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THE INFLUENCE OF THE GLOBAL WARMING REGARDING THE FLIGHT PERIOD, THE BIOLOGY AND THE ECOLOGY OF SOME BUTTERFLIES AND MOTHS FROM THE NORTH WESTERN PART OF ROMANIA (TINCA AREA, BIHOR COUNTY)

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Abstract
In this paper are presented biological and phenological anomalies observed at the butterflies and moths from the north-western part of Romania (Tinca area, Bihor county) due to the consequences of global warming. These anomalies were observed during 2010-2018 at 33 species of butterflies and moths. These climatic changes cause the extension of the flight period, the appearance of additional generations or the hibernation in another development stage, simultaneously with the stage known in the scientific literature, precocious appearances in nature, some resistance at dryness and heat of some species.

Keywords: butterflies, moths, phenological anomalies, Tinca area

1. INTRODUCTION

The effects of the global warming, felt intensely during the last period (2010 – 2018) leaved its mark on the life of butterflies and moths.

These effects determined climatic changes in the seasons structure: precocious and short springs, sometimes with extreme thermic variations, droughty summers, autumns with high temperatures but also with thermic shocks (for example – some days with very high temperatures then days with low temperatures), mild winters, sometimes with high temperatures for this season, the replacement of snow with rain.

The premature beginning of the flight period, the extension of this period during the autumnal season, the reduction or even the stoppage of flight during the summery season because the sudden appearance of the dryness and the heat, the appearance of additional generations or hibernation in another development stage, sometimes simultaneously with the stage known in the scientific literature, are only some phonological changes observed at this group of insects.

In Romania, there were not performed researches regarding the effects of the global warming over the butterflies and the moths, but at the global level there were performed different researches (Karlsson, 2014; Navarro-Cano et al., 2015; Rodenhouse et al., 2009).

Ilie (2013, 2014, 2015, 2016, 2017 and 2018) published different observations about the phenological changes observed in Tinca area, Bihor County.

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This paper is a synthesis of the observations performed by the authors regarding the influence of the global warming over the butterflies and the moths materialized by phonological anomalies registered in Tinca area (the north-western part of Romania).
These phenological anomalies must be attentively supervised because numerous species of butterflies and moths are pests for forestry or agriculture.
Tinca area is situated in the north-western part of Romania, in the south-western part of Bihor county having a hilly relief. The climate is temperate-continental, the hydrographic system is represented by Crişul Negru river and some lakes, the average altitude is 110 m. The vegetation belongs to the oak stage.
Tinca village is formed by five villages: Tinca, Râpa, Belfir, Girişu-Negru and Gurbediu.

2. MATERIALS AND METHODS

The researches were performed during 2010-2018 in Tinca area. There was used an entomological net, sweeping the vegetation (bushes and herbs).
The identification of the species was made in the laboratory, using some sources mentioned in specialized literature (Rakosy, 1996, 2013; Szekely, 2008, 2010).

3. RESULTS AND DISCUSSIONS

In Tinca area, during 2010-2018, there were observed phenological anomalies at the following species:

Family, species	Specimen, period, village, temperature	Flight period
Hesperidae family		
Pyrgus alveus alveus Hubner, 1803	1 M, Râpa, 5X 2014, t=16^{0}C	VI –VIII
Hesperia comna Linnaeus, 1758	1M, Râpa, 25 III 2018, t=10^{0}C	15 VI -1 X
Papilionidae family		
Parnasius appolo jaraensis Kertsz, 1922	1 F, Râpa, 20V 2015, t=19^{0}C 1F, Râpa, 15 VI 2015, t=21^{0}C	15 VII – VIII
Iphiclides podalirius Linnaeus, 1758	1M, Râpa, 4 III 2016, t=10^{0}C ; 1F, Râpa, 25 XI 2016, t=8^{0}C; 1 M, Tinca, 7 I 2018, t=13^{0}C	15 IV – VIII
Papilio machaon Linnaeus, 1758	1M, 6 XI 2013, t=14^{0}C, Gurbediu; 1 M, 15 XI 2013, t=15^{0}C, Gurbediu; 1 M, Tinca, 8 I 2018, t=13^{0}C	15 IV – VIII
Zerynthia polyxena Dennis, 1775	1M, Râpa, 12 III 2018, t=16^{0}C	V – 15 VI
Pieridae family		
Leptidea sinapis Linnaeus, 1758	1 M, Râpa, 2 XI 2014, t=19^{0}C	IV – 7 IX
Anthocaris cardamines Linnaeus, 1758	2 F, Tinca forest, 30 VIII 2014, t=19^{0}C 1 M, Râpa, 2 XI 2014, t=19^{0}C	III-VI
Pieris rapae Linnaeus, 1758	1 M, Râpa, 6 III 2016, t=12^{0}C 1 M, Tinca, 4 XI 2015, t=14^{0}C 1 M, Tinca, 12 XI 2015, t=16^{0}C 1 M, Tinca, 4 I 2018, t= 7^{0}C	IV – 15 X
Pieris brassicae Linnaeus, 1758	2 M, Tinca, 15 XI 2010, t=19^{0}C 1 M, Tinca, 19 II 2014, t=20^{0}C 2 M, Râpa, 14 I 2015, t=9,5^{0}C	20 IV -15 X

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	3 M, Tinca, 25 X – 7 XI 2017, t=15-17^{0}C 1 M, Tinca, 28 III 2018, t= 9^{0}C	
Pieris napi Linnaeus, 1758	1 M, Tinca, 23 II 2017, t=11^{0}C	20 III- X
Colias croceus Fourcroy, 1785	1 M, Tinca, 16 XI 2010, t=21^{0}C 25 specimens, Râpa, t=16^{0}C, 2 XI 2013; 1 M, Tinca, 16 XI 2015, t=16^{0}C 1 M, Tinca, 22 XI 2016, t=14^{0}C	V – X
Colias hyale Linnaeus, 1758	1 M, Tinca, 15 XI 2015, t=14^{0}C	V – X
Colias alfacariensis Ribbe, 1905	3 M, Râpa, 21 I 2015, t=13^{0}C	V = X
Gonopteryx rhamni Linnaeus, 1758	1 M, Râpa, 12 II 2014, t=17^{0}C	20 III=IX
Lycaenidae family		
Lycaena phleas Linnaeus, 1761	1 M, Râpa, 14 II 2014, t=16^{0}C 1 M, Belfir, 18 II 2014, t=18^{0}C 1 M, Râpa, 2 III 2014, t=20^{0}C	15 IV – X
Cupido alcetas Hoffmannsegg, 1804	1 M, Râpa, 2 XI 2013, t=14^{0}C	20 IV – 7 X
Polyommatus icarus Rottenburg, 1775	Resistant species at the drought during 2015 and 2018	20 IV= X
Nymphalidae family		
Vanessa atalanta, Linnaeus, 1758	1 M, Râpa, 6 III 2016, t=12^{0}C 1 M, Tinca, 14 XII 2011, t=11^{0}C 1 M, Tinca, 22 I 2015, t=12^{0}C 1 M, Tinca, 6 I 2014, t=14^{0}C 1 M, Tinca, 20 I 2014, t=14^{0}C 1 M, 2 F, Râpa forest, 26 X 2014,t=12^{0}C 11 specimens, Tinca, t=8 - 17^{0}C, 20 X-25 I 2018	IV = X
Inachis io Linnaeus, 1758	1 M, Tinca, 18 XII 2012, t= 2^{0}C 1 F, Râpa, 2 XI 2013, t=16^{0}C 1 F, Tinca, 9 XI 2015, t=12^{0}C 1 M, Râpa, 4 XII 2016, t=4^{0}C 1 M, Tinca, 8 I 2018, t=14^{3}C	III = IX
Polygonia c - album Linnaeus, 1758	1 M, Râpa, 24 I 2017, t=13^{0}C 1 M, Tinca, 17 II 2016, t=16^{0}C	III – X
Aglais urticae Linnaeus, 1758	1 M, Râpa, 26 I 2917, t=14^{0}C 1 M, Tinca, 7 I 2018, t=13^{0}C	III = VIII
Nymphalis antiopa Linnaeus, 1758	1 F, Belfir, 17 XI 2013, t=16^{0}C 1 F, Tinca, 28 XI 2013, t=15^{0}C	IV – VIII
Nymphalis polychloros Linnaeus, 1758	1 F, 2 XI 2014, Râpa, t=19^{0}C	III – IX
Melitaea phoebe Denis, 1775	1 F, Râpa, 1 XI 2015, t=14^{0}C	V – IX
Pararge aegeria tircis Godat, 1821	1 F, Râpa, 2 XI 2013, t=16^{0}C 1 F, Tinca, 6 XI 2017, t=15^{0}C	IV = IX
Lassiommata megera Linnaeus, 1758	1 M, Tinca, 3 XI 2015, t=15^{0}C 2 F, Tinca, 21 – 22 X 2017, t=16 - 17^{0}C	15 IV – 7 X
Erebia medusa Denis, 1775	2 M, Tinca, 5 III 2017, t=18,5 ^{0}C	

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	1 F, Tinca, 22 III 2917, t=20^{0}C 1 caterpillar, Tinca, 3 II 2017, t= 7^{0}C	V – VIII
Minois dryas Scopoli, 1763	1 F, Tinca, 29 X 2015, t=15^{0}C 1 F, Râpa, 2 XI 2014, t=19^{0}C	VII – 7 IX
Apatura ilia Denis, 1775	1 M, Râpa, 2 XI 2014, t=19^{0}C	VI – VIII
Apatura iris Linnaeus, 1758	1 F, Râpa, 3 XI 2014, t=19^{0}C	VI – VIII
Sphingidae family		
Hyles euphorbiae Linnaeus, 1758	1 M, Tinca, 24 I 2018, t=4^{0}C	15 IV– 15 VI
Noctuidae family		
Polypogon tentacularia Linnaeus, 1758	1 M, Tinca, 15 II 2018, t= 5^{0}C	15 V– 15 VII

The specific distribution of the butterflies and moths' families is as follows: Nymphalidae (13 species), Pieridae (9 species), Papilionidae (9 species), Lycaenidae (3 species), Hesperidae (2 species), Sphingidae (1 species) and Noctuidae (1 species).
From the point of view of the collected specimens`sex, we observe the predominance of the males (November – March), the females being collected in most of the cases during May – August, rarely in November, proving a high ecological plasticity compared to the females.
To be noticed the presence of a very rare species at national level: *Parnasius apollo jaraensis* Kert., the species being accidental, even vagrant in Tinca area.
At *Vanessa atalanta* L. to be noticed a new generation comparatively to the scientific literature (Rakosy, 2013): larvae specimens at the end of September until October 10 2015, pupa after October 20 and even new adult specimens at the beginning of November. The scientific literature indicates the following periods: larvae (May 15 – September), pupa (June – September 7), adult (April – July, sometimes till to October).
Precocious apperances in nature were observed at the following species: *Parnasius apollo jaraensis* Kert. (with one – two months) *Iphiclides podalirius* L. (with one – three monts), *Papilio machaon* L. (with one – three monts), *Pieris rapae* L. (with one – three monts), *Pieris napi* (with one mont), *Colias alfacarieensis* Rib. (with four months), *Gonopteryx rhamni* L. (with one month), *Lycaena phleas* (with one – two monts), *Vanessa atalanta* (with one – three monts), *Aglais urticae* (with two months), *Polygonia c-album* (with one – two months), *Erebia medusa* Den. (with two – three months), *Hyles euphorbiae* L. (with three months), *Polypogon tentacularia* L. (with three monts).
The extension of the flight period was observed almost for all species, additional generations at Vanessa atalanta L., the hibernation in another development stage, sometimes simultaneously with the stage, sometimes simultaneously with the stage known in the scientific literature: *Pieris napi* L. and *Papilio machaon* L. (adulte, but not pupa, according to scientific literature).
Some species revealed some resistance at drought and heat during June – September 16, 2012 and June 8 – August 16, 2015 (*Pieris brassicae* L., *Polyommatus icarus* Rott.) other did not (*Papilio machaon* L., *Colias croceus* Four., *Colias hyale* L., *Colias alfacariensis* Rib., *Vanessa atalanta* L., *Inachis io* L.).

4. CONCLUSIONS

During 2010-2018, in Tinca area were observed phenological anomalies at 31 species of butterflies and 2 species of moths.
The extension of the flight period (majority of the species), the apperance of aditional generations (at one species), the hibernation in another development stage (at two species), precocious

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appearances in nature (at 14 specdies), resistence at dryness and heat (at two species), the predominance of the males specimens during the cold season, were observed like phenological anomalies. A very rare species in Romania (*Parnasius apollo jaraensis* Kert.) was observed in the analyzed area.

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