PHENOLOGICAL ANOMALIES REGARDING THE FLOWERING OF SPONTANEOUS AND SUBSPONTANEOUS PLANTS FROM FOUR DIFFERENT PARTS OF ROMANIA

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Abstract. The paper presents observations about the phenological anomalies regarding the flowering of spontaneous and subspontaneous plants from four different parts of Romania, during the period 2000 - February 2018 (south-western, central, central-western, north-western of Romania). These anomalies are the consequences of global warming and have become more prominent particularly in the last five years (2013-2017), being observed in 100 species of spontaneous and subspontaneous plants. Both premature flowering and flowering extension were observed, sometimes even supplementary flowerings in the cold season (November-February).

Keywords: phenological anomalies, flowering, spontaneous plants, Romania.

Rezumat. Anomalii fenologice privind înflorirea plantelor spontane şi subspontane din diferite părţi ale României. Lucrarea prezintă observaţii despre anomaliile fenologice privind înflorirea plantelor spontane şi subspontane din patru părţi ale României în perioada 2000 - februarie 2018 (sud-vestul, centrul, central-vestul şi nord-vestul României). Aceste anomalii sunt consecinţe ale încălzirii globale şi s-au accentuat mai ales în ultimii 5 ani (2013-2017), fiind observate la 100 de specii de plante spontane şi subspontane. Au fost observate atât înfloriri premature cât şi prelungirea înfloririi, uneori chiar înfloriri suplimentare în sezonul rece (noiembrie-februarie).

Cuvinte cheie: anomalii fenologice, înflorire, plante spontane, România.

INTRODUCTION

Global warming determined climatic changes in the structure of seasons: premature and shorts springs, with thermal variations, sometimes extreme, dry and sultry summers, autumns with high temperatures but sometimes with extreme thermal extreme variations, mild winters, sometimes with high temperatures for this season, the substitution of the snows with rains. Premature flowerings, its extension, the existence of some supplementary flowerings in the cold season (November – February) are only some phenological aspects observed in plants, as a consequence of global warming effects (Figs. 1-6).

This paper is a synthesis of the observations performed by the authors in four parts of Romania (south-western, central, central-western and north-western) regarding the influence of global warming on the flowering of spontaneous and subspontaneous plants (ANGHEL et al., 1971; ROMAN, 1974; IVAN, 1979; NĂSTASE, 1982; CIOBOIU, 2005).

Figure 1. *Rudbekia triloba* (photo Ilie, 2017).

Figure 2. *Erigeron annuus* (photo Ilie, 2017)

Figure 3. *Oenothera biennis* (photo ILIE, 2017).

Figure 4. *Solanum nigrum* (photo ILIE, 2017).

Figure 5. *Ranunculus sardous* (photo Ilie, 2017).

Figure 6. *Taraxacum officinale* (photo Ilie, 2017)

MATERIAL AND METHODS

The observations were made during the period 2000 – February 2018, in 15 areas, 8 counties, with the altitude ranging from 30 to 500 m, as follows: Tinca (Bihor county, the north-western part of Romania) – average altitude 130 m, hilly area; Oradea (Bihor county) – average altitude 120 m, hilly area; Maieru – Anieș (Bistrița-Năsăud county) – average altitude 500 m, hilly area; Dârmănești (Argeș county, the central part of Romania) – average altitude 400 m, hilly area; Sebeș (Alba county, the central-western part of Romania) average altitude 350 m, hilly area; Geoagiu Bai (Mureș county, the central part of Romania) – average altitude 400 m, hilly area; Drobeta Turnu-Severin (Mehedinți county, the south-western part of Romania) – average altitude 65 m, plain area; Batoți (Mehedinți county) – average altitude 70 m, plain area; Craiova, Bechet, Cârcea, Desa, Calafat (Dolj county, the southern part of Romania) – average altitude 30 – 50 m, plain areas; Racovița (Vâlcea county, the central part of Romania) – average altitude 300 m, hilly area; Caraula (Dolj County, the southern part of Romania) – average altitude 100 m, hilly area (Fig. 7).

The identification of plant species was made using different books (SĂVULESCU, 1952 -1976; TODOR, 1968; TIȚĂ I. & NĂSTASE A. 1997; CIOCÂRLAN, 2000; SÂRBU et al., 2013).

Figure 8. The map of localities where plant blooming abnormalities were found:
1. Tinca, 2. Oradea, 3. Maieru-Arieş, 4. Dărmăneşti, 5. Sebeş, 6. Geoagiu, 7. Drobeta-Turnu-Severin, 8. Batoţi, 9. Craiova, 10. Bechet, 11. Cârcea, 12. Desa, 13. Calafat, 14. Racoviţa, 15. Caraula (original).

RESULTS

During the analysed period, 2000 - 2018, phenological anomalies were observed regarding flowering in the following 100 species of spontaneous and subspontaneous plants (Table 1).

Table 1. Phenological anomalies regarding the flowering of spontaneous and subspontaneous plants from four parts of Romania.

Name of the species	Data of observations in different areas (see legend)	Temperature (Celsius degrees)	Phenological anomalies of flowering	Period of normal flowering, months
Hepatica transsilvanica Fuss, 1850	27.III.2009 , R	13	P. f.	IV – V
Ranunculus acris Linnaeus, 1758	16.XI.2017, A	7	S. f.	V – VIII
Ranunculus sardous Crantz, 1774	10.XI.2017 – 19.I.2018, T	3 – 15	S. f.	V – VII
Chelidonium majus Linnaeus, 1758	19.X – 26 XI.2017, T 10.X –11.XII 2017, Ba	3 – 15 7 – 15	S. f. –	V – IX –
Betula pendula Roth, 1828	26.I – 28.II.2018, T	5 – 15	P. f.	IV – V
Corylus avellana Linnaeus, 1758	26.XII. 2017 – 28.II.2018, T	8 – 15	P. f.	II – IV
Polygonum arenarium Waldst & Kit, 1878	10.X.2017, B, D	15	S. f.	VII – IX
Polygonum aviculare Linnaeus, 1758	19..X. – 3.XII.2017, T 21.XI.2017 B, C 13.V.2017 B, C	2 – 25 – 6 – 20	S. f. – P. f.	VI – X – –
Polygonum amfhibium Linnaeus, 1758	2.X. – 3.XII.2017, T 21.XI.2017 B, C, D 15.V.2017 B, C, D	2 – 25 6 21	S. f. – P. f.	VI – X – –
Rumex acetosa Linnaeus, 1758	25.IX. – 4.XII.2017, A	8	S. f.	VI – VII
Stellaria media Linnaeus, 1758	8.XI. – 13.XII.2017, T 4.XI.2017 – 11.I.2018, O 12.XI. – 23.XII.2017, A 28.XII.2017, S	2 -12 0 – 17 1 -13 1	S. f. – – –	III –V – – –
Fragaria vesca Linnaeus, 1758	12.XI.2017, R 18.XI. – 10.XII.2017, A	26 3 – 10	S. f. –	V – VI –
Potentilla reptans Linnaeus, 1758	1.XI.2017 – 9.I.2018, T 15.XI.2017, A	1 – 17 6	S. f. –	VI – VIII –

Potentilla leucopolitana Muller, 1862	12.XI.2017, R 23.XII.2017, T	26 3	S. f. –	V – VII –
Alchemilla vulgaris Linnaeus, 1758	20 – 25.XI.2017, A	6 - 8	S. f.	V – VIII
Agrimonia eupatoria Linnaeus, 1758	2.XI – 25.X.2017, T 14.IX -28.XI.2017, B, C 12.V.2016, B, C	12 – 25 16 – 26 23	S. f. – P. f.	VI –VIII – –
Crataegus monogyna Jacquard, 1800	28.X.2013, C	10	S. f.	V –VI
Pyrus communis Linnaues, 1758	15.X.2013, R	12	S. f.	IV – VI
Prunus cerasifera Ehrh., 1784	10.II.2017, Cv 15.III.2009, Cv 18.III.2017, Cv	5 7 10	P. f. – –	IV – V – –
Armeniaca vulgaris Lamarck, 1753	27.II.2016, Cv	3	P. f.	III – IV
Medicago sativa Linnaeus, 1758	5.XII.2017, A	1	S. f.	V – X
Medicago lupulina Linnaeus, 1758	2 – 10.XII.2017, T	2 – 8	S. f.	V – IX
Melilotus albus Medik, 1787	10 – 15.XI. 2017, A	5 – 7	S. f.	VI –IX
Melilotus officinalis Lamarck, 1753	10-15.XI 2017, A	5 – 7	S. f.	VI – IX
Trifolium repens Linnaeus, 1753	16.XII. 2017, Tr. S 2.X. – 2.XII.2017, A 11.X. – 22.XII.2017, T	9 2 – 20 1 – 23	S. f. – –	V – IX – –
Trifolium pratense Linnaeus, 1758	4.X. – 21.XII.2017, T 2.XII.2017, A 9.X – 20.XI.2017, C, R	3 – 18 0 2 – 15	S. f. – –	V – IX – –
Robinia pseudoacacia Linnaeus, 1753	20.IV.2016, Cv 26.IV.2007, Cv 25.IV.2017, Cv 16.VIII.2015, T 9.IX.2014, T	16 15 20 31 26	P. f. – – – S. f.	V – VI – – – –
Oenothera biennis Linnaeus, 1758	16.X.2009, Cv 29.XI – 3.XII.2017, T (floral buds)	1 – 4 –	S. f. –	VI – VIII –
Aesculus hippocastanum Linnaeus, 1758	20.IV.2017, Cv 16.VIII. – 7.IX.2015, T 10.IX. – 29.IX.2017, O	17 23 – 27 14 – 17	P. f. – S. f.	V – VI – –
Geranium robertianum Linnaeus, 1758	12.X – 13.XI.2017, A	8 – 10	S. f.	V – IX
Daucus carota Linnaeus, 1758	3.X – 10.XII.2017, A	3 – 9	S. f.	VI – IX
Carum carvi Linnaeus, 1758	7.X – 15.XII.2017, A	3 – 9	S. f.	VII – IX
Pimpinella saxifraga Linnaeus, 1758	1.X. – 10.XII.2017, T 12.X.2015, B, D 20.VI.2000, B, D	2 – 23 15 30	S. f. – P. f.	VII – IX – –
Aethusa cynapium Linnaeus, 1758	14.X – 12.XII.2017, T 2.IX. – 30.X.2015, B, D	2 – 21 15 – 26	S. f. –	VI – VIII –
Hypericum perforatum Linnaeus, 1758	19.X – 15.XI.2017, A	5 – 13	S. f.	VI – IX
Malva sylvestris Linnaeus, 1758	20.XI.2017, A 2.X – 13.XII.2017, T 26.IX. – 9.XII.2017, Tr. S 14.X.2017, B, C 20.V.2000, B, C	4 3 – 20 5 – 25 17 25	S. f. – – – P. f.	VI – IX – – – –
Viola odorata Linnaeeus, 1758	5.IX. – 20.XII.2017, A 20.X.2007, 3.XI.2009, 5.XII.2017, R 11.X. – 26.XII.2017, T	4 – 17 6 - 14 4 - 17	S. f. – –	III – IV – –
Sisymbrium orientale Linnaeus, 1753	20.V.2000 B, D 28.VIII. – 25.IX.2013 B, D 28.XI.2017, T	26 21 – 32 6	P. f. S. f. –	VI – VII – –
Capsella bursa-pastoris Linnaeus, 1753	10XI. – 16.XII.2017, A 16.I.2018, T 5.I.2018, O 3.IX.2017, R	1 – 11 7 4 17	S. f. – – –	IV – VII X – XI – –
Thlaspi arvense Linnaeus, 1758	14.XI.2017, A	4 –	S. f. –	IV – VI IX – X
Primula acaulis Linnaeus, 1758	18.XII.2017, G 20.XI.2017, A	1 6	S. f. –	III – IV –
Primula veris Linnaeus, 1758	9.XII.2017, A	7	S. f.	IV – V
Lysimachia numularia Linnaeus, 1758	24.XII.2017, A	5	S. f.	V – VII
Centarium erythraea Rafin, 1800	15.X.2013, R	16	S. f.	VII – IX
Gentiana asclepiadea Linnaeus, 1758	19.X.2013, R	14	S. f.	VII – IX
Asclepias syriaca Linnaeus, 1758	11.VI.2000, Ca 15.VI.2004, Ca	40 35	P. f. –	VII – VIII –
Syringa vulgaris Linnaeus, 1758	2.XII.2017, Cv	2	S. f.	IV – V
Solanum heterodoxum Dunal, 1813	15.VI.2004, Ca	27	P. f.	VII – X
Solanum nigrum Linnaeus, 1758	8.XII.2017, T 14.XI.2017, B 20.V.2004, B 26.V.2009, B	8 10 19 22	S. f. – P. f. –	VI – X – – –

Calystregia sepium Linnaeus,1758	16.X.2017, B, D	17	S. f.	VI – IX
	10.V.2004, B, D	23	P. f.	–
	29.X.2017, T	15	S. f.	–
Ipomoea purpurea Linnaeus, 1758	30.X.2017, T	12	S. f.	VI – IX
	23.X.2017, B, C	14	–	–
	9.V.2004, D	18	P. f.	–
Ajuga reptans Linnaeus, 1758	20.IX.2017, A	6	S. f.	IV – VI
Glechoma hederacea Linnaeus, 1758	16.III.2000, B	11	P. f.	IV –VI
	26.IX.2017, B	16	S. f.	–
Prunellla vulgaris Linnaeus, 1758	10.XII.2017, T	9	P. f.	IV – VI
	16.IX – 10.X.2017, C	16 – 20	S. f.	–
Lamium purpureum Linnaeus, 1758	20.X.2017, B	17	S. f.	III – IX
	25.XII.2017, A	8	–	–
	9.XII.2017 Tr. S	11	–	–
Lamium maculatum Linnaeus, 1758	21.XII.2017, T	0	S. f.	IV – VI
	20.III.2004, B	7	–	–
	3.IX.2007, B	21	–	–
Lamium album Linnaeus, 1758	25XII.2017, A	8	S. f.	IV –VI
Salvia officinalis Linnaeus, 1758	1XII.2017, A	4	S. f.	V – VII
Salvia pratensis Linnaeus, 1758	1.XII.2017, A	4	S. f.	V – VII
Origanum vulgare Linnaeus, 1758	5.IX. – 26.X.2017, B	12 – 23	S. f.	VII – VIII
Thymus vulgaris Linnaeus, 1758	3.V.2004, C	21	P. f.	VII – VIII
	19.X.2017, B	10	S. f.	–
Lycopus europaeus Linnaeus, 1758	10.XI.2017, B	12	S. f.	VI – VIII
Plantago lanceolata Linnaeus, 1758	15.XI.2017, Ba	10	S. f.	V – VIII
Veronica polita Fries, 1777	2.I.2018, O	7	S. f.	III – VI
	15.XI.2017, Ba	9	–	–
	21.II.2018, T	7	–	–
	3.VII. – 20.IX.2017 C, R	23 – 31	–	–
Veronica longifolia Linnaeus, 1758	25.XI.2017, T	13	S. f.	VI – VIII
	10.XI.2017, Car	12	–	–
Euphrasia officinalis Linnaeus, 1758	10.XII.2017, A	2	S. f.	VII – X
Campanula patula Linnaeus, 1758	20.XI.2017, A	3	S. f.	V – VII
Galium mollugo Linnaeus, 1758	6.XII.2017, A	1	S. f.	VI – IX
Sambucus nigra Linnaeus, 1758	28.IV.2017, Cv	17	P. f.	VI – VII
Lonicera tatrica Linnaeus, 1758	3.VII – 16.X.2017, Cv	9 – 26	S. f.	V – VI
	20.X.2016, Car	16	–	–
Dipsacus laciniatus Linnaeus, 1758	11.X. – 23.XI.2017, R	3 – 15	S. f.	VII – VIII
Knautia arvensis Linnaeus, 1758	25.XI.2017, A	10	S. f.	VI – VIII
Oxalis corniculata Linnaeus, 1758	13.XII.2017, T	7	S. f.	IV – V
Vinca minor Linnaeus, 1758	5.XI.2017, R	17	S. f.	IV – VI
Bellis perennis Linnaeus, 1758	26.I.2017, A	8	S. f.	III – X
	28.II.2018, T, O	7	–	–
	28.XII.2017, G	9	–	–
Aster amellus Linnaeus, 1758	13.XII.2017, T	7	S. f.	VII – IX
	5.I.2018, A	6	–	–
Erigeron annuus Linnaeus, 1758	22.XII.2017, T	1	S. f.	VII – VIII
	31.XII.2017, O	3	–	–
Erigeron canadensis Linnaeus, 1758	25.XI.2017, T	13	S. f.	VI – IX
	29.X.2017, C, R	12	–	–
Inula salicina Linnaeus, 1758	28.XI.2017, T	6	S. f.	VI – IX
Inula helenium Linnaeus, 1758	20.XI.2017, T	6	S. f.	VI – IX
	16.XII.2017, Ba	9	–	–
Ambrosia artemisiifolia Linaeus, 1758	2.I 2018, O (floral buds)	7	S. f.	VII – VIII
Galinsoga ciliata Blake, 1922	9.XII.2017, T	8,5	S. f.	VII – IX
	20.XI.2017, B, C	8	–	–
Achillea millefolium Linnaeus, 1758	20.II.2018, T	7	S. f.	VI – VIII
	26.XI.2017, Da	11	–	–
	28.XII.2017, S	9	–	–
Matricaria perforata Merat, 1753	21.XII.2017, T	0	S. f.	VI – X
	26.XI.2017, B, C	13	–	–
Tanacetum vulgare Linnaeus, 1758	28.X.2017, R	10	S. f.	VII – IX
	31.I.2018, T	8	–	–
	26.XII.2017, Tr. S	10	–	–
Tussilago farfara Linnnaeus, 1758	16.II.2007, C	4	P. f.	III - V
Senecio vulgaris Linnaeus, 1758	3.XII.2017, T	1	S. f.	III – IX
Carduus acanthoides Linnaeus, 1758	22.XII.2017, T	1	S. f.	VI – IX
	31.XII.2017, O	3	–	–
	15.X.2017, C, R	18	–	–
Cichorium intybus Linnaeus, 1758	26.XI.2017, A	9	S. f.	VII – IX
Leontodon saxatilis Lamarck, 1779	21.XII.2017, T	0	S. f.	VI – VII
Leontodon autumnalis Linnaeus, 1758	29.XI.2017, T	7	S. f.	VII – IX
	20.XI.2017, C	7	–	–

Picris hieracioides Linnaeus, 1758	8.XII.2017, T 3.XI.2017, B, D 15.VI.2004, B	8 14 25	S. f. – P. f.	VII – IX – –
Taraxacum officinale Weber, 1992	16.XII.2017, Tr. S VII – XII.2017 C, R 24.XI.2017, Da 6.I.2018, O 28.XI.2017, A 28.XII.2017, S 28.II.2018, T	7 4 -28 9 8 3 9 7	S. f. – – – – – –	IV – VI – – – – – –
Sonchus asper Linnaeus, 1758	14.X.2017 C, R	17	S. f.	VII – IX
Sonchus arvensis Linnaeus, 1758	25.XI.2017, A X – XI.2017, C, R 12.XII.2017, T	10 6 – 17 17	S. f. – –	VII – VIII – –
Hieracium umbellatum Linnaeus, 1758	9.XII.2017, Tr. S	10	S. f.	VII – IX
Rudbekia triloba Linnaeus, 1758	26.XI.2017, T	12	S. f.	VII – X
Tragopogon pratensis Linnaeus, 1758	3.I.2018, A	1	S. f.	VI – VII
Leucojum vernum Linnaeus, 1758	6.I.2018, A	9	P. f.	III – IV
Galanthus nivalis Linnaeus, 1758	3.I.2018, A 20.XII.2017, T	1 3,5	P. f. –	II – III –

Legend: R = Racovița; A = Anieș; T = Tinca; Ba = Batoți; B = Bechet; D = Desa; C = Cârcea; O = Oradea; Cv = Craiova; S = Sebeș; G = Geoagiu Băi; Ca = Calafat; Da = Dârmănești; Tr. S = Drobeta Turnu-Severin; Car = Caraula; Premature flowering = P. f..; Supplementary flowering = S. f.

DISCUSSIONS

The observed species belong to 33 families. Two families are best represented. They are: Asteraceae (24 species, 24%) and Rosaceae (9 species, 9 %), the other 31 families presented a smaller number of species, ranging from 7 to 1 species, as it follows: Fabaceae – 7 species (7 %), Lamiaceae – 5 species (5 %), Polygonaceae – 4 species (4%), Apiaceae – 4 species (4%), Ranunculaceae – 3 species (3%), Brassicaceae – 3 species (3 %), Scrophulariaceae – 3 species (3 %), Primulaceae – 3 species (3 %), Convolvulaceae – 2 species (2 %), Solanaceae – 2 species (2%), Amaryllidaceae – 2 species (2 %), Dipsacaceae – 2 species (2 %), Caprifoliaceae – 2 species (2 %), Gentianaceae – 2 species (2 %), Papaveraceae – 1 species (1 %), Oleaceae – 1 species (1 %), Oxalidaceae – 1 species (1 %), Molvaceae – 1 species (1 %), Hypocostanaceae – 1 species (1 %), Caryophyllaceae – 1 species (1 %), Onograceae – 1 species (1 %), Plantaginaceae – 1 species (1 %), Corylaceae – 1 species (1 %), Apocynaceae – 1 species (1 %), Asclepiadaceae – 1 species (1 %), Campanulaceae – 1 species (1 %), Geraniaceae – 1 species (1 %), Violaceae – 1 species (1 %), Hypericaceae – 1 species (1 %), Rubiaceae – 1 species (1 %), Betulaceae – 1 species (1 %).

Premature flowerings were registered in 25 species of plants, supplementary flowerings in 88 species of plants and both premature flowerings and supplementary flowerings in 12 species of plants. These data are preliminary, of course, since the number of vegetal species, as well as the number of families they belong to is much higher; new researches will be realised at the level of the entire country in the future.

The analysis of the table presents the phenological anomalies of plants flowering because of the positive temperatures registered in the cold season or because of the high temperatures during springtime (NĂSTASE & NĂSTASE, 2002; DRĂGULESCU, 2003).

CONCLUSIONS

During 2000 – February 2018, phenological anomalies were identified regarding the flowering of spontaneous plants in 100 species from four parts of Romania (south-western, central, central-western and north-western). The positive temperatures from the cold season and the high temperatures from spring have determined both the premature flowerings and flowering extension, sometimes even supplementary flowerings in the cold season (November – February).

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