Our birch trees

Učenici: Helena Herman, Leo Košak, Elizabeta Tkalec
Mentori: Marina Ostrugnjaj, Anita Sečan

OŠ Belica

1. Summary

Observing the beginning and duration of different stages of the development of plants, we can determine, the influence of individual climatic factors on their growth and development. Analysing the process of sprouting, browsing and leafing of six individual birch trees, we determined which factors affect the development of buds and leaves. Birch trees, the dominant tree species in our area, were analysed at five different locations. We have evaluated the thermal conditions for this year for the observed trees, comparing their age and the position on which the amount of sun radiation is dependent. Air temperature and rainfall are the most important factors affecting the growth of plants. Although our observed trees are geographically rather close, the difference in the dates of the opening of the buds of the first and last propagated breeds was 14 days. We tried to explain the cause of the differences, with their different position in relation to the sun and their age. We have also concluded that the structure of the soil, is the factor that affects plants growth. By comparing the air temperature, surface temperature of the soil and the temperature of the list, we showed their linear dependence.

2. Reasearch questions – hypothesis

By observing beginning and duration of particular phases in plant development we can determine their dependance on certain climate elements. Those elements are variable during the years. Therefore, using the phenological exploration we can establish the influence of certain factors on plant growth and development on a smaller area.

Budding is the appearance of new leaves on plants, which indicates the beggining of a growth season, one of the phases explored by phenology. With birch (Betula) being a dominant species in our area, during the last year we have began, with this year further continuing, our phenological survey; observation of budding and leaves growth. A birch tree can grow up to 30 metres high. Bark on young branches is smooth and white, while on older trees it becomes hardened, thick and rough. The branches are hanging, young branches are reddish-brown in colour, slightly sticky, densely covered in warty-like clusters. The buds are sticky, between 3 and 5 millimetres long, covered in numerous greenish-brown to reddish-brown scales. Leaf length is between 3.5 and 7 centimetres, the width of the leaf is between 2 and 4 centimetres, their shape is triangular with pointy edges and a spiked point. The leaves are on long pedicles located on long, hanging little branches. We observed the growth and development of the six birch trees on five different locations. These were the questions we asked ourselves:

- How long does the birch budding and greening process lasts?
- How does the budding and greening depend on habitat conditions?
- Does a leaf temeperature depend on the air and soil surface temperature?

Our assupmtion is that the budding and greening process in our surveys will match, considering the small distance between our phenological stations. On two birches, located near our atmospherical station, we also measured leaf temperature. We assume that the measured temperature will be linearly dependant on observed temperature.

3. Survey methods

We began our work by studying a GLOBE protocol for budding and literature study; in order to learn what phenology is and what the importance of phenological study is. Beside the literature, we located six birch trees which we would conduct our survey on. We have marked the buds on the birches with visible tapes and numerated them.
Geographycal position of observed trees:

1. Birch and Birch_1 – N 46.4012°, E 16.518°
2. Birch Bam N 46.398081°, E 16.511809°
3. Birch 21 N 46.400523°, E 16.5109°
4. Birch Tara N 46.4263°, E 16.5546°
5. Birch Kime N 46.4273°, E 16.5625°

Two of the observed birches are located on the grass-covered surface next to Belica Primary School, and the rest are in the surrounding area of Belica – two in the actual village of Belica and two in the village of Gardinovec, the two being at a 4.1 kilometres distance.

Figure.1: Accommodation map GLOBE Station of School Belica, with marked observation trees (https://vis.globe.gov/GLOBE/)

Figure 2 : Breza located in Belica school area

Figure 3 : Breza_1 located in Belica school area

Birch and Birch 1 are located in a park near our school. They were planted at the same time and are now about 35 years old. Both birches are in the shadow made by other trees only on the north side so they are exposed to light during the daytime.

Figure 4 : Breza Bam located in Belica school area

Figure 5 : Breza 21 located in Belica school area

Birch Bam is about 15 years old, placed in a family house garden, being in the shadow of the house on the east side. In the morning the birch is in the shadow, while in the afternoon is fully exposed to sunlight. Birch 21 is about 25 years old and located by the road partially sheltered by trees on the north side. Because of its position the birch is exposed to sunllight during the day.

Figure 6 : Breza Kime located in Belica school area

Figure 7: Breza Tara located in Belica school area

The youngest birch observed, Birch Kime is about 10 years old and located in a park in the village of Gardinovec. Trees in the park are not denselly planted which allows the birch to be in the sunlight almost all of the time, except early in the morning, when sheltered by trees on the east side. Birch Tara, also located in the village of Gardinovec, is over 30 years old. It is located west from the house which partly gives it shadow during early morning hours. Because of its position and size, it is well alight.

We began our observations in the middle of February and impatiently waited for buds to open. After they did, we daily monitored the leaves growth on all the birches and in additon to that we also measured the temperature of the leaves on two of the birches near our atmospherical station. There was also something we added to our standard measuring (air temperature and percipitation); we also measured the soil surface temperature, in order to be able to note possible correlation. For the purpose of making temperature condition estimation and getting as accurate results as possible, we required the official data by DHMZ (Meteorological and Hydrological Service) for the period of January 1st 2017 to March 23rd 2017, minimum and maximum temperature values and overall percipitation (rain and water equivalent of snow), which were than used for the purpose of calculating the water difference. For comparison of leaves temperature, soil surface temperature and air temperature we used our self-obtained data.

4. Data description and analysis:

The data was statistically processed and analysed for being able to derive conclusion and confirm or deny our initial assumptions. Following the GLOBE protocol we conducted the temperature condition estimation for this year. For every tree we calculated the growing degree summation – GDS by using data on minimum and maximum temperature for the period from January 1st to the day when the buds started openning. By determination of arithmetic mean of minimum and maximum of daily temperature we calculated Tavg – average temperature. The sum of positive values of average temperatures is the GDS.

$$GDS = \sum_{i=1}^{n} Tavg_i > 0;\ \ Tavg = \frac{t_{min} + t_{max}}{2}\ \ : n = bud\ openning\ date$$

Available moisture is determined by comparison of water input and output. The input consists of rain and water equivalent for snow , for the period of 29 days before the budding and for the day when the buds opened. Assessment of the output was made by determing potential evapotranspiration (PET) for the same period as for the input. By detraction the PET value from the moisture input we obtained the water difference (WD). We displayed the results in table and graphically.

Table 1: Phenological and climatic data for the research area in the period from 1 January to 23 March 2017; GDS - total growth rate, PET - estimate of potential evapotranspiration, total precipitation and WD - water difference (climatic data - GMP Varaždin)

						Vodeni ekvivalent snježnog pokrivača			
Stablo *(br)*	**Ime breze**	**Datum otvaranja pupova god/mjes/dan**	**GDS *(°C)***	**PET *(mm)***	**Oborina *(mm)***	**Početak (-29 dana) (mm)**	**(Kraj otvaranja) (mm)**	**Ukupni input (mm)**	**WD *(mm)***
1	**Breza**	2017-03-12	229.05	38.50	43.0	0	0	43.0	4.5
2	**Breza_1**	2017-03-09	209.95	37.14	41.6	0	0	41.6	4.46
3	**Breza 21**	2017-03-23	343.50	45.50	39.6	0	0	39.6	-5.9
4	**Breza Bam**	2017-03-20	301.70	43.10	42.9	0	0	42.9	-0.2
5	**Breza Tara**	2017-03-20	301.70	43.10	42.9	0	0	42.9	-0.2
6	**Breza Kime**	2017-03-16	255.05	40.00	42.9	0	0	42.9	2.9

By comparing the date of budding on five different stations, we determined the difference in plant development, although the plants are in the same location. The table clearly shows that of six plants WD is positive for the three of them, while being negative on the other three. The negative WD values are present with those trees which have the highest GDS value. It indicates dry conditions. The tree with the highest GDS and the lowest WD value is the one that started budding later than all the other trees observed.

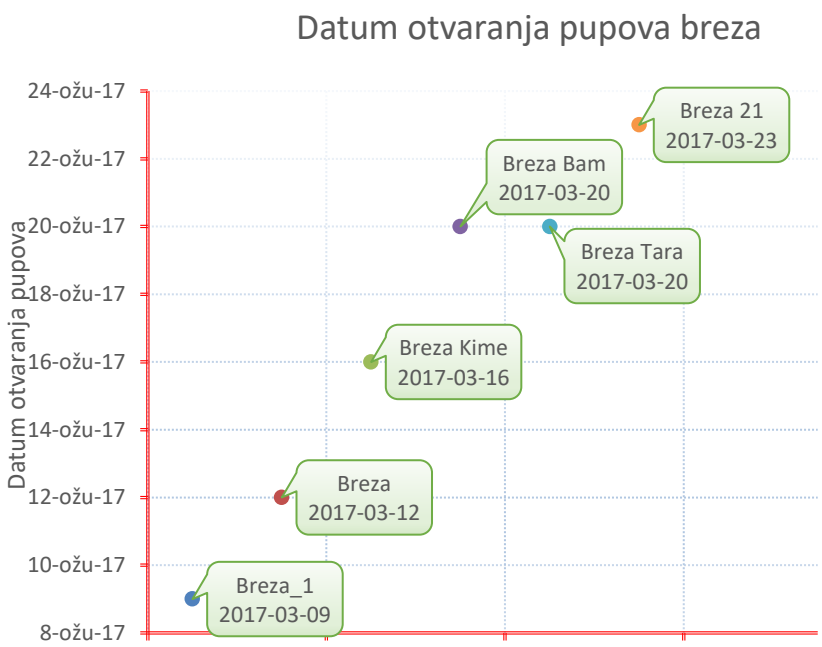

Figure 8: Observed trees arranged according to the opening time of the buds.

Graphical display of observed trees shows the distance of 14 days between the budding of the first and the last birch. Contrary to our expectation, the measuring showed that even the small distance results in significant differences in the dates of budding. Birch and Birch 1 are both located in the school park, distanced merely 10 metres from each other and the difference of budding dates is 3 days. Four days later Birch Kime, the most distanced of the observed birches, started budding. March 20th is the date of budding of the two birches, of which Birch Bam is located in Belica and Birch Tara in Gardinovec. Birch 21, which is the closest to the school, took the longest to bud; even 14 days later that the first birch.

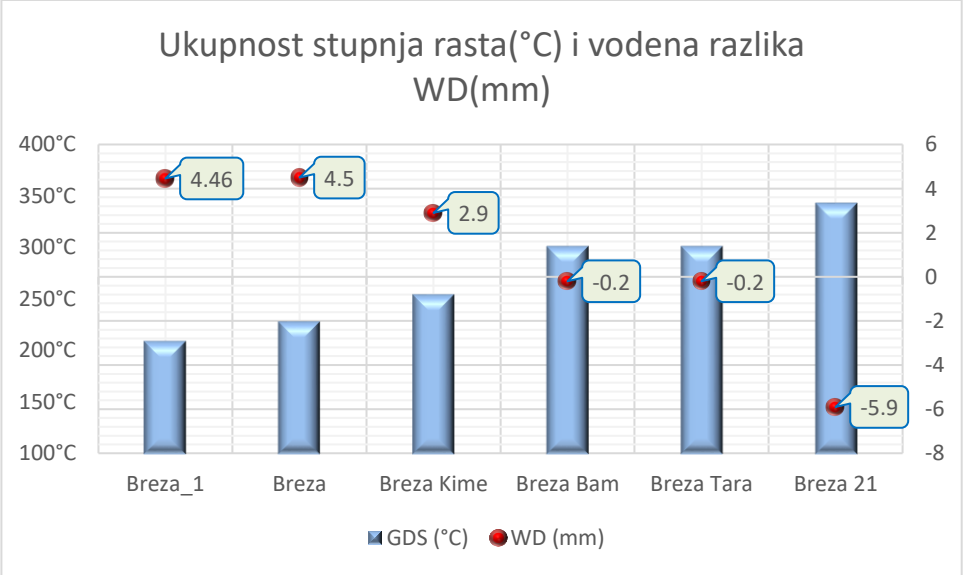

Figure 9: Degree of Growth (GDS /°C) and Water Difference (mm) for the observed birch. The order of trees follows the opening time of the buds.

Dependance of the budding date and GDS and WD values is also visible from the graphical display. Birch that budded first has the highest WD difference, which implies the wettest conditions, while the value of GDS is the lowest. Values for Birch 21, which took the longest to bud, are the highest GDS and the lowest WD, which implies dry conditions.

Table 2: The date of the opening of the buds, the approximate age of the birch and the position of the birch on the side of the world from which the sunlight shines.

Stablo *(br)*	Ime breze	Datum otvaranja pupova god/mjes/dan	Približna starost breza (god)	Strana svijeta
1	**Breza_1**	2017-03-09	35	jug
2	**Breza**	2017-03-12	35	jug
3	**Breza Kime**	2017-03-16	10	zapad
4	**Breza Bam**	2017-03-20	15	zapad
5	**Breza Tara**	2017-03-20	30	zapad
6	**Breza 21**	2017-03-23	25	jug

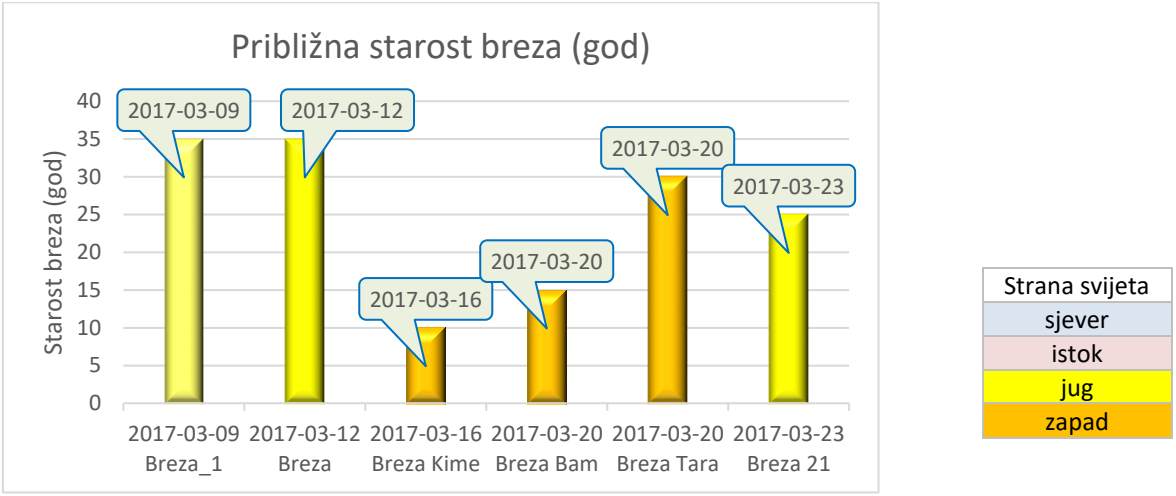

Figure 10 : The approximate age of the observed generations and the world.
The order of trees follows the opening time of the buds.

Both the table and the graphical display show that by comparing the age of the trees and the date of budding, as with the geographical distance, there is no proportion between the obtained values. „The oldest“ birches budded first, followed by the two „youngest“ and finally the two around 30 and 25 years old.
When looking at the position and the amount of direct sunlight , we see that the first to bud were the birches located on the south side and receive the greatest amout of sunlight. Birch 21, which was the last to bud, is also located on the south side. Since it was the only birch growing on gravel soil by the road, we can assume that the lack of moisture was the reason of its late budding.

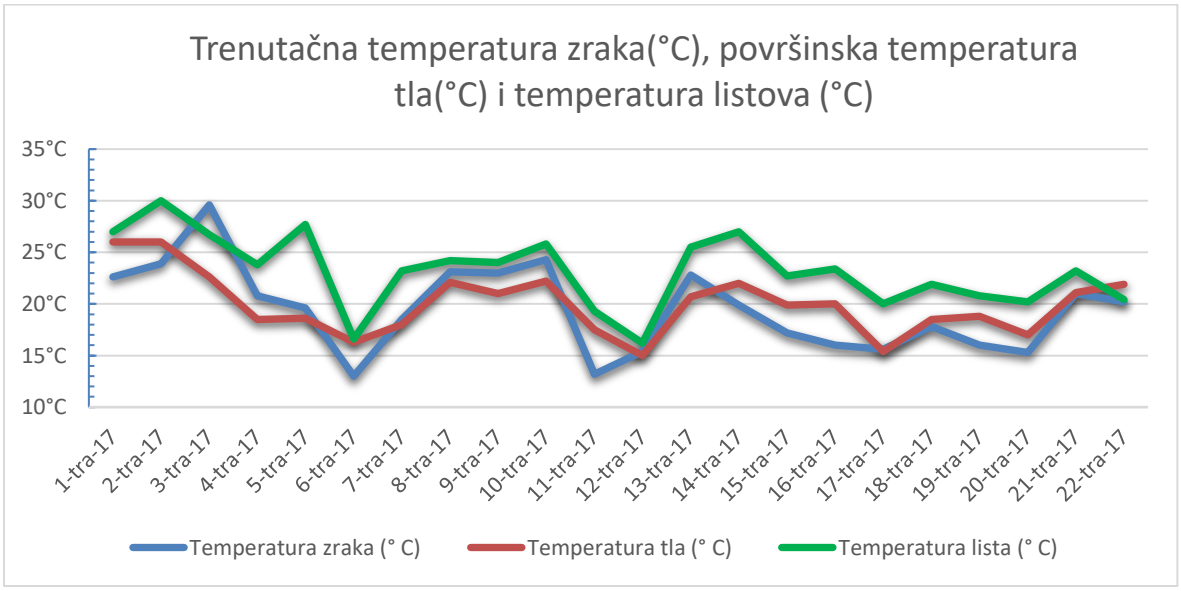

Figure.11 :. The current air temperature (Belica atmospheric station), the surface temperature of the soil and the temperature of the list during the Breze brewing period (1-2 April 2017)

Based on our expectations we can see a proportional dependance of leaf temperature and soil surface temperature with the current air temperature. Results of our measuring shows that the leaf temperature is slightly higher than the temperature of air and soil surface.

5. Conclusion:

Air temperature, percipitation, relative air moisture, sunlight, frost and wind are the climate elements which directly affect plant growth and development. Air temperature and soil temperature are the most relevant factors which affect the end of resting period. Therefore, budding time largely depends on their values. Water is also very important in plant growth and development, so the amout of percipitation which ensures enough water for the plants, is also a factor which influences budding. Positive WD value indicates wet conditions on the habitat. Sufficient amount of water during the time of Green-up is of the greatest importance because it is the period when plants need water the most for the transpiration process.
During this-year surveys we determined the dependance between the budding and leaf production in our area. Surprised by the results, we have decided to use the gathered data for comparison next year, as we plan to continue our surveys.
Temperatura zraka, količina oborina, relativna vlažnost zraka, sunčeva svjetlost, mraz i vjetar elementi su klime koji neposredno utječu na rast i razvoj biljaka. Temperatura zraka i temperatura tla najvažniji su čimbenici koji utječu na kraj razdoblja mirovanja, pa vrijeme pupanja uvelike ovisi o njihovim vrijednostima. Voda je također vrlo bitna kod rasta i razvoja biljaka, pa je količina oborina koja osigurava vodu biljkama također faktor koji utječe na pupanje. Pozitivna vodena razlika ukazuje na vlažne uvjete na staništu. Dovoljna količina vode u vrijeme *Green up*-a je najvažnija jer biljka tada treba najviše vode za transpiraciju. Tokom ovogodišnjeg smo istraživanja odredili ovisnost pupanja i listanja o tim veličinama na našem području. Iznenađeni rezultatima odlučili smo podatke prikupljene ove godine, koristiti za usporedbu i sljedeće godine, kada planiramo nastaviti naše istraživanje.

6. Izvori:

[1] Habdija Ivan, Primc – Habdija Biserka, Biološki leksikon, Profil, Zagreb, 1999.

[2] Morris Parker Bertha, Riznica prirode, Školska knjiga, Zagreb, 1980.

[3] Vrt, Velika ilustrirana enciklopedija, Mozaik knjiga, Zagreb, 2005.

[4] http://globe.pomsk.hr/prirucnik.htm (7. 5. 2017.)

[5] http://www.enciklopedija.hr/natuknica.aspx?ID=19235 (7. 5. 2017.)