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Collecting Data of Late Recordings of Dragonflies in Poland in the Period of 2013-2020, as an Example of the Citizen Science

Zbieranie danych o późnych pojawach ważek w Polsce w latach 2013-2020 jako przykład nauki obywatelskiej

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Abstract: The group "Ważki (Odonata) w Polsce" is an excellent example of citizen science, understood as a cooperation between society and professionals in scientific activity. The goal of the present paper is to show the data concerning the very late appearances of dragonflies and damselflies in the years 2013 – 2020, to enrich the knowledge about the phenology of various species in comparison to published data, which is no longer valid, taking into consideration the climatic changes over the last decades. It would not have been possible to gather such a great amount of information, if not for the amateurs engaged into a project like that (ca. 100 people). The data was catalogued according to date, place, and species. The main methods used were: the visual observation and taking photos of adult dragonflies. After thoroughly studying the data collected in early, middle, and late autumn (October, November, December), and analysing it carefully, the records were divided into three groups. The information gathered, enables us to show the differences in phenology of some of the species. The project organised as a citizen science action, contributed to the increase of the knowledge concerning the late aspect of Polish odonatofauna.

Keywords: citizen science, dragonflies, Odonata, phenology, last records, Poland

Streszczenie: Grupa „Ważki (Odonata) w Polsce" jest doskonałym przykładem nauki obywatelskiej rozumianej jako zaangażowanie społeczeństwa w aktywność badawczą wspólnie z profesjonalistami. Celem niniejszego opracowania jest pokazanie danych o najpóźniejszych pojawach ważek w Polsce zgromadzonych w latach 2013 – 2020, a tym samym poszerzenie wiedzy dotyczącej fenologii poszczególnych gatunków w zestawieniu z danymi literaturowymi, które nie są już aktualne, biorąc pod uwagę choćby zmiany klimatyczne. Zgromadzenie takich danych było możliwe wyłącznie przy dużym udziale amatorów zaangażowanych w gromadzenie odpowiednich informacji (ok. 100 osób). Dane zostały skatalogowane pod kątem daty, miejsca i gatunku ważki. Podstawą danych we wszystkich przypadkach są obserwacje przyżyciowe ważek i ich dokumentacja fotograficzna. Po przestudiowaniu danych z okresu jesiennego i późnojesiennego (październik, listopad i początek grudnia) i ich dogłębnej analizie, rekordy podzielono na trzy grupy. Zebrane informacje pozwoliły na wykazanie zmian w fenologii części gatunków. Prowadzona akcja gromadzenia danych o charakterze nauki obywatelskiej, pozwoliła na poszerzenie wiedzy dotyczącej aspektu późnojesiennego odonatofauny Polski.

Słowa kluczowe: nauka obywatelska, ważki, Odonata, fenologia, ostatnie obserwacje, Polska

Introduction

"Dragonflies (Odonata) in Poland" ("Ważki (Odonata) w Polsce") is an open *Facebook* group founded on the 10th of December 2012 by Bogusława Jankowska, currently moderated by Grzegorz Tończyk, Anna Rychła, Piotr Mikołajczuk, Emil Dzienniak and Agnieszka Tańczuk. Nowadays, it has almost 3 thousand members (2.8 thousand) who are insect enthusiasts, especially dragonflies and damselflies. This group gathers mostly amateurs, yet it is scientific in its assumption, connected with the Odonatological Section of the Polish Entomological Society. Its main aim is to present the biodiversity of the dragonfly fauna, help in identification of species, get acquainted with specific habitats and biology as well as gather faunistic data, especially about phenology and distribution of dragonflies. The statute of the group directly emphasizes the crucial points important for all who want to post some information on the group's page. The members have to write the name of the species (or ask for it), as well as the date and the place of observation. These data play a cognitive role and help to draw up a map of the distribution of the species in Poland, and as such, they are of scientific value. The moderators and other group members are very helpful in substantive issues such as identifying species, explaining a typical dragonfly behaviour, or providing clues concerning the occurrence of the dragonfly species in various habitats. In this way, they educate the amateurs who may, in the future, cooperate with scientists in many projects. "Dragonflies (Odonata) in Poland" is a perfect example of citizen science, understood as a form of scientific activity or even a separate field of research (Hecker et al. 2018).

The conducted research usually focuses on such issues as protection and expansion of species, climatic changes (Lewandowski et al. 2017), monitoring of species' phenology and distribution (Hurlbert et al. 2019), which is also described in this paper. Considering the broadness of the subject and the spectrum of research, participation of as many people as possible is needed to get the results in a short period of time from different places simultaneously. This issue will be mentioned later. The volunteers' help allows researchers to examine a greater part of the area and discover rare phenomena which might otherwise be overlooked by academics who devote most of their their time to students or simply lack money to finance such large-scale research (Golumbic et al. 2017).

As far as odonatology is concerned, the input provided by citizens is priceless and may contribute to active protection of a species or a habitat. There are many projects all over the world for which active participation of citizens is crucial. Dragonflies and damselflies, similarly to butterflies, are a well-known group of insects, and what is more, they are simply attractive to the public. They are also quite easy to identify as imagines, and when there is a kind of a validation or approval by professionals or when specific and simple tools are used, enthusiasts may learn, and at the same time, provide some important information on ecology, distribution, phenology, etc. Such a project was proposed by a group of Czech scientists, and it involved construction of a mobile Android application for biological species recognition known as "Dragonfly Hunter CZ" (Ožana et. al 2019). The idea was to help in the classification of the odonata species and contribute to nature conservation (Ožana et. al 2019). Thanks to citizen science projects, such as the "OdonataMap – Atlas of the Dragonflies and Damselflies of Africa", a new species in the genus *Trithemis* Brauer, 1868 was discovered and a damselfly *Spesbona angusta* (Selys 1863), which was considered to be extinct, was rediscovered in RSA (Cannings 2019). Such monitoring programmes are important to study both Odonates and aquatic organisms and, of course, freshwater ecosystems in general. A more holistic approach, involving not only specific, endangered species, but the abundance of populations of all dragonflies and damselflies is needed. It is crucial since, species do not

exist in separation and the existence of one of them depends on the behaviour and existence of other – on the basis of an enormous amount of data taken from participants of citizen science projects, researchers may find out more about biodiversity and climate change (Bried et. al. 2020). Observations of certain phenomena by a large group of people cooperating for a given purpose or goal may be the reason why scientists from Cyprus were able to notice the longer flight season of some species of dragonflies (Sparrow et. al. 2021) – the same is happening in Poland. The increased number of observers enable odonatologists to monitor and predict changes through time because such projects are very often continued in many seasons or even decades (Bried et. al. 2020).

Similar projects were realised by "Ważki (Odonata) w Polsce" group in various ways and were followed by scientific publications in the journal *Odonatrix*. One of the texts was about the unprecedented influx of Vagrant Emperor *Anax ephippiger* in Poland to which ample data was gathered by amateurs and then transferred to researchers who analysed it (Michalczuk et al. 2020). Another one was a very interesting phenological text about the earliest records of dragonflies and damselflies in April and May 2018 in Poland (Rychła et al. 2019). Unpublished materials of greatest value were collected under the supervision of Alicja Miszta, PhD in the years 2009-2013 (Miszta 2013). The aim of this action was to find out more about the distribution of the southern species of dragonflies in Poland. 95 observers sent 775 records from 381 sites. Such long-term projects helped to gather data which contributed to the compilation of *A Distribution Atlas of Dragonflies (Odonata) in Poland* – 224 observes were involved and all the authors of the data were listed on the cover of the book (Bernard et al. 2009). To sum up, citizen science shows that the ultimate success depends on a wide group of people cooperating with each other in a form of partnership (Wołoszyńska-Wiśniewska 2016).

From the beginning of its activity, "Ważki (Odonata) w Polsce" group (Facebook.com 2021) has emphasized the quality of the published data: name of the species, place and date of observation. Every post is verified by administrators or other members of the group, so that the data could be considered scientifically useful. For the purposes of this article, only the data which were fully documented were taken into consideration: date, localisation and photo were crucial – all mistakes in identification were corrected, some information had to be completed based on correspondence with the author of the data. The group is also a good place to talk (usually informally) about dragonflies. There are a lot of links to articles or films about dragonflies, occasional greetings, posts showing the meaning of insects in pop culture, especially dragonflies. A contest has been organised for observing the last adult dragonfly (active, flying, apart from winter damselflies *Sympecma fusca* and *Sympecma paedisca*). It still is a great way to activate the members of the group. The element of competition introduced in this way (each year, there is a small prize for the winner) motivates the members to observe nature and increases their involvement in the matters of the group which becomes an additional value.

An analysis of the data gathered from 2013 concerning the last observations of imagines showed that some of them are different (sometimes the difference is very substantial) from the data found in literature. The goal of this paper is to present the analysis of data collected in the years 2013–2020 to enrich the knowledge about the phenology of various species of dragonflies and damselflies in Poland. The authors also wished to encourage future prospective and potential co-workers or volunteers by showing them that such actions bring specific, measurable, scientific results.

1. Material and methods

The authors of the article collected data posted on "Ważki (Odonata) w Polsce"

Facebook group (Facebook.com 2021) in October, November and December in the period from 2013 to 2020 by about 100 members of the group. The data was catalogued by date, site and the dragonfly species. All the posts were checked paying attention to the genus and species of the dragonfly. The basic method for gathering observations was observing imagines with the naked eye or using binoculars as well as taking photographs. The data is qualitative in character. In the beginning, in 2013, collecting data concerning the latest records of adult dragonflies in Poland was treated as a kind of fun and its goal was to integrate the group of amateur observers interested in these insects. Over the years, it has turned out that such information has a great scientific value. Yet, the rules of publishing materials on the group have not been changed. As a consequence, in many cases, there is not enough important data enabling an analysis of the collected information. The number of observers and the time of observation, etc., were not taken into consideration in the analysis, similarly was in the case of weather conditions. All observations were analysed holistically, being aware of the fact that such an assessment is methodologically insufficient. Regardless such limitations, gathered material is scientific in its nature and it shows one of the biological features of various species not only for a given site, but for the whole country.

2. Results

The analysis of data gathered in the years 2013-2020 (records = *FB* post) focuses on the presentation of a few aspects of the late autumn records of dragonflies in Poland. The first element deals with the distribution of recorded sites in Poland. The distribution was presented in total for the completed period of research on the maps, separately for October (fig. 1), November (fig. 2,) and December (fig. 3).

The distribution of sites where dragonflies were observed in the late autumn period indicates areas where favourable weather conditions enable dragonflies to be still active. Taking into consideration all the inaccuracies resulting from unequal number of observers in various areas of Poland, it is clear that in October (middle autumn), sites were scattered in the whole country (apart from mountainous areas). The greatest accumulation of sites was recorded in the lowlands and uplands, smaller number of sites were in the area of the lake district and in the north of Poland (fig. 1). In November (late autumn) (fig. 2), the accumulation of observations was similar to the one in October. Nevertheless, the distribution of observations was restricted to the lowlands and uplands (the greatest majority of them was concentrated in the centre and the southern part of Wielkopolska (Greater Poland) and Silesia. The only one, single observation from December (fig. 3) was recorded in the centre of Wielkopolska (Greater Poland).

The second aspect of the analysis is the number of recorded species. Overall, in the period of the late autumn (2013–2020) – October-November – the activity of 30 species of imagines was observed. In the first decade of October, the number of species recorded obviously corresponds to the summer period (28 species). Yet, it has to be stressed that for the greatest number of species the records were from 1 to 9 observations. The main part of the group of species recorded in the first part of October were: *Lestes virens*, *Chalcolestes viridis*, *Aeshna mixta*, *A. cyanea*, *Sympetrum danae*, *S. sanguineum*, *S. striolatum* and *S. vulgatum* (35-74 records). The second decade of October was characterized by a visible decrease of recorded species – 16 were observed. The most frequently recorded group of species is the same as in the first decade of October, however, with the smaller number of observations (19-60). In the third decade of October, 12 species were observed, some of them (4 species) were presented on the basis of single observations. Some species such as *Aeshna mixta*, *Sympetrum danae*, *S. sanguineum* were rarely observed

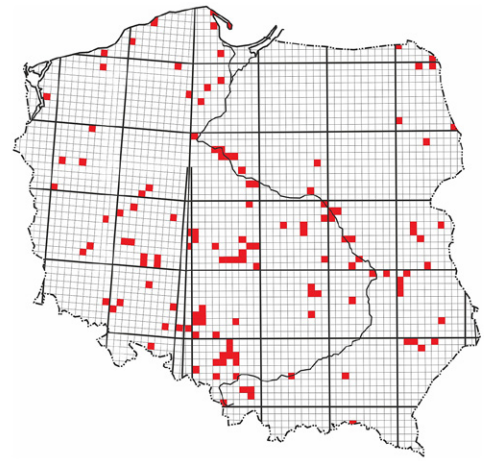

Figure 1. Places of observations of the last recordings of dragonflies in October in 2013-2020 in Poland in UTM-squares 10×10 km

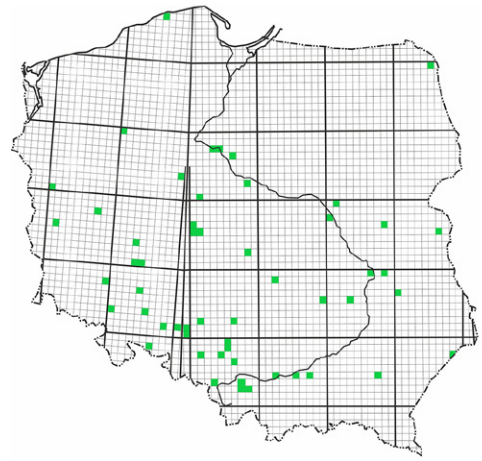

Figure 2. Places of observations of the last recordings of dragonflies in November in 2013-2020 in Poland in UTM-squares 10×10 km

Figure 3. The place of observation of the last recording of a dragonfly in December in 2017 in Poland in UTM-squares 10×10 km

(4-6 records). Similarly, to the first and the second decade of October, the most frequently observed species were: *Lestes virens*, *Chalcolestes viridis*, *Aeshna cyanea*, *Sympetrum striolatum* and *S. vulgatum* (16-51 observations). The set of species observed in the first decade of November was similar – 7 species. Nevertheless, there was a decrease in the number of records of *Lestes virens* and *Chalcolestes viridis* (7-11 observations) as well as *Aeshna cyanea* and *Sympetrum vulgatum* (15-17 observations). Very rarely *Aeshna mixta* and *Sympetrum sanguineum* (2-3 records) were observed. Numerous records were of *Sympetrum striolatum* only (87 observations). The second decade of November brought further decrease in the number of observations – 5 species were recorded. *Lestes virens*, *Chalcolestes viridis*, *Aeshna cyanea* and *Sympetrum vulgatum* were recorded only few times (2-4 observations). Numerously (69 observations) *Sympetrum striolatum* was recorded. In the latest – the third decade of November and the first decade of December – only one species was observed – *Sympetrum striolatum*.

The collected data clearly show also (third aspect of data analysis) that along with the passing time, the number of observations of various species was gradually decreasing. For example, for *Aeshna cyanea*, numbers of observations in respective decades from the beginning of October to the second part of November were as follows: 41, 33, 23, 17 and 4. Such a structure was characteristic to almost all species of dragonflies occurring in a given period: *Lestes virens*, *Chalcolestes viridis*, *Aeshna mixta*, *A. cyanea*, *Sympetrum danae*, *S. sanguineum*, and *S. vulgatum*. Quite differently, observations of *Sympetrum striolatum* were set – the number of observations of such a darter was increasing from the beginning of October to the second decade of November, reaching its climax (87 observations) in the first 10 days of November. Probably, it is connected to the increasing number of observers.

To sum up, dragonflies observed in Poland within a period of the middle autumn to the late autumn (October, November and the beginning of December) can be divided into three groups:

- the group observed in the first decade of October – 28 species, among which there were both species observed also further in time and the species characteristic for summer that could been observed because of favourable weather conditions until the beginning of October such as: *Calopteryx splendens*, *Coenagrion puella*, *Erythromma najas*; to that group nomadic species should be also added which start their flying period at the turn of summer and autumn – *Anax ephippiger*, *Sympetrum fonscolombii*,
- the group of species recorded in the second and third decade of October – 19 species, comprising of dragonflies numerously occurred in autumn (*Lestes virens*, *Chalcolestes viridis*, *Aeshna mixta*, *A. cyanea*, *Sympetrum danae*, *S. sanguineum*, *S. striolatum* and *S. vulgatum*) as well as some species not commonly observed and decreasing in number in that period (*Lestes sponsa*, *L. barbarus*, *Enallagma cyathigerum*, *Aeshna juncea*, *Cordulia aenea*, *Sympetrum depressiusculum*, *S. pedemontanum*, *S. flaveolum* and *S. meridionale*),
- the group of species recorded in November and at the beginning of December (late autumn) – 7 species especially in the greatest number of individuals: *Aeshna cyanea*, *Sympetrum striolatum* and *S. vulgatum*.

The summary of the occurrence of dragonflies in the late autumn period (October-December 2013-2020) and the comparison to the already published data concerning phenology are presented in the Table 1.

For few species (*Ischnura elegans*, *Coenagrion puella*, *Aeshna subarctica*, *Sympetrum vulgatum*) little extension of the flying period of imagines was recorded (less than 10 days) in comparison to the already published data. Such information should

Table 1. The summary of the occurrence of dragonflies in Poland in the middle/late autumn period (October-December 2013-2020). PD – published data (wazki.pl), LP – little extension of the flying period (less than 10 days), AP – average extension of the of flying period (10-30 days), SP – significant extension of the flying period (over 30 days), NP – no changes in the flying period in comparison to the published data

Species	PD	Observations 2013-2020	LP	AP	SP	NP
Calopteryx splendens	To the end of Aug	1st decade of Oct			x	
Lestes sponsa	To the end of Oct	2nd decade of Oct				xx
Lestes dryas	To the end of Oct	1st decade of Oct				x
Lestes barbarus	To the end of Sep	2nd decade of Oct		x		
Lestes virens	To the end of Oct	2nd decade of Nov		x		
Chalcolestes viridis	To the end of Oct	2nd decade of Nov		x		
Ischnura elegans	To the end of Sep	1st decade of Oct	x			
Enallagma cyathigerum	To the middle of Oct	2nd decade of Oct				x
Coenagrion puella	To the end of Sep	1st decade of Oct	x			
Erythromma najas	To the end of Aug	1st decade of Oct			x	
Erythromma viridulum	To the end of Aug	3rd decade of Oct			x	
Aeshna mixta	To the beginning of Nov	1st decade of Nov				x
Aeshna cyanea	To the beginning of Nov	2nd decade of Nov		x		
Aeshna juncea	To the end of Sep	2nd decade of Oct		x		
Aeshna subarctica	To the end of Sep	1st decade of Oct	x			
Anax imperator	To the end of Aug	1st decade of Oct			x	
Anax ephippiger	To the end of July, then the 2nd generation to the end of Aug, occasionally to the first decade of Oct	1st decade of Oct				x
Ophiogomphus cecilia	To the end of Sep	2nd decade of Oct		x		
Cordulia aenea	To the middle of Aug	2nd decade of Oct			x	
Orthetrum cancellatum	To the end of Aug	1st decade of Oct			x	
Sympetrum danae	To the beginning of Nov	3rd decade of Oct				x
Sympetrum sanguineum	To the end of Oct	1st decade of Nov	x			
Sympetrum depressiusculum	To the end of Aug, occasionally to the 3rd week of Sep	2nd decade of Oct		x		
Sympetrum flaveolum	To the beginning of Oct	3rd decade of Oct		x		
Sympetrum fonscolombii	To the end of Sep, then the 2nd generation to the end of Oct	2nd decade of Oct				x
Sympetrum striolatum	To the end of Oct, occasionally to the middle of Nov	1st decade of Dec		x		
Sympetrum vulgatum	To the end of Oct, occasionally to the middle of Nov	2nd decade of Nov	xx		x	
Sympetrum meridionale	To the end of Sep, then, occasionally, the 2nd generation to the 1st decade of Nov	3rd decade of Oct				x
Sympetrum pedemontanum	To the end of Oct	3rd decade of Oct				x
Crocothemis erythraea	To the end of Oct, probably the 2nd generation	1st decade of Oct				x

be treated as additional to the phenology of given species. The extension of the flying period over 10-30 days (average) for: *Lestes barbarus*, *L. virens*, *Chalcolestes viridis*, *Aeshna cyanea*, *A. juncea*, *Ophiogophus cecilia*, *Sympetrum striolatum, S. depressiusculum* and *S. flaveolum* shows that such data are important as supplementary knowledge about the species. It can be assumed that in favourable conditions (long and warm autumn, lack of major ground frost periods), the extension of the flying period seems to be quite natural. For some species (6), the extension of the flying period over 30 days has been recorded. That case was with: *Calopteryx splendens*, *Erythromma najas*, *E. viridulum*, *Anax imperator*, *Cordulia aenea*, *Orthetrum cancellatum*. The collected data change the description profile of all or the majority of given species. They have been described as summer species and as such their flying period ends in the last decade of Autumn or, rarely, the second decade of September. The analysed data are not enough to draw such far-reaching conclusions, but they may be connected with the large number of observers and changing climatic conditions. In autumn, the activity of dragonflies is limited to the warmest part of the day. There are some important weather conditions which may be generalised on the basis of the collected information. In October, in sunny weather, the period when dragonflies are active is rather long (10 a.m. – 4 p.m.) and it does not have to be connected with the full insolation. High temperatures enable dragonflies to be active during the whole day. The collected data confirm such a conclusion. Gradually, with the temperature dropping, when the day is shorter with shorter periods of sun, the activity of dragonflies is decreasing. Most of observations from November were gathered between 11.a.m. to 2 p.m. and always in the sunny, warm weather. The data concerning temperatures are not complete. *Sympetrum striolatum* was active in 10-12 °C, but it has to be emphasised that imagines chose such places where temperature was higher (strong insolation). Interesting is the fact that observations were also conducted in similar types of places. There were light surfaces (fallen branches or leaves) strongly reflecting the sun rays and in that way the warmest. Such places were used by dragonflies the most often. In the urbanised areas, species observed in November, were spotted on the bright architectural elements from the southern side – walls, small roofs etc.

Lack of detailed weather data which might be assigned to the records, prevents the authors from doing an analysis showing the connection between the weather conditions in autumn in the years 2013 to 2020 and the longer period of flight by imagines. Using the information from the portal of Institute of Meteorology and Water Management "Maps of the Polish climate" (IMGW.pl 2022), klimat.imgw.pl), the authors may confirm that the data are correlated with climatic data for the years 1991-2020, regarding the average extreme temperatures (max and min).

3. Discussion

Late records of imagines compared with the data from publications and set with climatic changes suggest a clear connection between the observed phenomena. Is that so in reality? Do we have enough data which may indicate actual relation between them? It is hard to assess. There are numerous publications showing the influence of the global warming on dragonflies and damselflies (Ott 2010; Ott and Samways 2010), but they rarely present such biological features of species like the length of the flying period (Wendzonka 2005; Żurawlew et al. 2010; Wiszniowska and Buczyński 2018; Rychła et al. 2019). Changes in odonatofauna caused by global warming are most often presented in the context of changes in distribution of the species such as expansion of southern species and contraction of northern species. Some data imply that the greater number of observations of the southern species and the decreasing records of the northern

ones are the result of the same phenomenon. The data which show that such changes in climate are correlated with the time of the flight period are only few. We see one shortcoming in the comparison of data from the years 2013-2020 with the already published data. Phenological tables presented in various papers are constructed on the basis of long periods of research.

In Poland, they are mainly taken from the information gathered since the beginning of odonatological research (the middle of the 19th century) which include very different und incomparable periods of time and weather conditions. Additionally, the published data are underestimated. The odonatological research in Poland was done from the middle of the 19th century to the end of the 20th century and mainly by scientists working in universities. The 1st of October, the beginning of the academic year, is also the time of interest for the purposes of this paper. Since the professionals were involved in academic matters, the intensity of field research was decreasing. That fact led to the situation in which data gathered by academics could not be representative for the late autumn period. Collected information enabled to show changes in phenology, but only for some of the species. Publications on the basis of gathered research became the foundation of the flying period of the species presented in literature (Bernard et al. 2009; wazki.pl). The proper list and its explanations have been shown in Table 1 (Results).

The collected data were also compared to the data known from Europe. Applicable phonological aspects of the late autumn species of dragonflies in the years 2013-2020 were shown in the Table 2.

It seems that the extension of the flying period of various species in Poland should result in greater resemblance

Table 2. Comparison of flight periods of species in the late autumn (2013-2020) in Poland and other European countries. N – the Netherlands, GB – Germany, Bavaria, NF – France, North, SF – France, South, NO – Norway, S – Sweden, B&G – Bulgaria and Greece, T – Turkey (Boudot and Kalkman 2015)

Species	Poland observations 2013-2020	N	GB	NF	SF	NO	S	B&G	T
Calopteryx splendens	1 decade Oct	2/Sep	1/Sep	2/Sep	2/Sep	3/Aug	3/Aug	1/Sep	-
Lestes sponsa	2 decade Oct	3/Sep	3/Sep	2/Sep	3/Sep	2/Sep	2/Sep	2/Aug	-
Lestes dryas	1 decade Oct	2/Sep	2/Sep	2/Sep	1/Sep	3/Aug	3/Aug	2/Sep	-
Lestes barbarus	2 decade Oct	3/Sep	3/Sep	3/Sep	3/Oct	-	-	2/Oct	-
Lestes virens	2 decade Nov	3/Oct	3/Oct	1/Nov	-	-	-	3/Oct	-
Chalcolestes viridis	2 decade Nov	1/Nov	3/Oct	2/Oct	3/Nov	-	-	-	-
Ischnura elegans	1 decade Oct	2/Sep	2/Sep	2/Sep	3/Sep	3/Aug	3/Aug	2/Oct	-
Enallagma cyathigerum	2 decade Oct	3/Sep	2/Sep	2/Sep	2/Sep	1/Sep	1/Sep	2/Sep	-
Coenagrion puella	1 decade Oct	3/Aug	1Sep	3/Aug	3/Aug	2/Aug	2/Aug	2/Aug	-
Erythromma najas	1 decade Oct	3/Aug	3Aug	1Sep	3/Aug	2/Aug	2/Aug	-	-
Erythromma viridulum	3 decade Oct	2/Sep	2/Sep	2/Sep	2/Sep	-	3/Aug	1/Oct	-
Aeshna mixta	1 decade Nov	3/Oct	2/Oct	3/Oct	2/Nov	2/Oct	2/Oct	2/Nov	-
Aeshna cyanea	2 decade Nov	3/Oct	2/Oct	2/Oct	1/Nov	1/Oct	1/Oct	3/Sep	-
Aeshna juncea	2 decade Oct	1/Oct	2/Oct	3/Sep	3/Sep	1/Oct	1/Oct	2/Aug	-
Aeshna subarctica	1 decade Oct	2/Oct	3/Oct	1/Sep	1/Sep	3/Sep	3/Sep	-	-
Anax imperator	1 decade Oct	2/Sep	1/Sep	1/Sep	2/Sep	-	2/Aug	2/Oct	-
Anax ephippiger	1 decade Oct	-	3/Sep	2/Sep	2/Sep	-	-	3/Nov	2/Nov
Ophiogomphus cecilia	2 decade Oct	2/Sep	3/Sep	2/Sep	2/Sep	-	-	-	-
Cordulia aenea	2 decade Oct	2/Jul	3/Aug	2/Aug	1/Aug	1/Aug	1/Aug	3/Jul	-
Orthetrum cancellatum	1 decade Oct	2/Sep	1Sep	2Sep	2Sep	3/Aug	3/Aug	1/Oct	-

Species	Poland observations 2013-2020	N	GB	NF	SF	NO	S	B&G	T
Sympetrum danae	3 decade Oct	2/Oct	2/Oct	2/Oct	2/Oct	2/Oct	2/Oct	2/Oct	-
Sympetrum sanguineum	1 decade Nov	1/Oct	1/Oct	1/Oct	3/Oct	3/Sep	3/Sep	2/Sep	
Sympetrum depressiusculum	2 decade Oct	1/Oct	3/Sep	3/Sep	1/Oct	-	-	1/Oct	-
Sympetrum flaveolum	3 decade Oct	3/Sep	3/Sep	3/Sep	3/Sep	3/Sep	3/Sep	3/Sep	-
Sympetrum fonscolombii	2 decade Oct	2/Oct	3/Sep	2/Oct	3/Oct	-	-	3/Nov	-
Sympetrum striolatum	1 decade Dec	1/Nov	3/Oct	1/Nov	3/Dec	1/Nov	1/Nov	3/Nov	-
Sympetrum vulgatum	2 decade Nov	2/Oct	2/Oct	1/Oct	2/Oct	2/Oct	2/Oct	1/Oct	
Sympetrum meridionale	3 decade Oct	1/Oct	-	3/Sep	1/Nov	-	-	1/Nov	-
Sympetrum pedemontanum	3 decade Oct	1/Oct	2/Oct	-	3/Sep	-	-	1/Sep	-
Crocothemis erythraea	1 decade Oct	1/Sep	3/Sep	2/Sep	2/Sep	-	-	2/Oct	-

to the corresponding data received from the southern Europe, where winter starts later than in the north of Europe. That kind of comparison is not unambiguous, and it does not show such a dependence directly. The reason for it, may be the period of collecting data concerning phenology and presenting them in the form of an analysis in a given country.

Observations recorded in the years 2013-2020 brought significant changes in the knowledge concerning phenology of some of the species – they should be connected to the climatic changes. The evidence of this are weather changes continued in the analysed years such as longer periods of higher temperatures than it was before, lack of precipitation, high insolation. The contest for the last record of an adult dragonfly or damselfly in Poland organised in the years 2013-2020 brought some record-breaking observations. The list of the latest records and the winners of the contest in corresponding years was presented in Table 3. The record-breaking observations are concentrated in south-east Wielkopolska (Greater Poland) and in the middle part of Silesia. The citizen science project of collecting data enabled to enhance knowledge concerning the late autumn aspect of odonatofauna in Poland.

To understand the processes taking place in the environment, researchers need more information. Citizen science projects are valuable tools to fulfil the blank spaces on the world map of dragonflies and damselflies. Thousands of volunteers gather a lot of important information because they have motivation with the elements of fun, pride and even healthy competition (Bried et. al. 2020). With some professional training or guidance, they contribute to some discoveries, enhancing the knowledge of organisms' behaviour and help to organise diversified means of nature protection.

Data presented in a given text are difficult to compare directly to results of other authors, since different methodological approaches were used. Analysing the data from Poland, contrary to the works of Ball-Damerow et al. (2014) or Sparrow et. al (2021), the authors of this text did not take into consideration such factors as: the number of observers and the exact time and weather conditions during observations. The authors are aware of the fact that it is a kind of a disadvantage of the text. The flight periods of described species are in line with the tendencies in species distribution and connected with climatic changes presented in Termaat et al. (2019). In addition, the authors of this text, showed also a different aspect of such changes, resulted in not so much with changes in locations, but rather with elongation of the occurrence of those insects during the autumn period.

Table 3. The winners of the contest for "The last record of an adult dragonfly or damselfly in Poland" with the detailed data. Winners: ŁB – Łukasz Berlik, MW – Maria Wiszniowska, MP – Mirosław Pielot, KL – Krzysztof Lewandowski, JD – Jacek Dumański, MK – Marcin Karetta. The link with the announcement of the first winner of the contest in 2013: (Facebook.org 2021)

Date	Species	Winner	UTM	Place
19.11.2013	*Sympetrum striolatum*	ŁB	YS01	Opole
15.11.2014	*Sympetrum striolatum*	MW	CA66	Katowice
13.11.2015	*Sympetrum striolatum*	MK	CA66	Katowice
8.11.2016	*Sympetrum striolatum*	MW	CA66	Katowice
2.12.2017	*Sympetrum striolatum*	JD	CC05	Złotniki Wielkie
25.11.2018	*Sympetrum striolatum*	MW	CA66	Katowice
		MP	CB12	Poczołków
24.11.2019	*Sympetrum striolatum*	MW	CA66	Katowice
		MP	CB12	Poczołków
24.11.2020	*Sympetrum striolatum*	MW	CA66	Katowice
		MP	CB12	Poczołków
		KL	CD82	Jez. Rakutowskie

Data from Poland, presented in this paper, are aligned with the observations of Sparrow et. al. (2021) from Cyprus, showing, among others, the elongation of the occurrence of dragonflies. The present paper shows the meaning and the significant role volunteers can play in collecting scientific data. It also confirms the opinion of Bried'a et al. (2020) about the importance of citizen science projects in odonatological and insects' research in the age of "Insect Apocalypse". Gathering such a number of records is only possible if amateurs are engaged in it together with the professionals. The authors of data are listed below in alphabetic order.

Barbara Babik, Tomasz Baziak, Arkadiusz Begier, Łukasz Berlik, Mariusz Blank, Jakub Błędowski, Paweł Bojar, Marta Wąsik-Boroń, Paweł Buczyński, Andrzej Burzik, Andrzej Cieśla, Robert Cymbała, Krzysztof Czajkowski, Paweł Czechowski, Bartosz Łukasz Czernik, Janusz Dądela, Marek Długosiewicz, Marian Domagała, Jacek Dumański, Zbigniew Fijewski, Nikola Góral, Mirosław Gromek, Ewa Grzeszczuk, Mariusz Gwardjan, Marcin Horbacz, Katarzyna Jakóbik-Wocka, Zofia Jankowska, Grzegorz Jędro, Adam Juraszczyk, Emilia Juzwiszyn, Mira Kalejta, Marcin Karetta, Mira Klęczek, Sławomir Kłusewicz, Paweł Kobyłecki, Sly Kociniak, Ryszard Kołakowski, Alina Kołodko, Dorota Konstantynowicz, Dawid Kozłowski, Wiktor Kroker, Elżbieta Kujawka, Karolina Kurz, Nina Kus, Izabela Kwaczyńska, Krzysztof Lewandowski, †Jakub Liberski, Danuta Lipińska, Piotr Łagosz, Robert Łuczak, Karol Mackiewicz, Katarzyna Matusik, Małgorzata Matyjasiak, Jacek Mazurek, Waldemar Michalak, Wiaczesław Michalczuk, Iwona Mielewska, Piotr Mikołajczuk, Ewa El Mohtar, Paweł Morawiec, Jacek Mościcki, Krzysztof Napierała, Jarek Niedojadło, Aleksandra Radołowicz-Nieradzik, Janusz Niewolik, Katarzyna Nowicka, Krzysztof Ostrowski, Katarzyna Panfil, Ryszard Pajkert, Izabela Persona, Benia Poj, Mirosław Pielot, Grażyna Pietrasik, Ireneusz Pilipczuk, Stanisław Powała-Niedźwiedzki, Witold Nocoń, Janusz Ratajczak, Ewa Rauner-Bułczyńska, Anna Rychła, Anna Sarna, Małgorzata Siuda, Jarosław Słowikowski, Artur Staszewski, Andrzej Staśkowiak, Anna Strauchmann, Anna Śnieżek, Rafał Świerad, Agnieszka Tańczuk, Adam Tarkowski, Grzegorz Tończyk, Izabela Tul, Teresa Urbańczyk, Robert Wakulski, Elżbieta Wasylków, Grzegorz Wieczorek, Maria Wiszniowska, Augustyna Włodarska, Katarzyna Wolska-Pociask, Zdzisław

Zalewski, Igor Załęski, Justyna Zawadzka, Michał Zawadzki, Jan Zieliński.

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