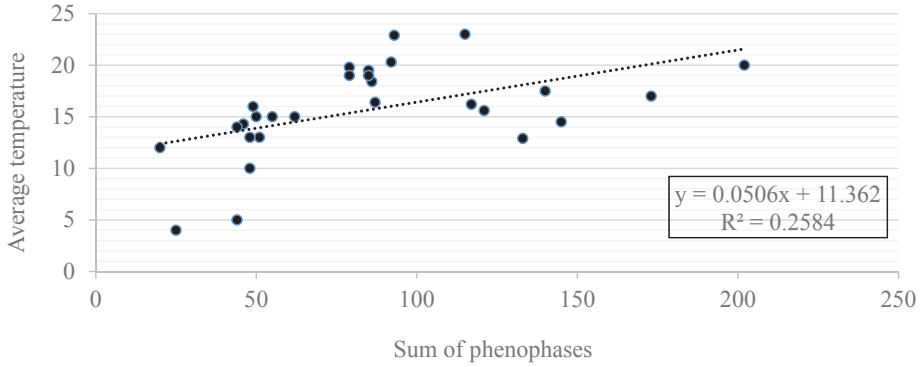
In 2012, the highest number of species present in a phenological spectrum occurred. Especially, it was during 19th, 29th March and 11th October which is a period when forest species start to grow because of a temperature increase and it also occurred in the autumn period when a re-growth of forest species took place. A situation when the highest number of species in a phenological spectrum was missing was monitored at the beginning and at the end of a vegetative period and then on the dates of 23rd April and 3rd May, which represents a period of efemeroid's death. In 2013, the highest number of species in a phenological spectrum was found on 22nd March and 2nd April and also later from 8th September to 23rd October. At the beginning of a vegetative period and also later during 4th and 15th May, there was documented the lowest number of species. Considering a year 2013, it was possible to observe the same situation as was mentioned earlier and the situation could be observed almost in the same year period.

The given facts agree with a work by Kubíček, Šimonovič (1975). The authors has monitored that a vegetative phenophase in the Báb forest has two maxima. The first maximum is in April, in the period when the majority of species starts its vegetative stage. The lowest percentage was documented on 23rd May. The vegetative phase's second maximum was collected on 19th September and the second minimum representing an occurrence of vegetative species was documented at the beginning of November. Comparing to a year 1973, a small difference is caused by a higher temperature and by a higher amount of precipitation in 2012 and 2013. It happend it the spring period and that is why one month shift of maximum of a vegetative fenophases to an earlier period was observed. A temperature which is ideal for a re-growth for observed taxa's individuals, which represents the second maximum of vegetative phases, was in October of 2012 and 2013.

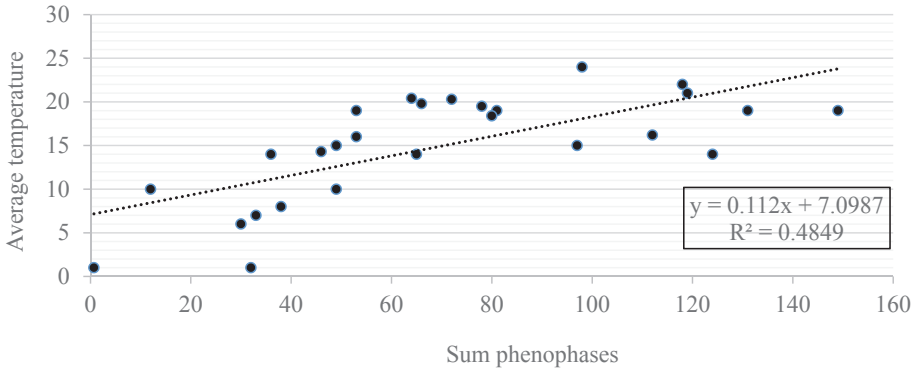
In 2012, species in generative phases occurred from 11th March until 1st September and after that, taxa in vegetative phases were found only. The highest number of taxa in vegetative phases, which represented around 40%, was collected during the dates of 13th, 23th April and 3rd May. In 2013, because of low March temperatures, it was possible to observe generative phases only since 22nd March until the last date of a phenological observation and that was on 11th December. The highest number of generative taxa was collected during 4th, 15th and 27th May (around 35%). The given fact matched the opinion of Kubíček, Šimonovič (1975) who introduced the fact that phenological development in the Báb forest starts in the early spring. During the summer, almost all of the monitored species were found in a vegetative phase only.

The Relationships of the Temperature and the Phenophases

The Figs. 7 and 8 depict dependence between average daily temperature and a sum of phenophases (a percentage divided by number 100, this was done for each phenophase and at the end, the numbers for each date were summed up) for the years 2012 and 2013. Rising temperature caused rising of the sum of the phenophases as



7: *The relationships – average temperature and amount of phenophases – year 2012*



8: *The relationships – average temperature and amount of phenophases – year 2013*

well. In the early spring months such as March and April there occurred more significant temperature rising together with higher development of individual vegetative and generative phenophases. The highest dependence of 2012 and 2013 occurred in April and May. During these months, there occurred the biggest phenophases' development, a significant vegetative growth of ephermeroids and a very significant blooming and production of ephermeroids and other spring species as well. The temperature was higher, the values of which were around 14 to 19 °C. The dependence decreased after the ephermeroids' death. During June of 2012 and 2013, the temperature was raising, but the sum of the phenophases decreasing. As I have already mentioned, the majority of ephermeroids were dead in June and the other forest species were ending their generative growth as well.

In 2012 was, at level of significance 0.05, p-value of 1.2. In 2013, the p-value was 2.3. A statistically significant relationship between temperature and the sum of phenophases was not confirmed. I think this relationship needs to be further pursued in the coming years. As you can see in the Figs. 7 and 8, higher dependence between average daily temperature and a sum of the phenophases happened in 2013.

At the beginning of 2012, there was significantly different temperature and also the sum of the phenophases. This period was characterized by higher daily temperature but the ephermeroids only began their vegetative growth. In 2013, there occurred lower temperature in close dependence to developing ephermeroids. In summer, autumn and winter months of 2013, we could observe closer dependence as well. Average daily temperature of 2013 was slowly getting lower together with death of forest herbs.

CONCLUSION

My study presents the results of a phenological research of herb layer of *Carpinion betuli* community which was realized on the locality of the Báb forest in 2012 and 2013. In the past it was marked by anthropogenic impacts especially short rotation management. A difference between the years was documented mainly in the spring period where a shift in vegetative and generative phenophases to a later period in 2013 happened.

In 2012, the highest number of present species in a phenological spectrum occurred. Especially, it was during 19th, 29th March and 11th October. In 2013, the highest number of species in a phenological spectrum was found on 22nd March and 2nd April and also later from 8th September to 23rd October.

I recorded two maxima in the synphenological spectrum. The first maximum is in April, in the period when the majority of species starts its vegetative stage. The lowest percentage was documented on 23rd May. The vegetative phase's second maximum was noticed on 19th September and the second minimum representing an occurrence of vegetative species was documented at the beginning of November. In 2012, species in generative phases occurred from 11th March until 1st September and after that, taxa in vegetative phases were found only. In 2013, because of low March temperatures, it was possible to observe generative phases only since 22nd March until the last date of a phenological observation and that was on 11th December.

The results of the phenological research focusing on the evaluation and comparison of chosen vegetative and generative phenophases of *Carpinion betuli* community confirmed larger differences in the onset, duration and ending of phenophases in 2012 and 2013.

REFERENCES

ELIÁŠ, P. 2010. Zmeny biodiverzity v Bábskom lese a blízkom okolí (Nitrianska pahorkatina, Juhozápadné Slovensko). In: *Starostlivosť o biodiverzitu vo vidieckej krajine*. Nitra: Slovenská poľnohospodárska univerzita, 151–158.

HAVLÍČEK, J. et al. 1986. *Agrometeorologie*. Praha: SZN.

KUBÍČEK, F., BRECHTL, J. 1970. Charakteristika skupín lesných typov výskumnej plochy v Bábe pri Nitre. *Biológia (Bratislava)*: 27–38.

KUBÍČEK, F., ŠIMONOVIČ, V. 1975. Dynamics and phenology of the total biomass of herbaceous layer in two forest communities. *Biológia (Bratislava)*, 30: 505–522.

KURPELOVÁ, M. et al. 1975. *Agroklimatické podmienky ČSSR*. Bratislava: Príroda.

MARHOLD, K., HINDÁK, F. et al. 1998. *Zoznam nižších a vyšších rastlín Slovenska*. Bratislava: Veda.

MORAVEC, J. et al. 1994. *Fytocenologie.* Praha: Academia.

ŠIŠKA, B., ŠPÁNIK, F. 1999. Predpokladané zmeny fenologických pomerov ozimnej pšenice a jarného jačmeňa v oblasti Podunajskej nížiny do roku 2075 ako dôsledok klimatickej zmeny. *Meteorol. Čas*, 1999(3): 35–40.

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