

# On the Occurrence of *Gomphus pulchellus* Selys, 1840 (Odonata: Gomphidae) on the Balkan Peninsula

*Paweł Buczyński*<sup>1\*</sup>, *Grzegorz Tończyk*<sup>2</sup>, *Edyta Buczyńska*<sup>3</sup>, *Piotr Gadawski*<sup>2</sup>, *Grzegorz Michoński*<sup>4</sup> & *Andrzej Zawal*<sup>4</sup>

<sup>1</sup>Department of Zoology, Maria Curie-Skłodowska University, Akademicka 19, 20-033 Lublin, Poland

<sup>2</sup>Department of Invertebrate Zoology and Hydrobiology, University of Łódź, Banacha 12/16, 90-237 Łódź, Poland

<sup>3</sup>Department of Zoology, Animal Ecology and Wildlife Management, University of Life Sciences in Lublin, Akademicka 13, 20-033 Lublin, Poland

<sup>4</sup>Department of Invertebrate Zoology and Limnology, Institute for Research on Biodiversity, Centre of Molecular Biology and Biotechnology, Faculty of Biology, University of Szczecin, Wąska 13, 71-415 Szczecin, Poland

**Abstract:** The status of a West European endemic species, *Gomphus pulchellus*, is unclear on the Balkan Peninsula. We report *G. pulchellus* from Skadar Lake (one site in Montenegro and one in Albania), among others based on exuviae, thus proving the autochthonic occurrence of the species in the western part of the Balkan Peninsula. A strongly isolated but stable island of the geographical range probably exists here. It is the first record of *G. pulchellus* in Albania.

**Key words:** records, distribution, Albania, Montenegro, Skadar Lake

## Introduction

*Gomphus pulchellus* Selys, 1840 (Odonata: Gomphidae) is considered a West European endemic species. Except for some regions of Spain, it is widespread from the Gibraltar to France, Germany and Austria (BOUDOT & CONZE 2015). Its occurrence further to the east is understudied, and the majority of the published data raises doubts. The controversy particularly concerns the Balkan Peninsula: only one site from Croatia located on the very edge of the Balkan Peninsula was recognised as certain (BOUDOT & CONZE 2015).

In order to determine the status of *G. pulchellus* on the Balkan Peninsula, we commenced searching for the species in various parts of the area, with particular consideration on its western part, where the occurrence of *G. pulchellus* seems to be the most probable. This paper presents and discusses results of this study.

## Materials and Methods

The study material was collected during four three-week expeditions in April, May, September and October 2014; July, August and October 2015. The research covered the following area: in the line south-north from Greece (including Crete) to Montenegro; in the line east-west from south-eastern Bulgaria to the coast of the Adriatic Sea (Fig. 1). A total of 328 sites in six countries (Montenegro: 183, Macedonia: 69, Greece: 62, Albania: 11, Serbia: 2, Bulgaria: 1) were studied. They represented all freshwater environments of importance for dragonflies, with particular consideration of waters typical of river valleys (rivers themselves, streams and springs feeding them) and lakes.

Skadar Lake (Serb. Skadarsko jezero, Alb. Liqeni i Shkodrës), where *G. pulchellus* has been recorded, is located on the boundary of Montenegro and Albania. It is a cryptodepression of tectonic ori-

\*Corresponding author: pawbucz@gmail.com

gin, filled with waters mostly of the Morača River (62%) and karstic springs pulsating from the bottom. It is connected with the Adriatic Sea through the Bojana River (Alb.: Bunë or Buna). The surface area of the lake, the largest on the Balkan Peninsula, varies from 370 to 6000 km<sup>2</sup>. Such high fluctuations of surface area result from high variability of the water level: the absolute altitude of the water surface in the season ranges from 4.7 to 9.8 m a.s.l. At high water level, the extensive shallow areas in the northern part of the lake are flooded. The mean depth of Skadar Lake reaches 5 m (RAKOCEVIC-NEDOVIC & HOLLERT 2005).

Larvae of dragonflies were collected using a hydrobiological net and, in inaccessible places, also by means of a hydrobiological dredge. The collection of exuviae, observations of imagines and preparation of photographic documentation of their occurrence were less systematic.

Measurements of physical and chemical water parameters were performed with a multiparametric meter Elmetron CX-401 and photometer Slandi LF205.

## Results

*Gomphus pulchellus* was recorded at two sites in Skadar Lake (Figs 2, 3):

1. Montenegro, Donji Murići, UTM: CM 56, ~8 m a.s.l.:

42°09'48" N, 19°13'13" E, 4.10.2014, shallow littoral (1.0 m), gravel-stony bottom, covered by *Najas* sp. and *Vallisneria spiralis* L. in patch distribution, one larva;

42°09'49" N, 19°13'19" E, 18.07.2015, shallow littoral (0.3 m), gravel-stony bottom with periphyton, vegetation: *Potamogeton lucens* L., *P. perfoliatus* L., *Myriophyllum* sp. and *Najas* sp., five larvae.

Water properties (18.07.2015) – pH: 7.94, conductivity: 250 μS·cm<sup>-1</sup>, temperature: 30.6°C, dissolved oxygen: 9.5 mg·dm<sup>-3</sup>, BZT<sub>5</sub>: 3.71 mg O<sub>2</sub>, nitrates: <10 mg·dm<sup>-3</sup>, ammonium nitrogen: 0.36 mg·dm<sup>-3</sup>, phosphates: 0.874 mg·dm<sup>-3</sup>, hardness: 5.23 °dH.

2. Albania, Dobër, UTM: CM 77, ~8 m a.s.l.:

42°10'37" N, 19°25'59" E, 1.05.2014, temporarily flooded meadow at the lake shore (high water level in the lake), 23 exuviae on herbaceous vegetation.

Water properties (1.05.2014) – pH: 8.11, conductivity: 500 μS·cm<sup>-1</sup>, temperature: 21.1°C, dissolved oxygen: 10.39 mg·dm<sup>-3</sup>, BZT<sub>5</sub>: 4.10 mg O<sub>2</sub>, nitrates: 1.01 mg·dm<sup>-3</sup>, ammonium nitrogen: <0.050

mg·dm<sup>-3</sup>, phosphates: <0.010 mg·dm<sup>-3</sup>, hardness: 8.78 dH.

Both sites were very similar: littoral areas with stony-gravel bottom; shallow, with evident water wave action, obviously positively affecting oxygen conditions. The vegetation was exclusively in the submerged form, displaying patches of various sizes.

## Discussion

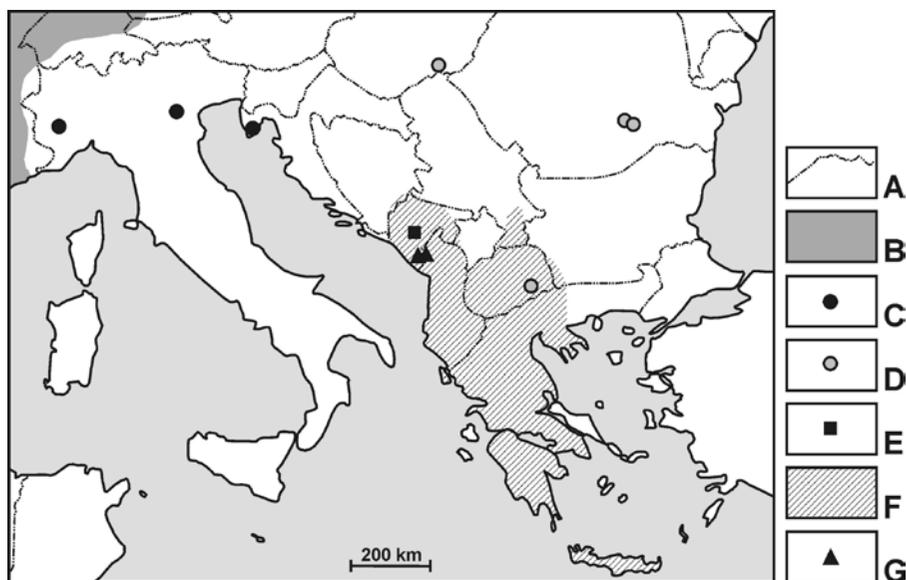
The state of knowledge on the geographic distribution of dragonflies in Western and Southern Europe is good, and continuously improving due to intensive faunistic studies conducted by numerous researchers. At the supranational level, the results have been recently compiled by BOUDOT *et al.* (2009) and BOUDOT & KALKMAN (2015). They have found that from the Pyrenees to central Germany and Switzerland, and to the eastern borders of France, the distribution area of *G. pulchellus* is very much clumped. Further east, however, only scarce, strongly dispersed sites are recorded. BUCZYŃSKI *et al.* (2013a) compiled a list of ten such sites from eight countries: Italy, Croatia, Macedonia, Romania, Hungary, Czech Republic, Slovakia and Poland. They also recorded another, new site from Montenegro. Then, ČERNÝ *et al.* (2014) again recorded the discussed species in the Czech Republic.

The majority of sites of *G. pulchellus* from outside of the clumped part of the geographical range located in Central Eastern Europe and on the Balkans was invalidated both in Polish and European monographs (review in BUCZYŃSKI *et al.* 2013a; BOUDOT & CONZE 2015). Only two sites from Italy and one from Croatia are commonly accepted, with the assumption that they were records of vagrant individuals (BOUDOT & CONZE 2015). The latest, well-documented record from western Czech Republic is also certain (ČERNÝ *et al.* 2014). These are sites located the nearest to the clumped part of the distribution area – all sites located further were rejected or questioned. This also applies to data of BUCZYŃSKI *et al.* (2013a) on the autochthonic occurrence of *G. pulchellus* in Montenegro. It was considered in BOUDOT & CONZE (2015) but, in spite of the inclusion of a good drawing of a collected larva in the reference paper, it was considered as requiring confirmation, contrary to our opinion.

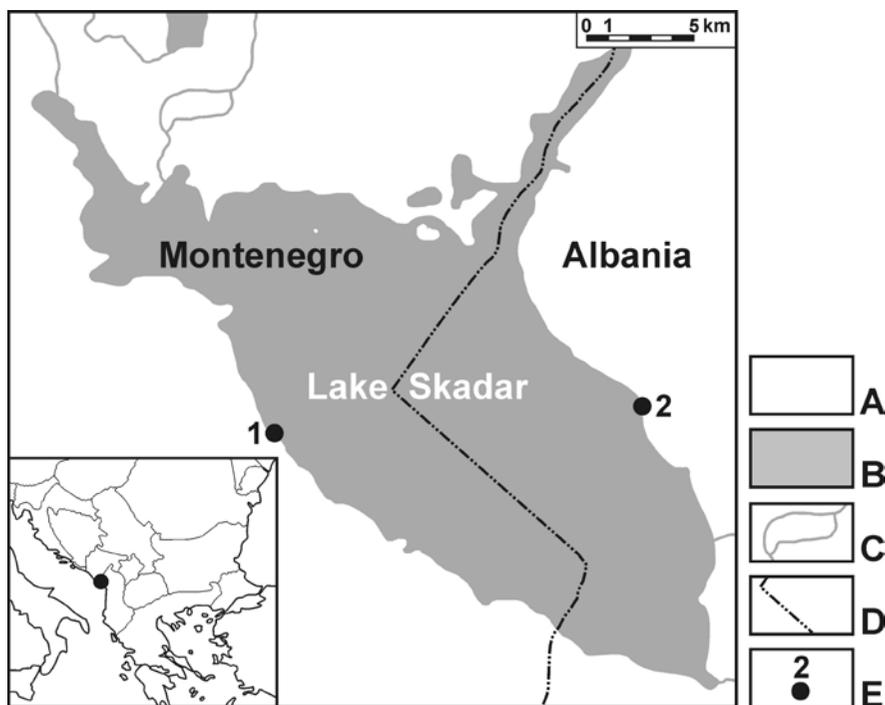
In the context of the above information, the status of *G. pulchellus* on the Balkan Peninsula seems to be very uncertain (Fig. 1). Thus, our data is important as, firstly, it confirms the occurrence of *G. pulchellus* in the western part of the Balkans where the species

is evidently autochthonic. Secondly, the new sites are located at less than 50 km from the known site (BUCZYŃSKI *et al.* 2013a), and also in the catchment area of the Skadar Lake. Recording *G. pulchellus* from two separated sites in the lake suggests its occurrence at least in a large part of the lake. The three sites together imply the existence of an island of the distribution area of the species in the western part of

the Balkan Peninsula. It is strongly isolated: according to currently available data, it is located approximately 1200 km from the main part of the distribution area defined by BOUDOT & CONZE (2015). The island is also rather permanent, as over several years larvae or exuviae have been collected (BUCZYŃSKI *et al.* 2013a; data in this paper). Its size and shape, however, are still unknown and require further research.



**Fig. 1.** Records of *G. pulchellus* on the Balkan Peninsula and in the adjacent area (after BUCZYŃSKI *et al.* (2013a), with alterations). A – state borders, B – clumped part of the distribution area in Western Europe; C – historical data, certain records; D – historical data, uncertain records; E – record of BUCZYŃSKI *et al.* (2013a); F – area covered by our study; G – new records of *G. pulchellus*. Drawn by Paweł Buczyński.



**Fig. 2.** Sites of *G. pulchellus* recorded in Skadar Lake. A – land; B – lakes; C – larger rivers; D – state border; E – sites (numbering like in the text). Drawn by Paweł Buczyński.

Nonetheless, *G. pulchellus* is a rarely occurring species here, as suggested by the low number of records: only four records at three sites in the scope of a very extensive faunistic research in recent years, covering numerous sites in many different areas (e.g. ZAWAL *et al.* 2010; BUCZYŃSKI *et al.* 2013a, 2013b; DE KNIJF *et al.* 2013; MURÁNYI & KOVÁCS 2013; DE KNIJF & DEMOLDER 2015; Pešić *et al.* 2017; present study).

It is worth paying attention to the water quality at the three sites. In the Skadar Lake, it was very good, as suggested by the concentration of the dissolved oxygen, an excellent indirect indicator (SANCHEZ *et al.* 2007). For the Morača River (site of BUCZYŃSKI *et al.* 2013a), no values of specific indicators were recorded, although its quality was mostly assessed, depending on the criterion, as good or very good (AZZ 2011). While in the main part of the distribution area of *G. pulchellus* the tolerance of the species to bad water quality seems very high (STERNBERG *et al.* 2000), the current data from the Balkans for now suggests a preference for waters with good quality. Nonetheless, the data is still too scarce to allow drawing far-reaching conclusions.

A question arises about the genesis of the island of distribution of *G. pulchellus* on the Western Balkans. It is not really explained by the eastward expansion of the distribution area of the species in Western Europe, which does not occur rapidly and over such long distances (Rudolph 1980; Suhling 2015). In our opinion, it could be explained with the colonisation by imagines wandering along the coast of the Adriatic Sea. This is suggested by the distribution of sites in Italy and Croatia, developing a logical sequence with data from Montenegro and Albania (Buczyński *et al.* 2013a; data in this paper). These are records from various periods of time, from the second half of the 19th century to the recent years (Pirota 1879; Schneider 1984; Buczyński *et al.*

2013a; present study). Therefore, the route of dispersal leading to range expansion migration might have been already functioning for a long time, and the presence of *G. pulchellus* in Montenegro and Albania also does not have to be a new phenomenon.

If it is certain that *G. pulchellus* is autochthonous in the west of the Balkan Peninsula, a question arises whether it is justified to negate other data from the area. The majority of the decisions were probably accurate, although in the case of materials from the first half of the 20<sup>th</sup> century and later, it is often risky to cite the argument of lack of evidence (cf. BUCZYŃSKI *et al.* 2013a). The turbulent history of the 20<sup>th</sup> century, with particular consideration of the 2<sup>nd</sup> World War, lead to destruction of numerous entomological collections of scientific institutions and private ones in Europe. This also concerns collections providing the “certain” basis for European odonatology. In view of this lack of evidence material, more or less justified speculations can be made, based on the distance from the nearest sites of a given species, knowledge on its distribution area, or number of mistakes in identification made by a given author. Moreover, collection of new data can change the basis of such calculations. In the case of our data, the site in Macedonia (PETKOV 1921) seems quite probable.

A local, although interesting aspect of our data is recording *G. pulchellus* for the first time from Albania, as the 59<sup>th</sup> species of dragonflies from the country (BOUDOT & KALKMAN 2015; DE KNIJF & DEMOLDER 2015). Albania belongs to Balkan and European countries studied in terms of occurrence of dragonflies to the lowest degree (KALKMAN 2015). This is evidenced by the comparison with the numbers of species known from other countries of the Western Balkans not all of which are thoroughly studied either. For example, in Slovenia 72 species have been determined so far, in Croatia 68, Montenegro



**Fig. 3.** Sites of *G. pulchellus* in Skadar Lake: Donji Murići (Montenegro), 4.10.2014; Dobër, 1.05.2014. Photographed by Piotr Gadawski.

67, Serbia 63, Macedonia 62 and Greece (without Crete): 76 (BOUDOT & KALKMAN 2015).

**Acknowledgements:** We thank Milen Marinov for valuable comments on the first version of this paper.

## References

- AZZ [AGENCIJA ZA ZAŠTITU ŽIVOTNE SREDINE CRNE GORE] 2011. Informacija o stanju životne sredine 2010. Agencija za zaštitu životne sredine Crne Gore, Podgorica: 342 p.
- BOUDOT J.-P. & CONZE K.-J. 2015. *Gomphus pulchellus* Selys, 1840. – In: BOUDOT J.-P., KALKMAN V. J. (eds.): Atlas of the European dragonflies and damselflies. Zeist, The Netherlands (KNNV Publishing): 191-192.
- BOUDOT J.-P., KALKMAN V. J. (eds.) 2015. Atlas of the European dragonflies and damselflies. Zeist, The Netherlands (KNNV Publishing): 380 p.
- BOUDOT J.-P., KALKMAN V., AZPICULETA AMORÍN M., BOGDANOVIĆ T., CORDERO-RIVERA A., DEGABRIELLE G., DOMMANGET J.-L., GARRIGÓS B., JOVIĆ M., KOTARAC M., LOPAU W., MARINOV M., MIHOKOVIĆ N., RESERVATO E., SAMRAQUI B. & SCHNEIDER W. 2009. Atlas of the Odonata of the Mediterranean and North Africa. – *Libellula*, Suppl. **9**: 1-256.
- BUCZYŃSKI P., ZAWAL A., STĘPIEŃ E., BUCZYŃSKA E. & PEŠIĆ V. 2013a. *Gomphus pulchellus* Selys recorded on the eastern edge of its distribution area in Montenegro (Anisoptera: Gomphidae). – *Odonatologica*, **42**: 293-300.
- BUCZYŃSKI P., ZAWAL A., STĘPIEŃ E., BUCZYŃSKA E. & PEŠIĆ V. 2013b. Contribution to the knowledge of dragonflies (Odonata) of Montenegro, with the first record of *Ophiogomphus cecilia* (Fourcroy, 1785). – *Annales Universitatis Mariae Curie-Skłodowska Sectio C*, **68**: 57-71.
- ČERNÝ M., WALDHAUSER M. & VINTR L. 2014. First documented record of *Gomphus pulchellus* in the Czech Republic (Odonata: Gomphidae). – *Libellula*, **33**: 189-194.
- DE KNIJF G. & DEMOLDER H. 2015. Some dragonfly records from Albania, with *Cordulegaster heros* and *Somatochlora metallica* new for the country (Odonata: Cordulegasteridae, Corduliidae). – *Libellula*, **34**: 181-185.
- DE KNIJF G., VANAPPELGHEM C. & DEMOLDER H. 2013. Odonata from Montenegro, with notes on taxonomy, regional diversity and conservation. – *Odonatologica*, **42**: 1-29.
- KALKMAN V. J. 2015. Country accounts. Albania. – In: BOUDOT J.-P. & KALKMAN V. J. (eds.): Atlas of the European dragonflies and damselflies. Zeist, The Netherlands (KNNV Publishing): 37.
- MURÁNYI D. & KOVÁCS T. 2013. Contribution to the Odonata fauna of Albania and Montenegro. *Folia Historico Naturalia Musei Matraensis*, **37**: 29-41.
- PEŠIĆ V., GLIGOROVIĆ B., SAVIĆ A. & BUCZYŃSKI P. 2017. Ecological patterns of Odonata assemblages in karst springs in central Montenegro. – Knowledge and management of aquatic ecosystems, **418**: 3.
- PETKOV P. 1921. Prinos kam izutchavane na balgarskite Odonata. – *Godishnik na Sofijskiya Universitet (Fiziko-matematicheski fakultet)*, **15/16**: 1-39 (In Bulgarian).
- PIROTTA R. 1879. Libellulidi Italiani. – *Annali del Museo civico di storia naturale di Genova*, **14**: 401-489.
- RAKOCEVIC-NEDOVIC J. & HOLLERT H. 2005. Phytoplankton Community and Chlorophyll a as Trophic State Indices of Lake Skadar (Montenegro, Balkan). – *Environmental Science and Pollution Research*, **12**: 146-152.
- RUDOLPH R. 1980. Ausbreitung der Libelle *Gomphus pulchellus* Selys 1840 in Westeuropa. – *Drosera*, **80**: 63-66.
- SÁNCHEZ E., COLMENAREJO M. F., VICENTE J., RUBIO A., GARCÍA M. G., TRAVIESO L. & BORJA R. 2007. Use of the water quality index and dissolved oxygen deficit as simple indicators of watersheds pollution. – *Ecological Indicators*, **7**: 315-328.
- SCHNEIDER W. 1984. Zum Nachweis von *Gomphus pulchellus* Selys 1840 in Jugoslawien (Odonata: Anisoptera: Gomphidae). – *Entomologische Zeitschrift*, **94**: 109-110.
- STERNBERG K., HÖPPNER B., HEITZ A. & HEITZ S. 2000. *Gomphus pulchellus* Selys, 1840. – In: STERNBERG, K. & BUCHWALD, R. (eds.): Die Libellen Baden-Württembergs, Vol. 2. Stuttgart (Ulmer), 293-303.
- SUHLING, F. 2015. *Gomphus pulchellus* Selys, 1840. Westliche Keiljungfer. – In: BROCKHAUS T., ROLAND H. J., BENKEN T., CONZE K.-J., GÜNTHER A., LEIPELT K.G., LOHR M., MARTENS A., MAUERSBERGER R., OTT J., SUHLING F., WEIHRAUCH F. & WILLIGALLA C. (eds.): Atlas der Libellen Deutschlands (Odonata). – *Libellula*, Suppl. **14**: 190-193.
- ZAWAL A., STOJANOVSKI S. & SMILJKOV S. 2010. Preliminary investigations on Odonata from Lake Ohrid (Macedonia). – *Biotechnology & Biotechnological Equipment*, **24** (Suppl. 1): 636-638.

Received: 24.03.2016

Accepted: 11.04.2016

