

New, rare and vagrant damselflies and dragonflies (Insecta: Odonata) in the Kaliningrad Oblast, north-western Russia

Nazar A. Shapoval¹, Galina N. Shapoval¹, Anatoly P. Shapoval²

1 Department of Karyosystematics, Zoological Institute of the Russian Academy of Sciences, 1 Universitetskaya nab., 199034, St. Petersburg, Russia

2 Biological Station “Rybachy”, Zoological Institute of the Russian Academy of Sciences, 32 Pobedy st., 238535, Rybachy, Kaliningrad District, Russia

Corresponding author: Nazar A. Shapoval (nazaret@bk.ru)

Academic editor: R. Yakovlev | Received 25 July 2022 | Accepted 15 August 2022 | Published 2 September 2022

<http://zoobank.org/62DA11B7-EAF9-457B-B797-A1BFE5FB72A7>

Citation: Shapoval NA, Shapoval GN, Shapoval AP (2022) New, rare and vagrant damselflies and dragonflies (Insecta: Odonata) in the Kaliningrad Oblast, north-western Russia. Acta Biologica Sibirica 8: 261–279. <https://doi.org/10.5281/zenodo.7703376>

Abstract

The paper presents new remarkable records of selected rare and uncommon Odonata species found in the Kaliningrad Oblast based primarily on our surveys conducted since 2007. Two species, *Erythromma viridulum* (Charpentier, 1840) and *Anax ephippiger* (Burmeister, 1839) are new to the region. The total number of Odonata species currently known for the territory of the Kaliningrad Oblast amounted to 66. Among them, 61 species have been recorded on the Courish (Curonian) Spit of the Baltic Sea.

Keywords

Baltic Sea, Courish (Curonian) Spit, damselflies, dragonflies, first records

Introduction

Until recently, the Odonata fauna of the Kaliningrad Oblast remained one of the less studied within Europe. The only checklists available, published by La Boeme

and Le Roi dates back more than 100 years ago (La Boeme 1908; Le Roi 1911). The former survey, while dedicated to the fauna of West Prussia, also comprises data on 46 species revealed in East Prussia. Among them, 33 species are clearly indicated for the territory of the present-day Kaliningrad Oblast. The latter faunistic work reports 50 species found in East Prussia, 46 of them are accounted for the region in question. Both surveys were primarily based on comprehensive studies of Hermann Hagen (Hagen 1839, 1846, 1849, 1855) and altogether reported 52 species for West and East Prussia and 46 species directly for the Kaliningrad Oblast. At the end of 20th century, several published papers provide new insights into the Odonata fauna of the Kaliningrad Oblast. Lewandowski (1996) mentioned 28 species found during 5 weeks of observations carried out at Zehlau peat bog (Pravdinsky District). Bertram and Haacks (1999) reported 14 dragonflies species collected in nine days at the Rybachy ornithological station on the Courish Spit. Notwithstanding the reports of Lewandowski and Bertram and Haacks were based on very limited periods of investigations, these works added four species as new for the region, *Aeshna subarctica* Walker, 1908, *Leucorrhinia albifrons* (Burmeister, 1839) and *Sympecma fusca* (Vander Linden, 1820), and *Anax parthenope* (Selys, 1839), respectively. Unfortunately, some other recent publications on the Odonata of the Kaliningrad Oblast, e.g. related to larvae identification (Shibaeva et al. 2011), or long-term studies conducted by Tumilovich (2008, 2009a, 2009b) are doubtful in many aspects or objectively wrong (see for detailed explanations, Shapoval and Buczyński 2012), and therefore need to be critically revised. Thus, the number of reliable Odonata species reported for the Kaliningrad Oblast by the early 21st century amounted for 50.

Long-term studies of dragonfly fauna and migrations that we have conducted since 2007 resulted in new and remarkable records for the Kaliningrad Oblast itself and Baltic countries as a whole (Shapoval and Buczyński 2012; Buczyński et al. 2014) and rose the number of species known for the territory of the Kaliningrad Oblast to 64. Fifty seven of them were particularly found on Courish Spit (Shapoval and Shapoval 2017). The present study summarizes personal data and observations of Odonata gathered in 2007–2021 on the Courish Spit in the Baltic Sea and some other localities of the Kaliningrad Oblast, provides new insights into dragonfly fauna and adds two species, namely *Erythromma viridulum* (Charpentier, 1840) and *Anax ephippiger* (Burmeister, 1839), as new to the region in question.

Material and methods

Dragonflies were collected at the “Fringilla” ornithological station, a part of the “Rybachy” Biological Station (Zoological Institute, RAS), during faunistic studies on insects conducted in 2007–2021. The ornithological station is situated on the Courish Spit 12 km S of Rybachy village (55°05'17"N, 20°44'04"E). The Courish Spit is a narrow, extending from the south-west to the north-east peninsula (98 km in length and 0.7 to 3.5 km in width), separating Courish Lagoon from the Baltic Sea. The pe-

ninsula funneling the migrants that often avoid moving over open waters (Alerstam and Christie 1991; Becciu et al. 2019) along onshore between the lagoon and the sea. During spring, summer and autumn seasons, the ornithological station operates two funnel traps (so-called “Rybachy-type” traps) which open to the north and to the south and allow passive capture of migrating birds, bats and also insects, primarily lepidopterans and dragonflies (Shapoval et al. 2005; Shapoval and Shapoval 2006, 2007; Shapoval and Buczyński 2012; Buczyński et al. 2014). Detailed description of the traps was given previously by several authors (Payevsky 2000; Shapoval and Buczyński 2012; Shapoval and Shapoval 2017). Observations and registration of odonates in the ornithological traps were carried out daily in the following periods: 2007 (07.VII-29.X), 2008 (30.III-27.X), 2009 (30.III-26.X), 2010 (31.III-29.X), 2011 (31.III-25.X), 2012 (30.III-29.X), 2013 (03.IV-28.X), 2014 (01.IV-27.X), 2015 (01.IV-26.X), 2016 (01.IV-26.X), 2017 (01.IV-26.X), 2018 (03.IV-25.X), 2019 (01.IV-25.X), 2020 (01.IV-25.X), 2021 (01.IV-25.X). Besides the ornithological station, dragonflies and damselflies were recorded and collected in several other localities on the Courish Spit and the Kaliningrad Oblast.

Results

New species for the Kaliningrad Oblast

Erythromma viridulum (Charpentier, 1840)

We conducted special search for this species in 2017-2019, exploring water bodies of the Kaliningrad Oblast and vegetated shore of the Courish lagoon, with a focus on localities where *E. najas* (Hansemann, 1823), the species with which *E. viridulum* is known to co-occur, was previously reported. *E. viridulum* was finally found at a single site – small artificial pond with dense vegetation on the territory of the Rybachy Ornithological Station (Rybachy village, 55°09'12"N; 20°51'26"E), where it was abundant.

Material. 22♂♂15♀♀, Kaliningrad Oblast, Zelenogradsk District, Courish Spit, Rybachy vill. (55°09'12"N; 20°51'26"E), 23.VII.2019. N.A. Shapoval, A.P. Shapoval, G.N. Shapoval leg.

Anax ephippiger (Burmeister, 1839)

The species is considered rare and vagrant in Eastern Europe. In Poland, it is known since at least 1992 (Bernard et al. 2009). The data on massive invasions of *A. ephippiger* in 1995 and 2019 significantly increased the number of reported localities in Poland and confirmed successful breeding of this species in the region (Buczyński et al. 2020). Recorded from Latvia (Rintelen 1997) at the Pape ornithological station

(four specimens collected on 12-13.IX.1995). This observation remains yet the sole record of *A. ephippiger* from Latvia and is considered somewhat doubtful. Firstly, at that time the species had never been observed in adjacent Baltic countries. Secondly, late collection dates (mid-September) assume that reported specimens indeed belong to the second generation, whereas the first generation (migrants) usually appears in Central and Eastern Europe in June. At that time, successful reproduction of *A. ephippiger* was not reported in the region. These facts suggested possible misidentification of dried specimens collected in Pape with somewhat morphologically similar species, *Anax parthenope* (Selys, 1839). However, the first evidences of *A. ephippiger* in Lithuania (two specimens observed on 23.VIII.2019 and 16.X.2019, certainly belonging to the second generation (Gliwa et al. 2019)), as well as numerous autumn records and observations of mating couples, egg-laying females, teneral individuals in Poland (Buczyński et al. 2018, 2020) give support of finding *A. ephippiger* in September 1995 at Pape (Latvia). In the Kaliningrad Oblast, *A. ephippiger* was found for the first time in June 2019. These records coincide well with data on enormous migration of the species in Europe in 2019 (Michalczyk et al. 2020).

Material. Three specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♂, (trap faced north), 06.VI.2019; 1♂, (trap faced north), 11.VI.2019; 1♂, (trap faced south), 13.VI.2019.

New species for the Courish Spit

In addition to *E. viridulum* and *A. ephippiger* registered as new for the Courish Spit and Kaliningrad Oblast as a whole, the following two species were found on the Courish Spit for the first time:

Coenagrion hastulatum (Charpentier, 1825)

During extensive exploring of water bodies of the Courish Spit conducted in 2017-2019, a single specimen of *C. hastulatum* was found in a vicinity of Rybachy village.

Material. 1♂, Kaliningrad Oblast, Zelenogradsk District, Courish Spit, vicinity of Rybachy vill. (55°08'51"N; 20°49'07"E), 16.V.2018. N.A. Shapoval, A.P. Shapoval, G.N. Shapoval leg.

Enallagma cyathigerum (Charpentier, 1840)

The species was found at the peat bog in the SW part of the Courish Spit in a vicinity of Zelenogradsk town. Not rare at the Zehlau peat bog in the Pravdinsky District.

Material. 2♀♀, Kaliningrad Oblast, Zelenogradsk District, Courish Spit, vicinity of Zelenogradsk town (54°57'59"N; 20°31'00"E), 12.V.2018. N.A. Shapoval, A.P. Shapoval, G.N. Shapoval leg. 4♂♂3♀♀, Kaliningrad Oblast, Pravdinsky District,

Zehlau peat bog (54°33'32"N; 20°52'56"E), 14.V.2018, N.A. Shapoval, A.P. Shapoval, G.N. Shapoval leg.

Rare species for the Kaliningrad Oblast and Courish Spit

Pantala flavescens (Fabricius, 1798)

Pantala flavescens is a circumtropically distributed species, that undertakes annual multigenerational long-distance migrations, having one of the longest (up to 6 000 km) migration flight within insects in a single generation. Nevertheless, the number of records of the species in Europe is surprisingly small, being mostly concentrated in southern countries. Our finding of *P. flavescens* specimen in 2013 on the Courish Spit of the Baltic Sea (Kaliningrad Oblast) was the first evidence for Central and Eastern Europe, being also the northernmost record of the species in the Palearctic (Shapoval and Buczyński 2014). Over the last few years, the number of records from Central and Eastern Europe increased significantly; in 2016 the species has been recorded for the first time from Poland (Buczyński 2019), in 2019 it has been observed for the first time in Germany (Günther 2019a) and Lithuania (Gliwa et al. 2019). Moreover, recent findings evidenced for successful reproduction of *P. flavescens* in Central Europe (Günther 2019b; Buczyński et al. 2020).

In addition to observation made in 2013, two females of *P. flavescens* have been recorded on the Courish Spit (Kaliningrad Oblast) in early June and mid-August 2019 (Fig. 1). The latter observation is of real importance considering that this specimen clearly referred to the second (native) generation. Our findings allowed to speculate on possible origin of individuals observed in Eastern Europe and possible migration strategies and routes in the western Palearctic.

Material. In total, three specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) by A.P. Shapoval in the ornithological trap, faced south. 1♂, 29.V.2013; 1♀, 06.VI.2019; 1♀, 18.VIII.2019.



Figure 1. A female of *Pantala flavescens* at the “Fringilla” field station (Kaliningrad Oblast, Courish Spit), 18.VIII.2019, photo A. Shapoval.

***Lestes barbarus* (Fabricius, 1798)**

The northern distribution limits of the species reach northern Poland and Kaliningrad Oblast (Bernard et al. 2009; Kalniņš 2011). *L. barbarus* is referred as a pronounced migrant that could spread and occupy broad territories forming permanent colonies in favorable years (Dijkstra 2006). The species has not been recorded from Latvia however mentioned as expected species for this country (Spuris 1993; Kalniņš 2011, 2012). Not annually recorded on the Courish Spit in the ornithological traps. It has been observed only in 2010, 2017 and 2021.

Material. In total, 14 specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♂, 17.VII.2010; 1♂, 23.VII.2010; 3♂♂2♀♀, 31.VII.2010; 1♂3♀♀, 16.VIII.2010; 1♂, 17.VIII.2010; 1♂, 04.VIII.2017; 1♀, 13.07.2021.

***Chalcolestes viridis* (Vander Linden, 1825)**

The species actively dispersed northwards in the last decades, colonizing new territories (Bernard et al. 2009; Cham et al. 2014; Gliwa and Švitra 2016). It has been recently reported for Latvia (Kalniņš 2017) for the first time. Regularly, but in small numbers recorded in mid-August - September in ornithological traps on the Courish Spit. During extensive exploring of water bodies of the Courish Spit conducted in 2017-2019, a single population of *L. viridis* was found in a vicinity of Rybachy village.

Material. 1♂, 09.IX.2009; 1♂, 17.VIII.2013; 2♂♂1♀, 05.IX.2014; 1♂, 27.VIII.2016; 1♂, 09.IX.2021; 2♂♂2♀♀, 11.IX.2021. “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) A.P. Shapoval leg. 3♂♂, Kaliningrad Oblast, Zelenogradsk District, Courish Spit, Rybachy vill. (55°08'58"N; 20°51'07"E), 23.VII.2019. N.A. Shapoval, A.P. Shapoval, G.N. Shapoval leg.

***Sympetma fusca* (Vander Linden, 1820)**

The species has been reported for the first time for Lithuania by Ivinskis and Rimšaitė (2010), without providing any details on this finding. Occurrence of *S. fusca* in Lithuania has been confirmed by Gliwa in 2016 (Gliwa et al. 2016). Not found in Latvia. Single specimen has been recorded at the “Fringilla” field station on the Courish Spit in the ornithological trap.

Material. 1♀, 24.VIII.2011, “Fringilla” ornithological station, Courish Spit (Kaliningrad Oblast, Zelenogradsk district, Courish Spit, 55°05'17"N; 20°44'04"E), A.P. Shapoval leg.

***Aeshna affinis* (Vander Linden, 1820)**

Recent surveys evidenced for the extensive dispersal of the species to the north starting in the 1990's (Bernard 2005; Bernard et al. 2009). *A. affinis* has been registered for the first time for Lithuania in 2003 (Bernard 2005). Reported for Latvia at the Pape ornithological station in 2016, while the first documented observation (photo) dates back to 2014 (Kalniņš 2017). The species was found in the Kaliningrad Oblast for the first time on the Courish Spit in 2007. Since 2010, annually recorded in the ornithological traps at the "Fringilla" Station.

Material. In total, 138 specimens have been recorded at the "Fringilla" field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♂, 09.VIII.2007; 1♀, 10.VII.2010; 1♂1♀, 12.VII.2010; 1♀, 13.VII.2010; 2♂♂2♀♀, 22.VII.2010; 1♀, 01.VIII.2010; 1♂, 19.VII.2011; 1♀, 30.VII.2011; 1♀, 29.VII.2012; 1♂, 06.VIII.2012; 1♂, 13.VIII.2012; 1♂, 03.VII.2013; 1♂, 04.VII.2013; 2♀♀, 31.VII.2013; 1♀, 08.VIII.2013; 2♂♂, 28.VII.2014; 1♂, 30.VII.2014; 1♂, 20.VIII.2015; 1♀, 28.VI.2016; 1♂, 09.VIII.2017; 1♂, 09.IX.2017; 1♀, 10.IX.2017; 1♂, 11.IX.2017; 2♂♂, 12.IX.2017; 1♂1♀, 16.IX.2017; 1♂, 20.IX.2017; 1♂, 28.IX.2017; 2♂♂, 30.VII.2018; 1♂, 31.VII.2018; 4♂♂8♀♀, 31.VII.2018; 12♂♂9♀♀, 01.VIII.2018; 1♂, 02.VIII.2018; 2♀♀, 08.VII.2018, 3♀♀, 09.VIII.2018; 1♂, 23.VIII.2018; 1♀, 30.VI.2019; 1♂1♀, 24.VII.2019; 1♂1♀, 29.VII.2019; 1♀, 16.VIII.2019; 2♂♂, 18.VIII.2019; 1♀, 09.IX.2019; 1♀, 25.VI.2020; 1♀, 04.VII.2020; 3♂♂1♀, 26.VII.2020; 1♀, 06.VIII.2020; 1♀, 07.VIII.2020; 1♀, 09.VIII.2020; 1♀, 13.VIII.2020; 2♂♂, 17.VIII.2020; 1♂1♀, 19.VIII.2020; 1♀, 30.VIII.2020; 1♂, 01.IX.2020; 1♂1♀, 12.VII.2021; 2♂♂3♀♀, 13.07.2021; 3♂♂2♀♀, 14.VII.2021; 2♀♀, 15.VII.2021; 1♀, 16.VIII.2021; 1♂1♀, 23.VII.2021; 1♂1♀, 25.VII.2021; 4♂♂3♀♀, 26.VII.2021; 2♂♂2♀♀, 27.VII.2021; 2♂♂1♀, 05.VIII.2021; 1♂, 10.VIII.2021; 1♀, 16.VIII.2021.

***Anax parthenope* (Selys, 1839)**

Since beginning of the 1990's, a pronounced expansion of the species northward has been recorded (Dijkstra 2006). *A. parthenope* has been registered for the first time for Latvia in 2008 (Kalniņš 2009). Regularly, but in small numbers, recorded in ornithological traps on the Courish Spit. The flight period of the species in the northern part of its distribution range lasts from June until August. Unusually late occurrence of *A. parthenope* on the Courish Spit (on 27th of September) has been recorded in 2021.

Material. In total, 102 specimens have been recorded at the "Fringilla" field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♂, 05.VIII.2007; 1♂1♀, 06.VIII.2007; 1♀, 12.VIII.2007; 1♂, 30.VI.2009; 1♀, 11.VII.2010; 1♀, 17.VII.2010; 1♂, 18.VII.2010;

2♀♀, 22.VII.2010; 1♀, 16.VIII.2010; 1♂, 11.IX.2010; 1♀, 31.V.2011; 1♂, 05.VI.2011; 1♂, 05.VII.2011; 2♂♂1♀, 06.VI.2011; 1♀, 07.VI.2011; 1♂1♀, 17.VII.2011; 1♂, 19.VII.2011; 1♂1♀, 22.VII.2011; 2♂♂2♀♀, 24.VII.2011; 1♂, 29.VII.2011; 2♀♀, 04.VIII.2011; 1♀, 08.VIII.2011; 1♀, 25.VIII.2011; 1♂, 15.VI.2012; 1♂1♀, 06.VII.2012; 1♂, 21.VII.2012; 1♂, 03.VI.2013; 1♀, 10.VI.2013; 1♂, 06.VII.2013; 1♂, 16.VII.2013; 1♀, 29.VII.2013; 1♂, 24.V.2014; 1♀, 07.VI.2014; 1♂, 20.VII.2014; 1♂, 21.VII.2014; 1♂, 24.VII.2014; 2♀♀, 26.VII.2014; 2♀♀, 03.VIII.2014; 2♂♂, 05.VIII.2015; 1♂, 18.VIII.2015; 1♂, 20.VIII.2015; 1♂, 18.VII.2016; 1♂, 09.VI.2017; 1♀, 26.VII.2017; 2♂♂, 09.VIII.2017; 1♂, 10.VIII.2017; 1♀, 27.V.2018; 2♀♀, 29.V.2018; 1♀, 01.VI.2018; 2♂♂1♀, 10.VI.2018; 1♂, 12.VII.2018; 1♂, 31.VII.2018; 1♀, 01.VIII.2018; 1♂, 12.VI.2019; 1♂, 14.VI.2019; 1♂1♀, 17.VI.2019; 1♂, 25.VI.2019; 1♀, 26.VI.2019; 1♂, 21.VII.2019; 1♂, 23.VIII.2019; 1♂, 29.VIII.2019; 2♀♀, 16.VII.2020; 1♂, 26.VII.2020; 1♀, 07.VIII.2020; 1♂, 22.VI.2021; 1♂, 09.VII.2021; 1♂1♀, 10.VII.2021; 1♂, 13.VII.2021; 1♀, 14.VII.2021; 1♂1♀, 14.VII.2021; 1♀, 16.VII.2021; 2♂♂1♀, 26.VII.2021; 1♀, 27.VII.2021; 1♀, 12.VIII.2021; 1♀, 29.VIII.2021; 1♀, 08.IX.2021; 1♂1♀, 27.IX.2021.

***Orthetrum albistylum* (Selys, 1848)**

Although not being a pronounced migrant, the species expands its distribution range northward rapidly (Bernard et al. 2009; Gliwa 2016). It has been observed for the first time in the Kaliningrad Oblast in 2011 (Shapoval, Buczyński 2012) and Lithuania in 2013 (Gliwa 2013). Since first occurrence in 2011 regularly reported in the ornithological traps on the Courish Spit. Unexpectedly late occurrence of *O. albistylum* on the Courish Spit (on 27th of September) has been recorded in 2020.

Material. In total, 79 specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♀, 05.VIII.2011; 1♂, 01.VII.2012; 1♂, 14.VI.2013; 1♂, 15.VI.2013; 1♀, 20.VI.2013; 1♂3♀♀, 21.VI.2013; 2♀♀, 04.VII.2013; 1♀, 09.VII.2014; 1♀, 24.VII.2014; 1♀, 28.VII.2014; 1♀, 05.VIII.2014; 1♂, 27.VI.2016; 1♀, 02.VII.2016; 1♂, 16.VII.2016; 1♂, 19.VII.2016; 3♂♂, 28.VI.2017; 1♀, 29.VI.2017; 2♂♂, 06.VII.2017; 1♀, 20.VII.2017; 1♂2♀♀, 22.VII.2017; 1♂, 05.VII.2017; 1♂, 02.VIII.2017; 1♀, 16.VIII.2017; 1♂, 21.VI.2018; 1♂, 26.VI.2018; 1♀, 07.VI.2019; 1♂, 08.VI.2019; 2♂♂, 11.VI.2019; 2♂♂, 12.VI.2019; 1♀, 20.VI.2019; 1♂, 20.VI.2019; 1♂, 23.VI.2019; 1♀, 24.VI.2019; 1♀, 01.VII.2019; 1♂, 28.VII.2019; 1♀, 29.VII.2019; 2♂♂1♀, 28.VI.2020; 1♀, 05.VII.2020; 1♂, 16.VII.2020; 2♀♀, 20.VII.2020; 1♀, 27.IX.2020; 1♂1♀, 18.VI.2021; 1♂1♀, 20.VI.2021; 1♂2♀♀, 21.VI.2021; 1♂, 22.VI.2021; 1♀, 25.VI.2021; 2♂♂, 01.VII.2021; 1♂2♀♀, 03.VII.2021; 1♂, 04.VII.2021; 1♀, 06.VII.2021; 1♀, 07.VII.2021; 1♂, 08.VII.2021; 1♀, 11.VII.2021; 1♂, 13.VII.2021; 1♀, 26.VII.2021; 1♂, 27.VII.2021; 1♂, 28.VII.2021; 1♂, 29.VII.2021.

***Orthetrum brunneum* (Fonscolombe, 1837)**

An expansion of *O. brunneum* to the north has been recently reported (Bernard and Ivinskis 2004; Bernard et al. 2009). The species has been observed for the first time in Lithuania in 2000 (Bernard and Ivinskis 2004; Gliwa et al. 2019) and in Latvia in 2005 (Kalniņš 2007). In the Kaliningrad Oblast, first occurrence of *O. brunneum* dates back to 2007. Since 2014 annually reported in the ornithological traps on the Courish Spit.

Material. In total, 84 specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♀, 11.VIII.2007; 1♀, 16.VIII.2007; 1♂, 26.VII.2008; 1♂, 30.VI.2011; 1♀, 24.VII.2011; 1♂, 26.VII.2011; 1♀, 01.VIII.2011; 1♀, 02.VIII.2011; 1♀, 03.VIII.2011; 1♀, 07.VIII.2011; 1♀, 08.VIII.2011; 1♀, 09.VIII.2011; 1♀, 09.VII.2014; 1♀, 10.VII.2014; 2♀♀, 14.VII.2014; 1♂, 19.VII.2014; 1♀, 23.VII.2014; 1♂, 24.VII.2014; 1♀, 25.VII.2014; 2♀♀, 27.VII.2014; 2♀♀, 28.VII.2014; 1♂, 29.VII.2014; 1♂, 30.VII.2014; 1♀, 04.VIII.2014; 1♂, 07.VIII.2014; 1♀, 27.VII.2015; 1♂, 01.VIII.2015; 1♀, 19.VI.2016; 2♀♀, 13.VIII.2017; 1♀, 16.VIII.2017; 1♂, 02.VI.2018; 1♀, 04.VI.2018; 1♀, 07.VI.2018; 1♀, 09.VI.2018; 1♀, 18.VII.2018; 1♂3♀♀, 12.VI.2019; 3♀♀, 13.VI.2019; 1♀, 14.VI.2019; 1♂1♀, 15.VI.2019; 1♂, 17.VI.2019; 1♂3♀♀, 26.VI.2019; 1♂, 28.VI.2019; 1♀, 28.VII.2019; 3♀♀, 29.VII.2019; 1♀, 05.VIII.2019; 1♀, 20.VIII.2019; 1♀, 21.VI.2020; 1♂1♀, 28.VI.2020; 3♀♀, 29.VI.2020; 2♂♂1♀, 29.VI.2020; 2♀♀, 02.VII.2020; 1♂1♀, 28.VII.2020; 1♀, 23.VIII.2020; 1♀, 19.VI.2021; 1♂1♀, 20.VI.2021; 2♀♀, 22.VI.2021; 1♀, 23.VI.2021; 1♀, 26.VI.2021; 1♀, 16.VII.2021; 1♀, 29.VII.2021.

***Orthetrum coerulescens* (Fabricius, 1798)**

Very rare and locally distributed species in the region. Several records are known for eastern Lithuania (Stanionyte, 1991; Gliwa et al. 2019). *O. coerulescens* has not been reported for Latvia yet, while occurrence of the species in this country is expected. Rarely observed in the ornithological traps on the Courish Spit.

Material. In total, 7 specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♀, 18.VII.2011; 1♂, 23.VI.2013; 1♂, 02.VIII.2013; 1♂1♀, 28.VII.2014; 1♀, 20.VI.2018; 1♀, 26.VI.2020.

***Crocothemis erythraea* (Brulle, 1832)**

Not being a pronounced migrant, this Mediterranean species tends to disperse gradually to the north (Ott 2001). The species has been observed once in Lithuania (Rackauskaite Gliwa 2015; Gliwa 2019) and has not yet been recorded for Latvia (Kalniņš 2017). The first evidence of *C. erythraea* in the Kaliningrad Oblast dates

back to 2008 (two individuals). The second observation has been made 9 years later, in 2017. Since 2017, annually occurs in the ornithological traps on the Courish Spit.

Material. In total, 12 specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♂, 05.VII.2008; 1♀, 12.VII.2008; 1♂, 16.VIII.2017; 1♂, 20.IX.2018; 1♀, 21.VI.2019; 1♂, 26.VI.2020; 1♂, 17.VII.2020; 1♀, 20.VII.2020; 1♂, 20.VI.2021; 2♀♀, 30.VI.2021; 1♂, 14.VII.2021.

Sympetrum fonscolombii (Selys, 1840)

Rare migrant species for the region. First reliable observations of *S. fonscolombii* for Latvia and Lithuania date from 2009 (Kalniņš 2011, 2017) and 2015 (Gliwa 2016, 2019), respectively. The species has been recorded in the Kaliningrad Oblast for the first time in 2007. Not annually recorded on the Courish Spit in the ornithological traps. It has been observed only in 2007, 2010, 2015, and 2017.

Material. In total, 11 specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♀, 20.VIII.2007; 1♂, 30.IX.2007; 1♂, 24.VII.2010; 1♂, 05.VI.2015; 1♂1♀, 06.VI.2015; 1♂, 08.VI.2015; 1♀, 16.VIII.2015; 1♀, 20.VIII.2015; 1♀, 25.IX.2017; 1♀, 28.IX.2017.

Sympetrum meridionale (Selys, 1841)

The northern limits of the distribution range of the species reach southern Poland (Dijkstra 2006). Although the species is not considering as pronounced migrant, vagrant specimens sporadically may occur far away from the main distribution range. The species has been observed several times in Lithuania (Jusys, Gliwa 2017; Gliwa 2019) and has not yet been recorded for Latvia (Kalniņš 2017). The species has been recorded in the Kaliningrad Oblast for the first time in 2010. Not annually recorded on the Courish Spit in the ornithological traps. It has been observed in 2010, 2013, 2014, 2015, and 2016.

Material. In total, 15 specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♀, 22.VII.2010; 1♂, 08.VIII.2010; 1♀, 11.VIII.2013; 1♀, 16.VIII.2013; 3♂♂, 18.VIII.2013; 1♂1♀, 19.VIII.2013; 1♀, 21.VIII.2013; 1♂, 05.VIII.2014; 1♂, 06.VIII.2014; 2♂♂, 02.VIII.2015; 1♂, 27.VIII.2016.

Sympetrum pedemontanum (Müller in Allioni, 1766)

Relatively rare species for the region. It is known for Latvia since 2001 (Kalniņš 2002); in Lithuania, the distribution of *S. pedemontanum* mainly restricted to eastern and southern parts of the country. Not annually recorded on the Courish Spit in the ornithological traps. It has been observed in 2007, 2010–2014, 2017, and 2020.

Material. In total, 28 specimens have been recorded at the “Fringilla” field station (Kaliningrad Oblast, Zelenogradsk District, Courish Spit, 55°05'17"N; 20°44'04"E) in the ornithological traps. 1♂, 12.VIII.2007; 2♂♂2♀♀, 22.VII.2010; 1♂, 04.VIII.2010; 1♀, 13.VIII.2010; 1♂, 24.IX.2010; 1♂, 25.IX.2010; 1♀, 05.VIII.2011; 1♂, 06.VIII.2011; 1♂1♀, 07.VIII.2011; 3♂♂, 08.VIII.2011; 1♀, 27.VIII.2011; 2♀♀, 17.IX.2012; 1♂, 28.VIII.2013; 1♀, 02.VIII.2013; 1♀, 07.VIII.2013; 1♀, 21.VIII.2013; 1♂, 28.VII.2014; 1♂1♀, 03.VIII.2014; 1♂, 24.IX.2017; 1♂, 24.VIII.2020.

Discussion

The territory of the Kaliningrad Oblast is significantly smaller (~ 15 100 km²) than the territories of neighboring Latvia (~ 64 600 km²), Lithuania (~ 65 300 km²), and especially Poland (~ 312 700 km²), bearing less number of habitats suitable for dragonflies and damselflies. Nevertheless, the number of species currently found in the Kaliningrad Oblast (66) is comparable to those, found in Latvia (63) and Lithuania (69), but expectedly fewer than in Poland (74), where elements of mountainous and Mediterranean fauna can be found (Table 1).

Table 1. List of Odonata species recorded in the Kaliningrad Oblast and adjacent countries (Poland, Lithuania, Latvia). The asterisk (*) indicates species known for the Kaliningrad Oblast only by historical records (Le Roi 1911)

| Taxon | Kaliningrad Oblast | Lithuania | Latvia | Poland |
|--|--------------------|-----------|--------|--------|
| <i>Calopteryx splendens</i> (Harris, 1782) | + | + | + | + |
| <i>Calopteryx virgo</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Lestes sponsa</i> (Hansemann, 1823) | + | + | + | + |
| <i>Lestes dryas</i> Kirby, 1890 | + | + | + | + |
| <i>Lestes barbarus</i> (Fabricius, 1798) | + | + | - | + |
| <i>Lestes virens</i> (Charpentier, 1825) | + | + | + | + |
| <i>Lestes macrostigma</i> (Eversmann, 1836) | - | - | - | + |
| <i>Chalcolestes viridis</i> (Vander Linden, 1825) | + | + | + | + |
| <i>Sympecma fusca</i> (Vander Linden, 1820) | + | + | - | + |
| <i>Sympecma paedisca</i> (Brauer, 1877) | + | + | + | + |
| <i>Ischnura elegans</i> (Vander Linden, 1820) | + | + | + | + |
| <i>Ischnura pumilio</i> (Charpentier, 1825) | + | + | + | + |
| <i>Enallagma cyathigerum</i> (Charpentier, 1840) | + | + | + | + |
| <i>Coenagrion pulchellum</i> (Vander Linden, 1825) | + | + | + | + |
| <i>Coenagrion puella</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Coenagrion ornatum</i> (Selys, 1850) | - | - | - | + |

| Taxon | Kaliningrad Oblast | Lithuania | Latvia | Poland |
|---|--------------------|-----------|--------|--------|
| <i>Coenagrion scitulum</i> (Rambur, 1842) | - | - | - | + |
| <i>Coenagrion hastulatum</i> (Charpentier, 1825) | + | + | + | + |
| <i>Coenagrion lunulatum</i> (Charpentier, 1840) | +* | + | + | + |
| <i>Coenagrion johanssoni</i> (Wallengren, 1894) | - | + | + | - |
| <i>Coenagrion armatum</i> (Charpentier, 1840) | +* | + | + | + |
| <i>Erythromma najas</i> (Hansemann, 1823) | + | + | + | + |
| <i>Erythromma viridulum</i> (Charpentier, 1840) | + | + | + | + |
| <i>Erythromma lindenii</i> (Selys, 1840) | - | - | - | + |
| <i>Pyrrhosoma nymphula</i> (Sulzer, 1776) | + | + | + | + |
| <i>Nehalennia speciosa</i> (Charpentier, 1840) | +* | + | + | + |
| <i>Platycnemis pennipes</i> (Pallas, 1771) | + | + | + | + |
| <i>Aeshna mixta</i> Latreille, 1805 | + | + | + | + |
| <i>Aeshna affinis</i> Vander Linden, 1820 | + | + | + | + |
| <i>Aeshna isoceles</i> (Müller, 1767) | + | + | + | + |
| <i>Aeshna grandis</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Aeshna caerulea</i> (Ström, 1783) | - | - | + | + |
| <i>Aeshna cyanea</i> (Müller, 1764) | + | + | + | + |
| <i>Aeshna crenata</i> Hagen, 1856 | - | + | + | - |
| <i>Aeshna viridis</i> Eversmann, 1836 | + | + | + | + |
| <i>Aeshna juncea</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Aeshna subarctica</i> Walker, 1908 | + | + | + | + |
| <i>Anax imperator</i> Leach, 1815 | + | + | + | + |
| <i>Anax parthenope</i> (Selys, 1839) | + | + | + | + |
| <i>Anax ephippiger</i> (Burmeister, 1839) | + | + | + | + |
| <i>Brachytron pratense</i> (Müller, 1764) | + | + | + | + |
| <i>Gomphus vulgatissimus</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Gomphus flavipes</i> (Charpentier, 1825) | + | + | + | + |
| <i>Ophiogomphus cecilia</i> (Fourcroy, 1785) | + | + | + | + |
| <i>Onychogomphus forcipatus</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Cordulegaster boltonii</i> (Donovan, 1807) | +* | + | + | + |
| <i>Cordulegaster bidentata</i> Selys, 1843 | - | - | - | + |
| <i>Cordulia aenea</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Somatochlora metallica</i> (Vander Linden, 1825) | + | + | + | + |
| <i>Somatochlora flavomaculata</i> (Vander Linden, 1825) | + | + | + | + |
| <i>Somatochlora arctica</i> (Zetterstedt, 1840) | + | + | + | + |
| <i>Somatochlora alpestris</i> (Selys, 1840) | - | - | - | + |

| Taxon | Kaliningrad Oblast | Lithuania | Latvia | Poland |
|---|--------------------|-----------|-----------|-----------|
| <i>Epitheca bimaculata</i> (Charpentier, 1825) | + | + | + | + |
| <i>Libellula quadrimaculata</i> Linnaeus, 1758 | + | + | + | + |
| <i>Libellula depressa</i> Linnaeus, 1758 | + | + | + | + |
| <i>Libellula fulva</i> Müller, 1764 | + | + | + | + |
| <i>Orthetrum cancellatum</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Orthetrum albistylum</i> (Selys, 1848) | + | + | - | + |
| <i>Orthetrum coerulescens</i> (Fabricius, 1798) | + | + | - | + |
| <i>Orthetrum brunneum</i> (Fonscolombe, 1837) | + | + | + | + |
| <i>Leucorrhinia dubia</i> (Vander Linden, 1825) | + | + | + | + |
| <i>Leucorrhinia rubicunda</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Leucorrhinia pectoralis</i> (Charpentier, 1825) | + | + | + | + |
| <i>Leucorrhinia albifrons</i> (Burmeister, 1839) | + | + | + | + |
| <i>Leucorrhinia caudalis</i> (Charpentier, 1840) | + | + | + | + |
| <i>Sympetrum danae</i> (Sulzer, 1776) | + | + | + | + |
| <i>Sympetrum pedemontanum</i> (Müller in Allioni, 1766) | + | + | + | + |
| <i>Sympetrum sanguineum</i> (Müller, 1764) | + | + | + | + |
| <i>Sympetrum depressiusculum</i> (Selys, 1841) | - | + | + | + |
| <i>Sympetrum flaveolum</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Sympetrum fonscolombii</i> (Selys, 1840) | + | + | + | + |
| <i>Sympetrum striolatum</i> (Charpentier, 1840) | + | + | + | + |
| <i>Sympetrum vulgatum</i> (Linnaeus, 1758) | + | + | + | + |
| <i>Sympetrum meridionale</i> (Selys, 1841) | + | + | - | + |
| <i>Crocothemis erythraea</i> (Brullé, 1832) | + | + | - | + |
| <i>Pantala flavescens</i> (Fabricius, 1798) | + | + | - | + |
| Total | 66 | 69 | 63 | 74 |

62 species out of 66 found for the Kaliningrad Oblast were observed by us during surveys conducted in 2007-2021, while four species, namely *Coenagrion lunulatum*, *Coenagrion armatum*, *Nehalennia speciosa*, and *Cordulegaster boltonii*, are known for the region only by historical records (Le Roi 1911). It should be noted that in 21st century, 16, 12 and 9 Odonata species have been recorded as new for the territories of Kaliningrad Oblast, Lithuania and Latvia, respectively (Table 2), while only one species (*Pantala flavescens*) was added as new for Poland in 2019 (Buczyński et al. 2019). *Lestes macrostigma*, included in the checklist of Polish Odonata in 2005 (Dolny 2005), originated from old museum collection and cannot be treated as a recent observation.

Table 2. List of Odonata species found for the first time in the Kaliningrad Oblast, Lithuania and Latvia after 2000. For each species, the year of first observation is given.

| Species | Kaliningrad Oblast | Lithuania | Latvia |
|----------------------------------|----------------------|-----------------------|----------------------------|
| <i>Lestes barbarus</i> | | 2007 ⁴ (*) | |
| <i>Chalcolestes viridis</i> | 2009 ¹ | | 2013 ¹⁵ |
| <i>Sympecma fusca</i> | | 2010 ^{5,12} | |
| <i>Sympecma paedisca</i> | 2009 ² | | |
| <i>Erythromma viridulum</i> | 2019 (present study) | 2011 ⁶ | 2012 ¹⁵ |
| <i>Aeshna affinis</i> | 2007 ¹ | 2003 ⁷ | 2014 ¹⁵ |
| <i>Aeshna crenata</i> | | 2001 ⁸ | 2002 ¹⁶ |
| <i>Anax imperator</i> | 2007 ² | | |
| <i>Anax parthenope</i> | | | 2008 ¹⁷ |
| <i>Anax ephippiger</i> | 2019 (present study) | 2019 ⁹ | |
| <i>Somatochlora arctica</i> | 2008 ² | | |
| <i>Libellula fulva</i> | 2011 ² | | |
| <i>Orthetrum albistylum</i> | 2011 ¹ | 2013 ¹⁰ | |
| <i>Orthetrum coerulescens</i> | 2011 ¹ | | |
| <i>Orthetrum brunneum</i> | 2007 ¹ | 2000 ¹¹ | 2005 ¹⁸ |
| <i>Sympetrum pedemontanum</i> | | | 2001 ¹⁹ |
| <i>Sympetrum depressiusculum</i> | | | 2016 ¹⁵ |
| <i>Sympetrum fonscolombii</i> | 2007 ¹ | 2015 ¹² | 2009 ²⁰ (**) |
| <i>Sympetrum striolatum</i> | 2007 ² | | |
| <i>Sympetrum meridionale</i> | 2010 ¹ | 2017 ¹³ | |
| <i>Crocothemis erythraea</i> | 2008 ¹ | 2014 ¹⁴ | |
| <i>Pantala flavescens</i> | 2013 ³ | 2019 ⁹ | |

The references are as follows: ¹Shapoval and Buczyński 2012, ²Shapoval and Shapoval 2017, ³Buczyński et al. 2014, ⁴Briliūtė and Budrys 2007, ⁵Ivinskis and Rimšaitė 2010, ⁶Gliwa and Stukonis 2011, ⁷Bernard 2005, ⁸Bernard 2003, ⁹Jusys et al. 2019, ¹⁰Gliwa 2013, ¹¹Gliwa et al. 2019, ¹²Gliwa et al. 2016, ¹³Jusys and Gliwa 2017, ¹⁴Račkauskaitė and Gliwa 2015, ¹⁵Kalniņš 2017, ¹⁶Bernard 2003, ¹⁷Kalniņš 2009, ¹⁸Kalniņš 2007, ¹⁹Kalniņš 2002, ²⁰Kalniņš 2011.

(*) – *Lestes barbarus* is mentioned by Prüffer for Lithuania (Prüffer 1952), but this record was not included in the Odonata checklist of the Lithuanian fauna.

(**) – *Sympetrum fonscolombii* has been reported for Latvia in 1938 (Bērziņš 1938), but the species was subsequently excluded from Latvian fauna (Spuris 1993, 1996). The second observation made in 1997 (Matthes and Matthes 1997) is considered somewhat doubtful by the authors, while the only one collected specimen escaped prior proper identification. Thus, the reliable record of *S. fonscolombii* for Latvia dates back to 2009.

Discovering a number of new species for the regions in question can hardly be explained by poor study of these areas, but rather evidences for changes in distribution of southern species and their expansion to the north and recent colonization of new territories. Being an effective and useful tool for studies on both mass dragonfly migrations and species involved in individual migrations or movements, the constantly operating ornithological traps allow detecting of such expansions and fluctuations in distribution range of certain species. Thus, since the beginning of our survey in 2007, more than 300 000 dragonfly specimens have been recorded in the ornithological traps, including multiple observations on rare migratory and vagrant species. The data obtained clearly indicate that at least some southern species (e.g. *Crocothemis erythraea*, *Aeshna affinis*, *Orthetrum brunneum*, *Orthetrum albistylum*) started to occur more regularly and at a higher frequency in last decade (Fig. 2).

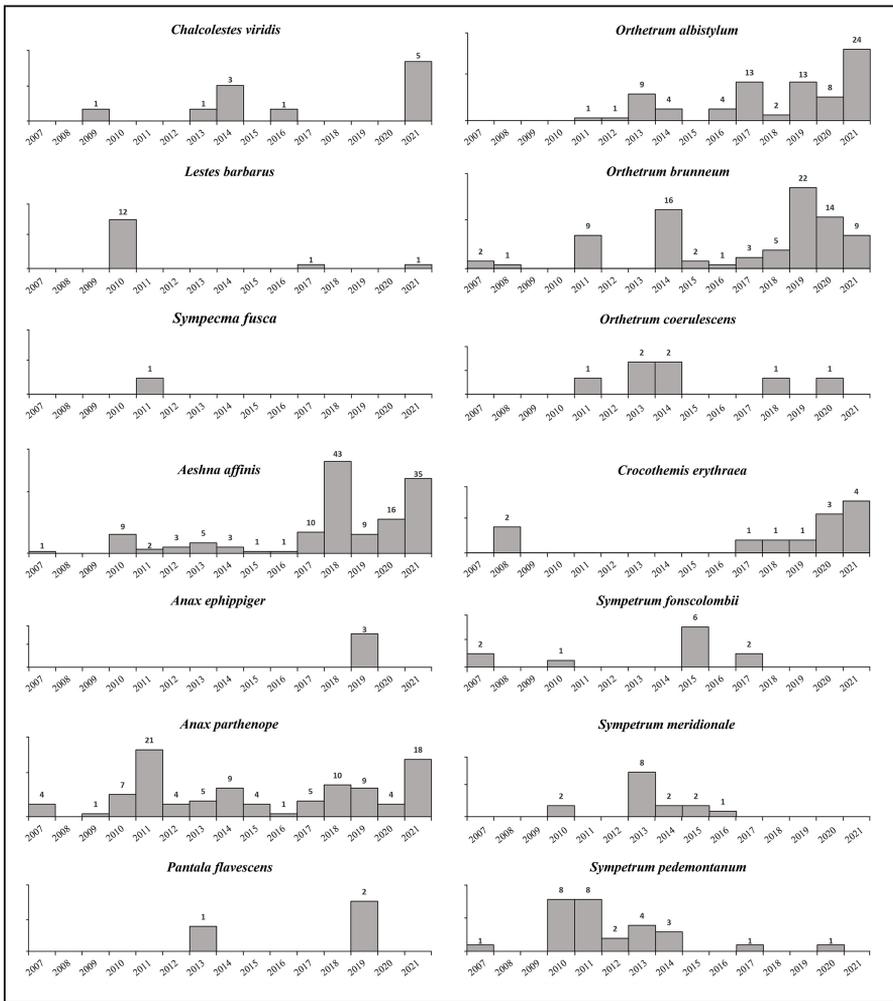


Figure 2. Annual records of some rare and vagrant species in ornithological traps in 2007-2021.

Conclusion

The present study adds two species, namely *Erythromma viridulum* and *Anax ephippiger*, as new to the Kaliningrad Oblast. The total number of Odonata species currently known for the region in question amounted to 66 and, thus, almost reached the possible maximum. Besides present-day confirmation of four species (*Coenagrion lunulatum*, *Coenagrion armatum*, *Nehalennia speciosa*, *Cordulegaster boltonii*), which are known for the region only by historical records, only occurrence of *Sympetrum depressiusculum* on the territory of the Kaliningrad Oblast is highly expected. To some extent, *Coenagrion johanssoni* and *Aeshna crenata* can be considered as potential species, but the closest known populations of these species have been found in eastern Lithuania, ca. 200 km away from the territory of the Kaliningrad Oblast.

Acknowledgements

We are grateful to Prof. Valentina Kuznetsova and Dr. Anatoly Krupitsky for valuable comments and suggestions. The financial support for this study was provided by the state research projects No. 122031100272-3 and No. 122031100261-7.

References

- Alerstam T, Christie DA (1990) Bird Migration. Cambridge University Press, 420 pp.
- Becciu P, Menz MM, Aurbach A, Cabrera-Cruz S, Wainwright C, Scacco M, Ciach M, Pettersson L, Maggini I, Arroyo G, Buler J, Reynolds D, Sapir N (2019) Environmental effects on flying migrants revealed by radar. *Ecography* 42 (5): 942–955. <https://doi.org/10.1111/ecog.03995>
- Bernard R (2003) *Aeshna crenata* Hag., a new species for the fauna of Latvia (Anisoptera: Aeshnidae). *Notulae Odonatologicae* 6 (1): 8–10.
- Bernard R, Ivinskis P (2004) *Orthetrum brunneum* (Fonscolombe, 1837), a new dragonfly species in Lithuania (Odonata: Libellulidae). *Acta Zoologica Lituonica* 14 (3): 31–36.
- Bernard R (2005) First record of *Aeshna affinis* Vander Linden, 1820 in Lithuania (Anisoptera: Aeshnidae) and corrective notes on the Lithuanian Odonata checklist. *Notulae Odonatologicae* 6 (6): 53–55.
- Bernard R, Buczyński P, Tończyk G, Wendzonka J (2009) A distribution atlas of dragonflies (Odonata) in Poland. Bogucki Wydawnictwo Naukowe, Poland, Poznań, 256 pp.
- Bertram G, Haacks M (1999) Beobachtungen von windverdrifteten Libellen auf der Kurischen Nehrung im September 1998. *Libellula* 18 (1/2): 89–94.
- Bērziņš B (1938) Piezīmes par spārēm (Odonata). [Notes on dragonflies (Odonata)]. *Daba un Zinātne* 5 (6): 186.

- Briliūtė A, Budrys E (2007) New record of damselfly *Lestes barbarus* in the south of Lithuania (Odonata: Lestidae). New and rare for Lithuania insect species 19: 10–12.
- Buczyński P, Shapoval AP, Buczyńska E (2014) *Pantala flavescens* at the coast of the Baltic Sea (Odonata: Libellulidae). Odonatologica 43 (1/2): 3–11.
- Buczyński P, Buczyńska E, Michalczyk W (2019) From southern Balkans to western Russia: Do first Polish records of *Pantala flavescens* (Fabricius, 1798) (Odonata: Libellulidae) indicate a migration route? Journal of the Entomological Research Society 21 (1): 11–16.
- Buczyński P, Lewandowska E, Lewandowski K (2020) Reproductive success of Wandering Glider *Pantala flavescens* (Fabricius, 1798) (Odonata: Libellulidae) recorded in Lake Rakutowskie (central Poland). Odonatrix 16 (11): 1–7.
- Cham S, Nelson B, Parr A, Prentice S, Smallshire D (2014) Atlas of Dragonflies in Britain and Ireland. Natural Environment Research Council, British Dragonfly Society, 280 pp.
- Dijkstra KD (2006) Field Guide to the Dragonflies of Britain and Europe. British Wildlife Publishing, UK, Dorset, 320 pp.
- Dolny A (2005) *Lestes macrostigma* (Eversmann, 1836), a new species for the odonate fauna of Poland (Zygoptera: Lestidae). Notulae Odonatologicae 6 (6): 64.
- Gliwa B, Stukonis V (2011) *Erythromma viridulum* (Odonata: Coenagrionidae) – a new species to Lithuania. Naujos ir retos Lietuvos vabzdžių rūšys 23: 5–7.
- Gliwa B (2013) First record of *Orthetrum albistylum* (Odonata: Libellulidae) in Lithuania. New and rare for Lithuania insect species 25: 5–6.
- Gliwa B, Švitra G (2016) Odonata of Lithuania. Sargeliai: Krūena, 352 pp.
- Gliwa B, Petraška A, Švitra G, Uselis V (2016) Data on one new and 23 rare to Lithuanian fauna species of dragonflies (Odonata) recorded in 2015–2016. Naujos ir retos Lietuvos vabzdžių rūšys 28: 5–18.
- Gliwa B, Švitra G, Petraška A, Uselis V, Jusys V (2019) Distribution Atlas of Dragonflies and Damselflies of Lithuania. Sargeliai: Krūenta, 118 pp.
- Günther A (2019a) First field record of *Pantala flavescens* in Germany (Odonata: Libellulidae). Libellula 38 (3/4): 127–136.
- Günther A (2019b) Successful breeding by *Pantala flavescens* in Germany (Odonata: Libellulidae). Odonatologica 48 (3/4): 203–210. <https://doi.org/10.5281/zenodo.3539732>
- Hagen H (1839) Verzeichniß der Libellen Ostpreußens. Preußische Provinzial-Blätter 21: 54–58.
- Hagen H (1846) Die Netzflügler Preußens. Neue Preußische Provinzial-Blätter 2: 25–31.
- Hagen H (1849) Verein für die Fauna der Provinz Preußen. 4 Bericht. Neue Preußische Provinzial-Blätter 7: 420.
- Hagen H (1855) Verein für die Fauna der Provinz Preußen. 7 Bericht. Neue Preußische Provinzial-Blätter, Andere Folge VII: 350.
- Hedlund JU, Lv H, Lehmann P, Hu G, Anderson RC, Chapman J (2021) Unraveling the World's Longest Non-stop Migration: The Indian Ocean Crossing of the Globe Skimmer Dragonfly. Frontiers in Ecology and Evolution 9: 698128. <https://doi.org/10.3389/fevo.2021.698128>
- Ivinskis P, Rimšaitė J (2010) Data on some spreading insects and spiders species in Lithuania. In: Aleksejeva A, Oļehnovičs D, Paņina L, Zuģiska I. (Eds) Abstracts of the 52nd

- International Scientific Conference of Daugavpils University. Daugavpils: Difra [no pagination].
- Jusys V, Gliwa B (2017) First record of *Sympetrum meridionale* (Odonata, Libellulidae) in Lithuania. Lietuvos Entomologų draugijos darbai 1 (29): 5–7.
- Jusys V, Eigirdas V, Gliwa B (2019) First records of *Pantala flavescens* and *Anax ephippiger* (Odonata, Libellulidae) in Lithuania. Lietuvos Entomologų draugijos darbai 3 (31): 5–7.
- Kalniņš M (2002) Banded Darter *Sympetrum pedemontanum* (Allioni, 1766) (Odonata, Libellulidae) a new dragonfly species in the fauna of Latvia. Latvijas Entomologs 39: 44–45.
- Kalniņš M (2007) Brown Orthetrum *Orthetrum brunneum* (Fonscolumbe, 1837) (Odonata, Libellulidae) a new dragonfly species in Latvia. Acta Biologica Universitatis Daugavpiliensis 7 (1-2): 109–111.
- Kalniņš M (2009) Lesser Emperor *Anax parthenope* (Selys, 1839) (Odonata: Aeshnidae) – a New Dragonfly Species in Latvia. Latvijas Entomologs 47: 16–20.
- Kalniņš M (2011) The distribution of southern dragonfly (Odonata) species in Latvia and adjacent territories. Environmental and Experimental Biology 9: 43–52.
- Kalniņš M (2012) Dragonflies (Odonata) in Latvia – history of research, bibliography and distribution from 18 century until 2010. Latvijas Entomologs 51: 91–149.
- Kalniņš M (2017) Dragonflies (Odonata) in Latvia: History of Research, Bibliography and Distribution from the 18 Century to 2016. Zala Upe, Sigulda, 352 pp.
- La Baume W (1908) Zur Kenntnis der Libellenfauna Westpreussens. Schriften der Naturforschenden Gesellschaft in Danzig 12: 75–83.
- Le Roi O (1911) Die Odonaten von Ostpreußen. Schriften der Physikalisch-Ökonomischen Gesellschaft zu Königsberg 52: 13–30.
- Lewandowski K (1996) A preliminary description of dragonflies (Odonata) of the Zehlau peatbog. In: "Flora and Fauna of the Bog Zehlau", Russia, Kaliningrad, 24-25 September 1996. KGU, Kaliningrad, 46–47 pp. [In Russian]
- Matthes J, Matthes H (1997) Die Libellenfauna des Teichi-Schutzgebietes in Lettland. Pētījumu materiāls 1–15.
- Michalczyk W, Buczyński P, Buczyńska E, Czechowski P, Cymbała R, Długosz I, Domagała M, Dumański J, Gałan M, Górajski L, Grabek M, Gumułka P, Gwóźdź R, Kolago G, Kowalczyk M, Król J, Lewandowska E, Lewandowski K, Łagosz P, Mikołajczuk P, Nowicka K, Ostrowski K, Pawlak S, Pietrasik G, Ratajczak J, Rauner-Bułczyńska E, Senn P, Sieczak K, Świtała D, Świtała M, Tańczuk A, Wiszniowska M, Wolny SM, Zabłocki P (2020) Vagrant Emperor *Anax ephippiger* (Burmeister, 1839) (Odonata: Aeshnidae) in Poland: the unprecedented influx of 2019. Odonatrix 16 (10): 1–24.
- Ott J (2001) Expansion of Mediterranean Odonata in Germany and Europe – consequences of climatic changes. In: Walther GR, Burga CA, Edwards PJ (Eds) „Fingerprints” of Climate Change. Adapted Behaviour and Shifting Species Ranges. Kluwer Academic Publishers, USA, New York, 89–111 pp.
- Payevsky VA (2000) Rybachy-type trap. In: Busse P (Ed.) Bird Station Manual. SE European Bird Migration Network, Poland, Gdansk, 20–24 pp.
- Prüffer J (1952) Uwagi o ważkach Wileńszczyzny. Sprawozdania Towarzystwa Naukowego w Toruniu 4 (1 I – 31 XII 50): 105.

- Račkauskaitė D, Gliwa B (2015) First record of *Crocothemis erythraea* (Odonata: Libellulidae) in Lithuania. *Naujos ir retos Lietuvos vabzdžių rūšys* 27: 5–6.
- Rintelen T (1997) Eine Vogelreuse als Libellenfalle: Beobachtungen in der Vogelwarte Pape, Lettland. *Libellula* 16 (1/2): 61–64.
- Shapoval AP, Buczyński P (2012) Remarkable Odonata caught in ornithological traps on the Courish Spit, Kaliningrad Oblast, Russia. *Libellula* 31 (1/2): 97–109.
- Shapoval NA, Shapoval AP, Matov A (2005) Noctuid Moths (Lepidoptera, Noctuidae) of the Curonian Spit in the Baltic Sea. *Entomological Review* 85 (8): 909–917.
- Shapoval NA, Shapoval AP (2006) Geometrid moths (Lepidoptera, Geometridae) of the Curonian Spit in the Baltic sea. *Entomological Review* 86 (4): 389–397. <https://doi.org/10.1134/s0013873806040038>
- Shapoval NA, Shapoval AP (2007) Nocturnal lepidopterans (Lepidoptera, Macroheterocera) of the Courish Spit in the Baltic Sea. *Entomological Review* 87 (7): 859–864. <https://doi.org/10.1134/s0013873807070081>
- Shapoval NA, Shapoval AP (2017) Annotated checklist of the dragonflies (Insecta: Odonata) of the Kaliningrad region, north-western Russia. *Ukrainian Journal of Ecology* 7 (4): 157–168.
- Shibaewa MN, Matweewa EP, Masyutkina EA (2011) Vidovoe raznoobrazie zoobentosa, bioindikaciya i ekologicheskoe sostoyanye ozer Kaliningradskoy oblasti. *Vestnik Baltijskogo Federalnogo Universiteta imeni I. Kanta* 7: 91–96.
- Spuris Z (1993) Identification Key to the Dragonflies (Odonata) of Latvia. *Zinātne, Latvia, Rīga*, 67 pp. [In Latvian]
- Spuris Z (1996) Latvijas kukaiņu katalogs. 12. Spāres (Odonata), papildinājums. [Catalogue of insects of Latvia. 12. Dragonflies (Odonata), supplement.]. *Acta Hydroentomologica Latvica* 3: 30–36.
- Stanionytė A (1991) *Orthetrum coerulescens* Fabr. – new to Lithuania Odonata species found in 1990. *Naujos ir retos Lietuvos vabzdžių rūšys* 11: 9–11.
- Tumilovich OA (2008) Dinamika vidovogo sostava strekoz ornitologicheskich setey Biologicheskoy stancii ZIN RAN v 2006-2007 godach. *Problemy izucheniya i ochrany prirodnoho i kulturnogo nasledya Nacyonalnogo parka "Kurshskaya Kosa"* 6: 86–92. [In Russian]
- Tumilovich OA (2009a) New species of Odonata of the Kaliningrad region. In: "Biodiversity, protection and prospects of Baltic seashore habitats", Lithuania, Klaipėda, 09-10 September 2009, 49–50 pp.
- Tumilovich OA (2009b) O faune strekoz (Odonata) Kaliningradskoy oblasti. *Uchebnye Zapiski Kazanskogo Gosudarstvennogo Universiteta (Estestvennye nauki)* 151: 192–196. [In Russian]
- Wiszniewska M, Buczyński P (2018) A late record of *Anax ephippiger* (Burmeister, 1839) (Odonata: Aeshnidae) in southern Poland. *Odonatrix* 14 (14): 1–4.