Odonatrix 16_7 (2020)

A new locality of Norfolk Damselfly *Coenagrion armatum* (CHARPENTIER, 1840) (Odonata: Coenagrionidae) from northern Poland

Nowe stanowisko łątki zielonej *Coenagrion armatum* (CHARPENTIER, 1840) (Odonata: Coenagrionidae) w północnej Polsce

Peter SENN
ul. Kańskiego 7D/9,81-603 Gdynia, e-mail: petersenn47@gmail.com

Abstrakt: Komunikat dotyczy obserwacji jednego młodocianego samca łątki zielonej *Coenagrion armatum* (CHARPENTIER, 1840) (Odonata: Coenagrionidae) w dn. 13.06.2013 przy pętli tramwajowej w Gdańsku Brzeźnie (UTM: CF43). Punkt ten zlokalizowany jest ok. 400 km na północny-zachód od obecnego zasięgu *C. armatum* w Polsce i ok. 600 km na wschód od najbliższych znanych populacji w Szlezwiku-Holsztynie (płn. Niemcy). W promieniu 100 km od Gdańska nie wykazano nigdy jakiejkolwiek populacji łątki zielonej. Nieliczne obserwacje tego gatunku na tym obszarze od połowy XIX w. odnoszą się wyłącznie do pojedynczych osobników. Podobnie jak w przypadkach historycznych, obecnie również najprawdopodobniej mamy do czynienia z „samotnym wędrowcem". Rozważano hipotezę, że cofnięcie areału występowania *C. armatum* w kierunku wschodnim zostało spowodowane przez cofnięcie w tym samym kierunku przebiegu izotermy stycznia –2°C w ciągu ostatnich kilkudziesięciu lat. Analizowano różne, możliwe przyczyny pojawienia się tej ważki na stanowisku w Gdańsku, lecz nie da się wyciągnąć konkretnych wniosków.

Key Words: Damselfly, Odonata, *Coenagrion armatum*, new record, northern Poland, climate change.

Introduction

The Norfolk Damselfly *Coenagrion armatum* is a rare and infrequently seen damselfly of Siberian origin. Its distribution in Eurasia stretches from Kamchatka in the Russian Far East right across central Russia, touching northern Mongolia and Kazakhstan, to east-central Europe: Belarus, the Baltic States, Finland, Sweden, northern Ukraine, Poland, northern Germany, Denmark and the Netherlands (BOUDOT & SAHLÉN 2015). It has been declining for many years at the western edges of its range. Its distribution in Poland has contracted significantly, too: its probable former range boundary extended in a wide curve from the Baltic Coast near Koszalin, southwards to the Poznań area, then south-eastwards to roughly Opole, then eastwards to Przemyśl on the border with Ukraine (Fig. 1) (BERNARD et al. 2009). The Norfolk Damselfly has disappeared from most of this area. Its likely present range extends in a fairly narrow band along the country's eastern frontier: from the border with Lithuania to the southern extremity of Lublin province and no farther west than the Biebrza Marshes, Międzyrzec Podlaski and Lublin, where the few extant but highly localized populations are still quite numerous. In 2011 a very small number of these damselflies was recorded at two localities to the west of their present range – at Jabłonów (near Łódź), and on the bank of the River Kurówka, a small tributary of the River Vistula (Wisła) near Puławy, although *C. armatum* from the latter locality will not have developed in this river but in some small waterbody nearby (BUCZYŃSKI et al. 2011). A year later, three further localities were found in southern Podlasie (Szaniawy-Poniaty and Zaścianki, east of Łuków) and in eastern Mazovia ("Torfisko", north of Mińsk Mazowiecki) (MIKOŁAJCZUK 2012).

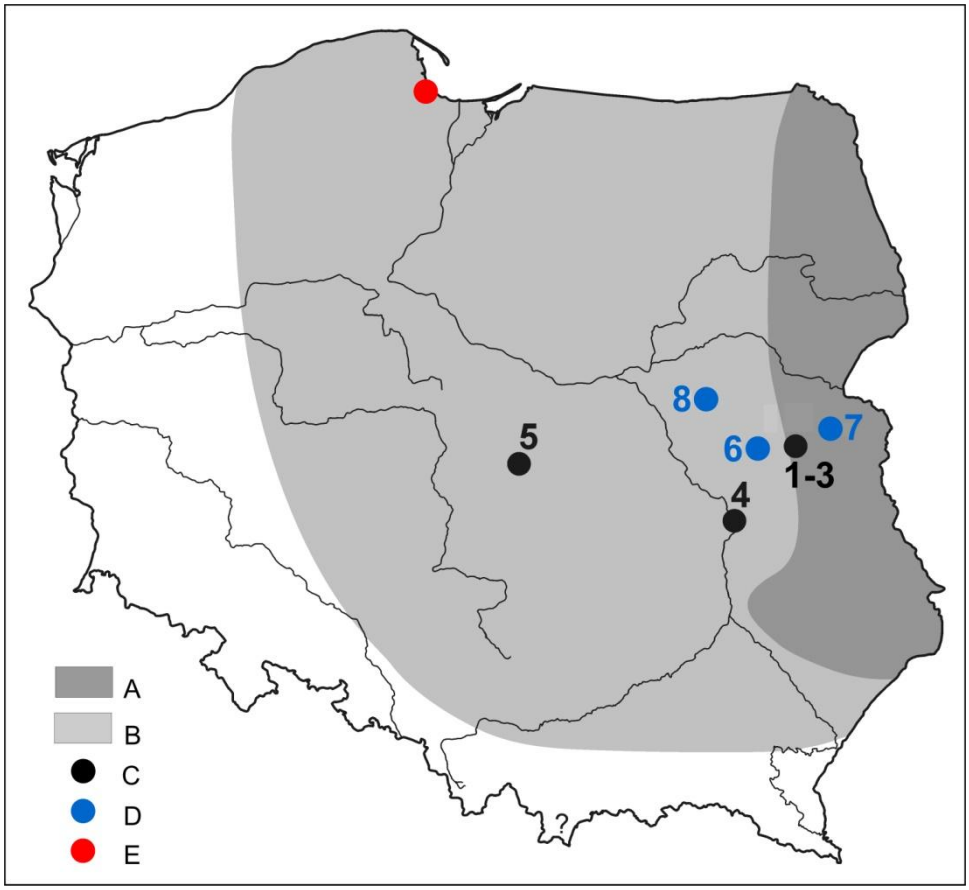

Fig. 1. The present (A) and historical (B) distribution of *Coenagrion armatum* in Poland (based on BERNARD et al. 2009). Black dots (C) – localities 1-5 (BUCZYŃSKI et al. 2011); blue dots (D) – localities 6-8 (MIKOŁAJCZUK 2012); red dot (E) – new locality in Gdańsk Brzeźno (UTM: CF43). Map based on Fig. 1 in BUCZYŃSKI et al. (2011), reproduced by courtesy of the authors.
Ryc. 1. Obecny (A) i historyczny (B) obszar występowania *Coenagrion armatum* w Polsce (mapa oparta na pracy BERNARDA et al. 2009). Czarne kropki (C) – stanowiska: 1-5 (BUCZYŃSKI et al. 2011); niebieskie kropki (D) – stanowiska 6-8 (MIKOŁAJCZUK 2012); czerwona kropka (E) – nowe stanowisko w Gdańsku Brzeźnie (UTM: CF43). Mapa oparta na Ryc. 1 w pracy BUCZYŃSKIEGO et al. (2011), za zgodą autorów.

New locality

Gdańsk Brzeźno (CF43; 54°24'32"N, 18°37'36"E; mesoregion – Vistula Spit (Mierzeja Wiślana) (KONDRACKI 1981) – tram terminus (Fig. 2). *C. armatum*: 13 VI 2013, 1 ♂ imm. (leg. et det. Michał KOWALCZYK, ver. Peter SENN, coll. Natural History Collections, Adam Mickiewicz University, Poznań). No other individuals of this species were sighted. During a visit to this locality in May 2018, I failed to find *C. armatum*. This is only the fourth locality of this species west of 22°E since 1999; the other three are sites 4, 5 and 8 shown on Fig. 1 (BUCZYŃSKI et al. 2011, MIKOŁAJCZUK 2012).

Discussion

This record is something of an enigma. The locality where it was found, 400 m from the Baltic Sea beach, is ca 600 m from the nearest freshwater body, and a good 400 km to the north-west of this damselfly's present-day range in Poland.

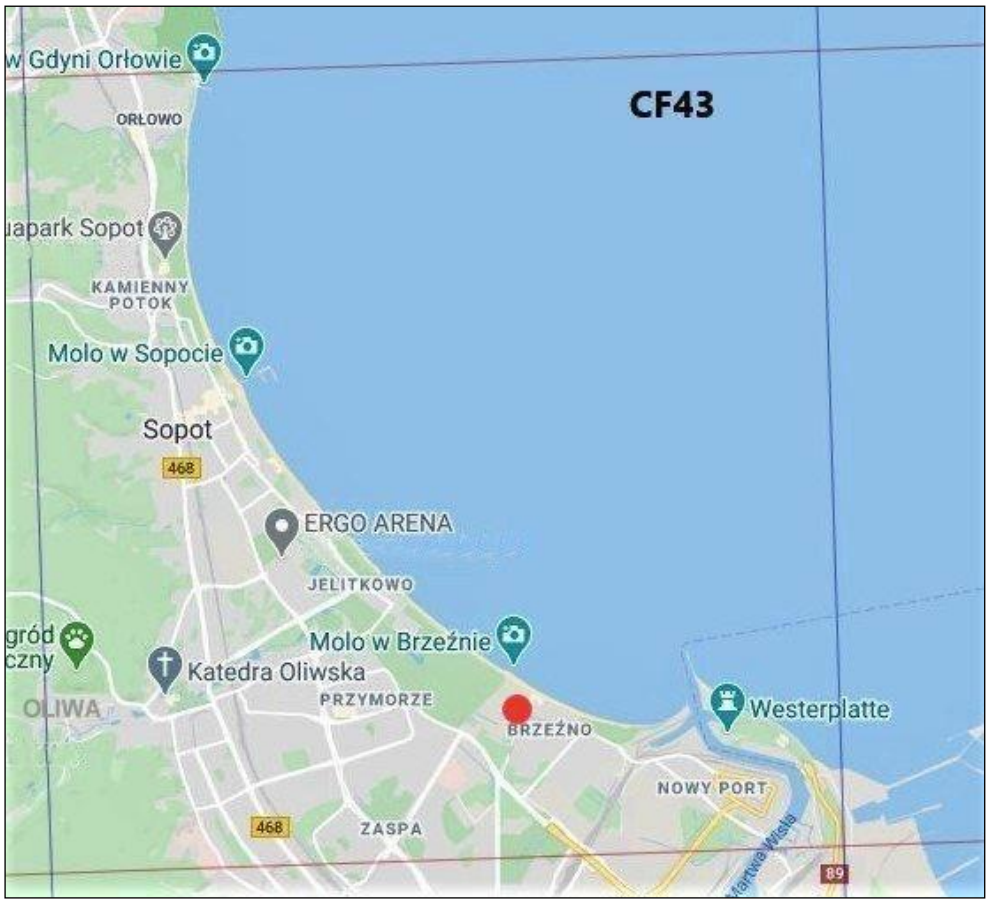

Fig. 2. Map showing the site location (https://lepidoptera.eu/utm).
Ryc. 2. Mapa lokalizacji stanowiska (https://lepidoptera.eu/utm).

The geographical range of *C. armatum* appears to be governed primarily by climate (BUCZYŃSKI 2000). The historical western range boundary of *C. armatum* in Poland more or less coincides with the line of the January –2°C isotherm during the period 1951-1980 (and presumably earlier). Between 1991 and 2015 this isotherm shifted eastwards some 400 km (https://blog.meteomodel.pl/pochod-izoterm-styczen/) (Fig. 3). The contemporary line of that isotherm roughly matches the present-day western range boundary of *C. armatum* in Poland. It thus looks as if this boundary has receded eastwards as a result of the evident upsurge in climate warming that began in the late 1980s (BERNARD et al. 2009). This is borne out by an analysis of anomalously cold and warm months in Poland for the period 1951-2015, which found that 16 of the 35 anomalously cold months in that period occurred between 1951 and 1965, 8 of them in spring. Such cold months became far less frequent in subsequent years (TWARDOSZ 2017). Another analysis indicates that winters without sub-zero temperatures in Poland are increasing in frequency. During six winter seasons between 1987/1988 and 2007/2008, mean air temperatures for all three winter months (December-February) were above zero (ZIERNICKA-WOJTASZEK and ZUŚKA 2016). In fact, global temperatures have actually been rising slowly ever since the late 19th century, as the so-called Little Ice Age gradually petered out. That was a very long period (several centuries) of low temperatures that would have been responsible for colder-than-usual winters farther west in Europe. *C. armatum* is a Siberian species, so it will be cold-tolerant, indeed requiring cooler temperatures

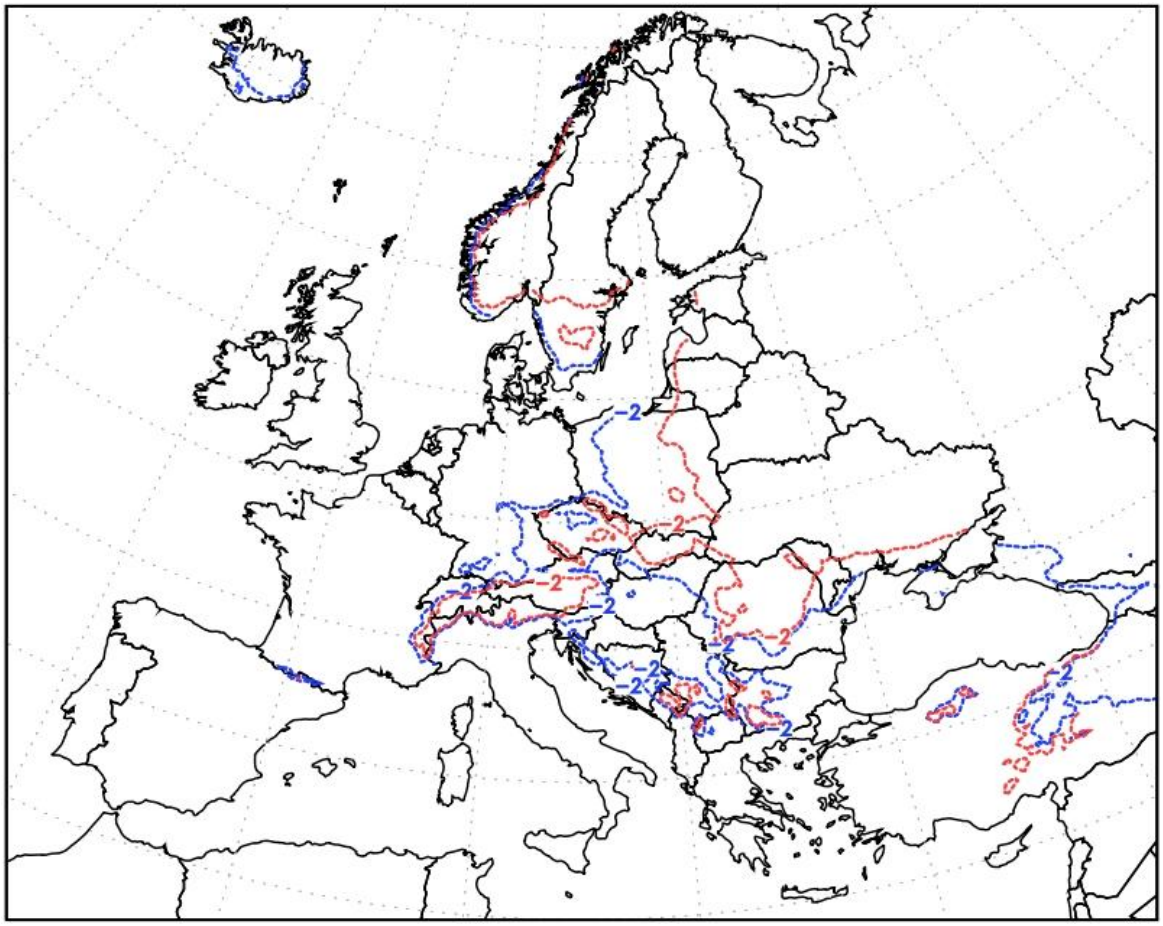

Fig. 3. January –2°C isotherm from 1951 to 1980 (blue) and from 1991 to 2015 (red) (https://blog.meteomodel.pl/pochod-izoterm-styczen/).
Ryc. 3. Przebieg izotermy stycznia –2°C w latach 1951-1980 (niebieski) i 1991-2015 (czerwony) (https://blog.meteomodel.pl/pochod-izoterm-styczen/).

for its development. This may explain its early and brief appearance as an adult in May, when air temperatures have not yet reached their summer heights. Its larval development must also take place in cool waters, before they are warmed by the summer sun. Moreover, its habit of flying rapidly among the stems of rushes, sedges and reeds keeps it within a microclimate which will be cooler than that over open water. Although habitat changes, both natural and anthropogenic, especially the draining of wetlands, have undoubtedly played a part in the Norfolk Damselfly's retreat from its former range, temperature does seem to be a major factor driving this phenomenon. The eastward retreat of the –2°C January isotherm appears to offer plausible circumstantial evidence as to why the range of *C. armatum* has likewise been retreating eastwards, habitat concerns notwithstanding. If this does turn out to be the case, then there is probably little one can do to prevent the species' extinction in Poland, especially if future winters are going to be as mild as those of 2018/2019 and 2019/2020. One way of testing this hypothesis would be to check current and historical air, water and soil temperature data (available on many different websites) against the known present-day and historical localities of the Norfolk Damselfly in Poland and in Europe as a whole. Obviously, this would have to be backed up by a statistical treatment and possibly validated by winter temperature measurements at its present-day sites. If the hypothesis survived this test, one could then seek out other areas with similar microclimatic

conditions and find out whether the habitat structure in those localities matched the Norfolk Damselfly's requirements. This would have important implications for the species' conservation.

In northern Germany (Schleswig-Holstein), a systematic search for *C. armatum* was carried out in 2008 at all the former sites of this species: 137 standing waters in 37 sites were investigated. However, imagines of *C. armatum* were found at just 12 sites on 18 water bodies, all of which were situated in the far north of Schleswig-Holstein; none of its former localities farther south in this Land were occupied (WINKLER et al. 2009). According to the https://libellenwissen.de website, the species appears to have all but disappeared from northern Germany because of the drainage of its habitats, even though most of the localities mentioned by WINKLER et al. (2009) were in Natura 2000 areas and in spite of proposed conservation measures. It is not clear whether this statement on the website refers to that 2008 survey or whether the situation regarding the Norfolk Damselfly in Schleswig-Holstein has deteriorated even further. It is worth noting, however, that in that region of Europe, too, the –2°C January isotherm has receded, this time northwards: in 1951-1981 it more or less followed the coastline of southern Sweden, whereas in 1991-2015 it crossed south-central Scandinavia in a line from Oslo to Stockholm. The course of this isotherm could be the reason why there are still viable populations of *C. armatum* in Belarus and Lithuania; indeed, the Red Book of Lithuania does not even consider it to be endangered! (BUCZYŃSKI et al. 2011). In Ukraine, a survey of 10 of the 14 known *C. armatum* localities was carried out in 2007, but this damselfly was not found at any of them (KHROKALO & KRYLOVSKAYA 2008). The authors give probable reasons for this absence of *C. armatum*: farming activities, more general habitat changes and global warming. The whole of Ukraine lies to the east of the contemporary –2°C January isotherm, so if the hypothesis considered above holds water, it will be these habitat changes that are probably responsible for its non-occurrence there.

The extinction of *C. armatum* in England in the 1950s was put down to habitat loss (BROWNETT 2005). Its presence there was practically confined to the eastern edge of the county of Norfolk, in the east of England, a region which often experiences extremely cold weather in winter. On the other side of the North Sea, however, a population of the Norfolk Damselfly has managed to persist at one site in the Netherlands for a number of years now. The species was rediscovered at a locality known as De Weerribben (PARR 1999, VAN DER HEIJDEN 2000) and this population survived until at least 2015 (BOUWMAN et al. 2016). In the Netherlands and neighbouring countries, the Norfolk Damselfly occupies a very specific type of habitat, with open helophyte vegetation in shallow water. It would seem that the spatial structure of the vegetation is more important than the plant species forming it (see also BUCZYŃSKI 2000). As the situation in the Netherlands is fragile with only one large population, specific management is required, aimed at maintaining current habitat locations and creating new ones (BOUWMAN et al. 2016).

The distributions of plants and animals are governed by a complex network of biotic and abiotic factors. Among them, climate, or perhaps more pertinently, microclimate, plays a major part. This applies in particular to species in marginal habitats, whose survival is governed not only by the habitats that are available to them, but primarily by the frequency of extreme, even catastrophic, weather events (CORBET 2004). In the case of the Norfolk Damselfly, such events may well be excessively high winter temperatures. Its life-cycle may depend on being exposed to low (below-freezing) winter temperatures; if this does not occur, as in many other insects, continued larval development and reproduction is not possible.

One could object to the above claim regarding the link between the –2°C isotherm and the Norfolk Damselfly's distribution range that while this is a Siberian species, there are many others of like origin that inhabit Europe, e.g. *Lestes dryas*, *L. sponsa*, *Sympecma paedisca*, *E. cyathigerum*, *C. lunulatum*, *Aeshna caerulea*, *A. subarctica*, *Somatochlora alpestris*, *S. arctica*, *Libellula quadrimaculata*, *Sympetrum danae* and *S. flaveolum.* The ranges of some, like *A. caerulea*, *S. arctica* and *C. lunulatum*, are indeed contracting for a variety of reasons, not just climate change. Others, like *L. sponsa*, *E. cyathigerum* and *L. quadrimaculata*, are widespread and very common.

In the light of the above, one can discuss a few possibilities regarding the presence of *C. armatum* in Gdańsk Brzeźno.

It was from a local, hitherto undiscovered, population, in a marginal habitat

This population would have established itself on one of the ponds or drainage ditches in the Ronald Reagan Park, some 600 m to the west. This park is just a few hundred metres from the sea, so it has a somewhat cooler microclimate than places farther inland. This part of Poland can be quite windy, and in winter strong, northerly winds gusting down from the Arctic bring freezing weather, while in summer sea breezes keep the temperature down. This could not have been a relict population, however, as the park ponds only came into being in the early 2000s, when what must have originally been some kind of wetland (evident from the numerous drainage ditches shown on early 20th century maps), later turned into allotment gardens, was converted into a park. The two ponds – a larger and a smaller one, neither of which dry out – are wholly given over to nature, i.e. no recreational activities such as angling or boating are permitted. The consequence is that they both boast quite a rich aquatic vegetation and offer nesting sites to a wide range of birds associated with water and wetlands. They also support fish and amphibians. Access to the waterside is restricted by broad swathes of reedbeds or willow and alder scrub. While this habitat may not be an optimal one for *C. armatum*, it could theoretically have developed there, if aside from temperature considerations, the habitat structure was roughly similar to that described by BOUWMAN et al. (2016). For lack of conservation measures, or due to neglect, this structure will have changed quite quickly during the following years. If the Gdańsk specimen did indeed emerge from one of those ponds, then it would have got to the tram terminus at Brzeźno on one of its first, pre-reproductive flights in order to forage well away from water, later to return to the pond(s).

Now, this putative population must have been founded by immigrants from somewhere. While undertaking pre-reproductive flights from their place(s) of emergence, a number of these damselflies must have flown in or been blown in on suitably strong winds from a nearby breeding habitat. As this, too, would have been a very long way from the species' present-day range, it is also likely to be sub-optimal: animals at the edges of their expanding or contracting distribution ranges do make use of suboptimal habitats. The nearest such area could have been the River Dead Vistula (Martwa Wisła), the banks of which are flanked by fairly dense stands of emergent vegetation. *C. armatum* is not a lotic species, but the waters in this river are practically stagnant (for more than 120 years this stretch has no longer been part of the Vistula's main course, so there is hardly any current). More likely, though, are the innumerable canals and drainage ditches in the low-lying Vistula Delta (Żuławy Gdańskie), immediately to the south-east of Gdańsk, again containing stagnant water and with abundant vegetation. A third possible source is one of the many lakes and ponds in the Pomeranian Lake District to the south. The wetland reserve "Ptasi Raj", a dozen or so km to the east, is

unlikely, however: MIELEWCZYK (1970) failed to find *C. armatum* during his study of that locality, which was hardly surprising given that the waters there are more or less brackish.

It was dispersing to this area

Another possibility is that this Norfolk Damselfly, itself a pioneering species, was on a dispersal flight from one of the habitats mentioned above, especially as on the day concerned (13 June 2013) a southerly wind (14.5 km/h) was blowing. The day before there had been hardly any wind, and two days earlier there was a light wind from the north (3.75 km/h) (https://www.ekologia.pl/pogoda/polska/pomorskie/gdansk/archiwum). But this does not seem likely. To quote from CORBET (2004): 'Dispersal, unlike migration, cannot be performed by a single individual because dispersal entails individuals separating and becoming farther apart. Dispersal diminishes population density and is centrifugal; … migration, in contrast to dispersal, relates to ground coordinates, not to other individuals, and may be performed in company or alone.'

It was migrating

The place where this specimen of *C. armatum* was found is, as I mentioned earlier, just a few hundred metres from the Baltic Sea shore. This lies on the Baltic Flyway, well-known to ornithologists, along which birds migrate from western and south-western Europe eastwards and north-eastwards towards the Arctic and the tundra regions of northern Scandinavia and Russia (and back, of course). There is anecdotal evidence from Polish ornithologists trapping birds on the Hel Peninsula, north of Gdańsk, that dragonflies do migrate along the spit, but none have actually been caught. Concrete evidence of dragonfly migration along the southern Baltic coast is provided by SHAPOVAL & BUCZYŃSKI (2012), SHAPOVAL & SHAPOVAL (2017) and SHAPOVAL (2018), who caught large numbers of migrating dragonflies of nearly 60 species in 'Rybachy'-type ornithological funnel traps on the Curonian Spit further up the Baltic Coast in the Kaliningrad Oblast of Russia (57 species, only 15 of which were zygopterans). Similar, though less extensive, data are available from the Lithuanian part of the Curonian Spit, including the latest record of *Pantala flavescens* caught in an ornithological net (JUSYS et al. 2019). *C. armatum* was not among the odonates caught in the 'Rybachy' traps, although other Siberian tyrphophilous and/or lacustrine species with similar habitat preferences did occur. Most of the odonates on the Curonian Spit were caught in July and August. 'Our' Norfolk Damselfly is thus extremely unlikely to have arrived in Gdańsk Brzeźno as a migrant, especially as it was a young individual.

In fact, only single individuals of this species have ever been caught in the region around Gdańsk. HAGEN (1846) mentioned a single male *C. armatum* that was caught at a place called Heidekrug bei Danzig. This record was initially assigned to Heidekrug near Zewitz (Cewice), about 60 km W of Gdańsk and situated in UTM: XA73 (BERNARD et al. 2009). At that time, however, there was another place called Heidekrug lying between the villages now called Częstkowo and Głazice (UTM: CF14), NW of Szemud, and much closer to Gdańsk, only ca 30 km to the NW of this city. Although an unequivocal location of this record cannot be determined from historical sources, the latter option appears more likely. The references to *C. armatum* by LA BAUME (1908) and LE ROI (1911) merely reiterate HAGEN'S (1846) record. LE ROI (1911), however, also mentioned another of HAGEN'S records from Landsgraben near Königsberg (Kaliningrad) and described this species as being 'very sporadic, but numerous' farther east, in the former East Prussia. Finally, MIELEWCZYK (1972) reported finding a single male at Cha-

łupy on the Hel Peninsula in 1968. Analysis of the historical and current records of this species thus suggests that its distribution in this region will tend to have concentrated around the Gulf of Gdańsk (A. RYCHŁA pers. comm.).

With the exception of the paper by MIELEWCZYK (1970) and a few recent records of my own (SENN 2018, 2019), the dragonfly fauna of Gdańsk and its immediate environs has not been surveyed for well over 100 years. So, we have no way of knowing whether viable populations of this species have ever existed in this region, or whether the individuals concerned have simply been strays.

To summarize, *Coenagrion armatum* is not only an evidently stenotopic species, with highly specific climate and habitat requirements. For this reason, it is rare, but it is also extremely elusive, difficult to observe, and has only a very short flight period. Couple this with the very small number of odonate recorders in Poland, and we have the situation as it is. How this individual got to Gdańsk Brzeźno must remain a mystery.

Acknowledgements

I would like to thank Paweł Buczyński for encouraging me to write this article and for providing me with some of the relevant literature, and also Adrian Parr for the links to the papers by BOUWMAN et al. (2016), VAN DER HEIJDEN (2000) and WINKLER et al. (2009).

References

BERNARD R., BUCZYŃSKI P., TOŃCZYK G., WENDZONKA J. 2009. Atlas rozmieszczenia ważek (Odonata) w Polsce [A distribution atlas of dragonflies (Odonata) in Poland]. Bogucki Wydawnictwo Naukowe, Poznań, 256 pp.

BOUDOT J.-P., SAHLEN G. 2015. *Coenagrion armatum* (CHARPENTIER, 1766), in: BOUDOT J-P., KALKMAN V.J. (eds) 2015. Atlas of the European dragonflies and damselflies. KNNV Publishing, The Netherlands.

BOUWMAN J.H., KETELAAR R., RUITER E.J. 2016. The Norfolk Damselfly (*Coenagrion armatum*) in the Netherlands: a balance fifteen years after its rediscovery. Brachytron 18: 3-15.

BROWNETT A. 2005. A re-examination of the status of the Norfolk Damselfly *Coenagrion armatum* (Charpentier): a species of Odonata now presumed extinct in Britain. J. Br. Dragonfly Society 21(1): 21-24.

BUCZYŃSKI P. 2000. On the occurrence of *Coenagrion armatum* (CHARPENTIER, 1840) in Poland (Odonata: Coenagrionidae). Opusc. zool. Flumin. 179(2000): 1-10.

BUCZYŃSKI P., MIKOŁAJCZUK P., TOŃCZYK G. 2011. Nowe stwierdzenia łątki zielonej *Coenagrion armatum* (CHARPENTIER, 1840) (Odonata: Coenagrionidae) na południowo-zachodnim skraju jej zasięgu (Polska Środkowa i Wschodnia). Odonatrix 7(2): 41-47.

CORBET P.S. 2004, Dragonflies. Behaviour and Ecology of Odonates (Revised Edition). Brill NV., 829 pp.

HAGEN H. 1846. Die Netzflügler Preußens. Neue Preuß. Prov.- Blätter 2: 25-31.

KONDRACKI J. 1981. Geografia fizyczna Polski [The physical geography of Poland]. PWN Warszawa, 464 pp.

JUSYS V., EIGIRDAS V., GLIWA B. 2019. First records of *Pantala flavescens* and *Anax ephippiger* (Odonata, Libellulidae) in Lithuania. Bulletin of the Lithuanian Entomological Society 3(31): 5-7.

KHROKALO L., KRYLOVSKAYA S. 2008. Distribution and current status of *Coenagrion armatum* (CHARPENTIER, 1840) in Ukraine. IDF-Report 13: 1-16.

LA BAUME W. 1908. Zur Kenntnis der Libellenfauna Westpreußens. Schrft. Naturf. Ges. Danzig. N.F. 12(2): 75-83.

LE ROI O. 1911. Die Odonaten von Ostpreußen. Schr. Phys. ökon. Ges. Königsb. 52: 13-30.

MIELEWCZYK S. 1970. Odonata i Heteroptera rezerwatu Ptasi Raj koło Gdańska ze szczególnym uwzględnieniem słonawego jeziora. Frag. Faun. XV: 343-363.

MIELEWCZYK S. 1972. Ważki (Odonata) Mierzei Helskiej. Polskie Pismo ent. 41(2): 361-369.

MIKOŁAJCZUK P. 2012. Nowe stanowiska łątki zielonej *Coenagrion armatum* (CHARPENTIER, 1840) (Odonata: Coenagrionidae) w południowej części Podlasia i na wschodnim Mazowszu. [New sites of Dark Bluet *Coenagrion armatum* (CHARPENTIER, 1840) (Odonata: Coenagrionidae) in the southern part of Podlasie and in the eastern Mazovia]. Odonatrix 8(2): 59-62.

PARR A.J. 1999. Norfolk Damselfly *Coenagrion armatum* Rediscovered in The Netherlands. Atropos 8: 52.

SENN P. 2018. Damselflies (Odonata: Zygoptera) and dragonflies (Odonata: Anisoptera) in northern Poland: new records. [Ważki (Odonata: Zygoptera, Anisoptera) Polski północnej – nowe dane]. Odonatrix 14_8: 1-13.

SENN P. 2019. New localities of Southern Darter *Sympetrum meridionale* (SELYS, 1841) and Banded Darter *S. pedemontanum* (MÜLLER IN ALLIONI, 1766) (Odonata: Libellulidae) in northern Poland. Odonatrix 15_3: 1-6.

SHAPOVAL A.P., BUCZYŃSKI P. 2012. Remarkable Odonata caught in ornithological traps on the Courish Spit, Kaliningrad Oblast, Russia. Libellula 31 (1/2): 97-109.

SHAPOVAL N.A., SHAPOVAL A.P. 2017. Annotated checklist of the dragonflies (Insecta: Odonata) of the Kaliningrad region, North-Western Russia. Ukrainian Journal of Ecology 7(4): 157-168.

SHAPOVAL A.P. 2018. Results of an 11-year survey of dragonflies (Insecta: Odonata) on the Couronian Spit, Baltic Sea [in Russian]. Problems of explore and conservation natural and cultural heritage of the national park "Kurshskaya kosa" [sic]: Collection of scientific articles. 1s. 14 / Compiler I. Zhukovskaya. Published by IK BFU, Kaliningrad, RF, 2018. 163 p.

TWARDOSZ R. 2017. Zmiany częstości anomalii termicznych w Polsce w latach 1951-2015. [Change in the frequency of temperature anomalies in Poland, 1951-2015]. Pol. J. Agron. 31: 3-10.

VAN DER HEIJDEN A.E. 2000. A population of Norfolk Damselflies (*Coenagrion armatum*) in The Weerribben. Brachytron 4(2): 16-19.

WINKLER C., NEUMANN H., DREWS A. 2009. Verbreitung und Ökologie von *Coenagrion armatum* am südwestlichen Arealrand in Schleswig-Holstein (Odonata: Coenagrionidae). Libellula 28 (1/2): 1-24.

ZIERNICKA-WOJTASZEK A., ZUŚKA Z. 2016. Zimy z dodatnią temperaturą powietrza na obszarze Polski (1981-2010). Infrastrukt. Obsz. Wiejskich III/2/2016: 983-993.

Websites:

https://blog.meteomodel.pl/pochod-izoterm-styczen/

https://libellenwissen.de/libellenarten/kleinlibellen/schlanklibellen-coenagrionidae/hauben-azurjungfer/

https://www.ekologia.pl/pogoda/polska/pomorskie/gdansk/archiwum,dzien,11-06-2013

https://www.ekologia.pl/pogoda/polska/pomorskie/gdansk/archiwum,dzien,12-06-2013

https://www.ekologia.pl/pogoda/polska/pomorskie/gdansk/archiwum,dzien,13-06-2013