LIFE19 BG/NAT/000804
Conservation of Pomorie Lake coastal lagoon

Final Report – 2023

D.3 – Monitoring of dragonflies & water regime



Authors: Philippe Lambret, Stanimira Deleva, Dimitar Popov and Spas Uzunov

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Cover picture: Nanevska Tuzla (43.4136° N | 28.5031° E), a new site of primary importance for the conservation of the Dark Spreadwing *Lestes macrostigma* in Bulgaria (© P. Lambret | TdV).

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1 – Action D3 summary

The project aimed the long-term improvement of priority habitat 1150* Coastal lagoon in SAC Pomorie. The action D3's purpose was to improve our knowledge for dragonfly species in SAC Pomorie and to propose usage of dragonfly assemblages as an indicator of water quality in coastal habitats in the SAC. Conserving dragonflies and their habitat is a priority because they are valuable environmental indicators. They rely on healthy aquatic ecosystems and healthy food chains. Threats to their wellbeing include habitat loss and decline of water quality. These threats are most evident for the "critically endangered" in Bulgaria Dark Spreadwing (*Lestes macrostigma*). Pomorie Lake is the only place in Bulgaria where this species has been established for the last 15 years. Its typical habitat is shore stagnant and temporary brackish water bodies (salinity of the water up to ca. 13-14 ‰) with the presence of *Bolboschoenus maritimus*. The registered average salinity in Pomorie Lake in May 2019 (12.58‰) was expected to influence the whole dragonfly assemblage, due to the specific salinity tolerance of every dragonfly species.

The study described following parameters:
(1) salinity levels, water levels and rainfalls;
(2) dragonfly habitat features: spring helophyte vegetation composition and cover;
(3) dragonfly assemblage by assessing from spring to summer the density of each species (using transect counts) and the number of individuals successfully emerging from larval aquatic habitat to adult terrestrial habitat (using exuviae counts); yet, exuviae counts revealed to be highly time-consuming and were changed into teneral (i.e. emerging adults) counts.

The developed monitoring scheme including the field protocol was tested in the SAC Atanasovsko Lake (BG0000270) and SAC Mandra-Poda (BG0000271). Other sites potentially harbouring *L. macrostigma* along the whole Black Sea coast if Bulgaria were also surveyed to assess the global conservation status of the species in the country. Gathered data during the survey were stored in a database, maintained by BBF. Data were statistically analysed on the annual basis and result described in annual reports.

The project results regarding action D3 were presented through a poster at the *International Congress on Odonatology* (25–30 June 2023 at Paphos, Cyprus). Also, a scientific paper with project results was developed and has now entered the publication process of *Odonatolgica*, a peer-to-peer reviewed international journal (with Impact Factor) dedicated to dragonflies. TdV research institute took the leadership of this transfer of knowledge.

The field protocol developed in the frame of the current LIFE project was proposed to the National Biodiversity Monitoring System as the Dark Spreadwing is listed as in need of monitoring but no specific monitoring scheme was existing.

2 – Accomplished tasks

2.1 – Monitoring of habitat features at Pomorie SAC

2.1.1 – Water management

Besides rainfall, these Pomorie peripheral basins are likely to be flooded by Kamenarska stream, which first floods basin 1, the northernmost, and then the directly connected to basin 2. Basins 6 and 7 should be the last to be flooded but, since Southern canal is currently blocked and water from the ditch does not reach them, they are flooded only by rain. The dry period of the season 2022-23 has been the longest over the monitoring period, with basins being flooded as late as March 2023 (Figure 1). Yet, since *Lestes macrostigma* larvae should not hatch in Bulgaria before the end of March[1], and that a slightly later flooding does not impair hatching of at least some eggs[2] , this very late flooding may have reduced egg survival, at most.

During the winter 2022-23, rainfall amounts were smaller than the two previous winters, and not enough to flood basins naturally (Figure 1). Further, water levels were lower in 2023 than in 2021 and 2022, with basin 7 even remaining totally dry. As salinity levels vary to the opposite of water levels (because of the dilution of salts during flooding events and, contrastingly, their concentration during evaporation events), these were higher in 2023 than in 2021-22.

As stressed by Edouard Gatineau (Project Adviser at the European Climate, Infrastructure and Environment Executive Agency) in his letter of the 21 June 2023, “the major issue with the hydrological regime of the lake caused by the construction works of the motor road (motorway) passing by the lake is persistent and negatively affects the conservation impact of the project. A part of the important bypass channel, which drains the rainwater, has been covered by a large amount of excavation material during the road construction works. Hence, the rainwater now enters the lake directly and both raising its level beyond the optimal for the breeding birds and diluting the salinity of the lake. This […] threatens the Natura 2000 sites BG0000620 - Pomorie and BG0000152 - Pomoriysko ezero, the priority habitat Coastal lagoons (1150*) […]”.

[1] Lambret P., Hilaire S. & Stoks R. (2017) Egg hatching phenology and success of *Lestes macrostigma* in two temporary brackish ponds. *International Journal of Odonatology* 20: 1-12. https://doi.org/10.1080/13887890.2016.1269690

[2] Lambret P., Rutter I., Grillas P. & Stoks R. (2018) Oviposition plant choice maximizes offspring fitness in an aquatic predatory insect. *Hydrobiologia* 823: 1-12. https://doi.org/10.1007/s10750-018-3663-3

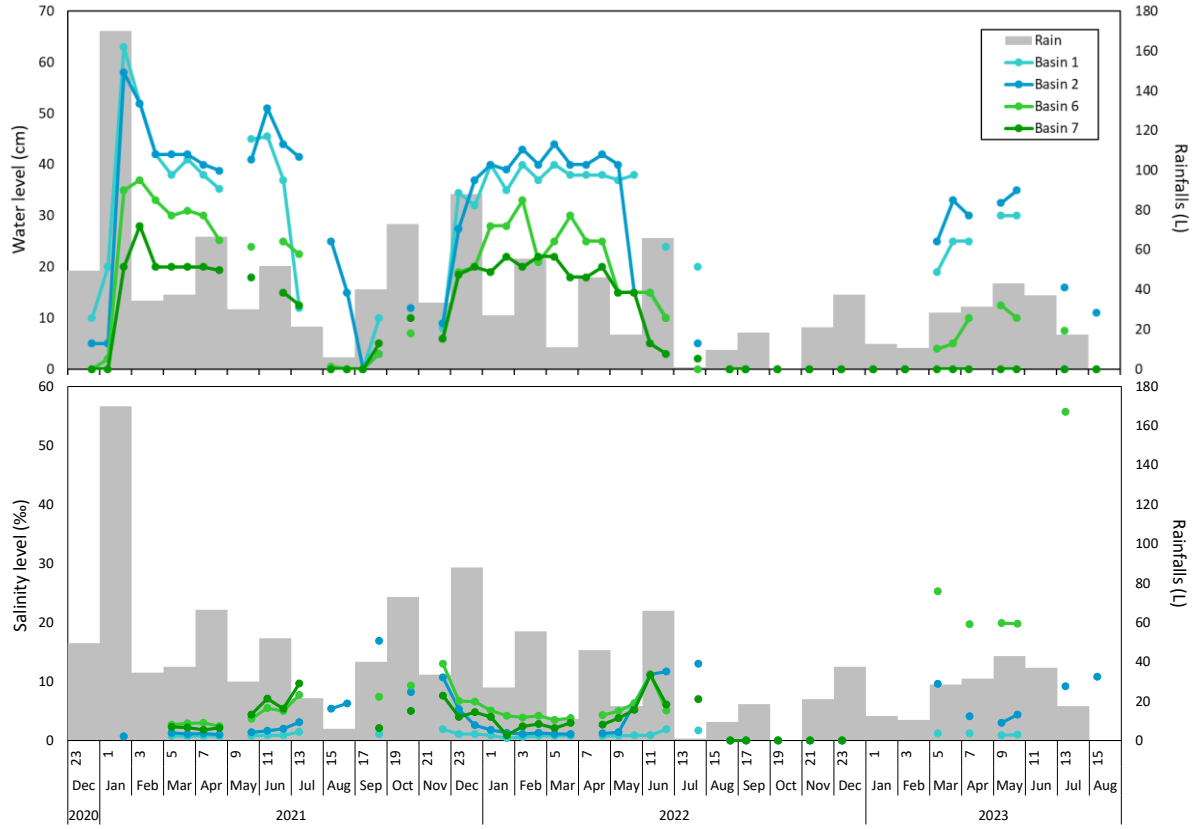


Figure 1. Variation of water levels (top) and salinity levels (bottom) during 2021 and 2022 (fortnight records). Note that in autumn and early winter 2022, basins remained dry despite rainfall, indicating that first rains are "drunk" by the soil that has to swell before water levels can rise up.

2.1.2 – Vegetation features

The results about the monitoring of the helophyte vegetation were already presented in the previous report (no further survey was made by drone in 2023). Yet, by walking through the basins, we did not noticed any major change. However, we found that the vegetation had been burnt in March 2023 in the Malak geren area (https://lifeforpomorielagoon.eu/fire-in-pomorie-lagoon--3-159) but also later on in the Honyat area (Figure 2). This was worrying regarding the conservation of the target damselfly *Lestes macrostigma* as its eggs are laid by females in the shoots of helophyte plants[3], and should only start hatching in Bulgaria at the end of March[4]. Fortunately, the fire in the Malak geren area only burnt the northern part of basin 1 (i.e. where *L. macrostigma* does not lay eggs and the species was found emerging from basin 2 in 2023 (see part 2.2.2). Further, its absence from basin 7 is 2023 is rather due to the basin drought (Figure 1). The helophyte vegetation started growing again in spring (Figure 2). Hence, these fires did not affect *L. macrostigma* population in 2023. Yet, fire in dry of shallow flooded basins remains a threat to the eggs when still in the shoots.

[3] Lambret P., Besnard A. & Matushkina N. (2015) Plant preference during oviposition in the endangered dragonfly *Lestes macrostigma* (Odonata: Zygoptera) and consequences for its conservation. *Journal of Insect Conservation* 19: 741-752. https://doi.org/10.1007/s10841-015-9796-z

[4] Lambret P., Hilaire S. & Stoks R. (2017) Egg hatching phenology and success of *Lestes macrostigma* in two temporary brackish ponds. *International Journal of Odonatology* 20: 1-12. https://doi.org/10.1080/13887890.2016.1269690



Figure 2. Helophyte vegetation of basin 6, i.e. *Phragmites australis* (left) and *Bolboschoenus maritimus* (right), recovering in May 2023 after a fire has burnt vegetation (© P. Lambret | TdV).

2.2 – Dragonflies of Pomorie SAC

2.2.1 – Species assemblage

The assemblage of species for which we found successful reproduction evidences (Table 1) is typical from brackish temporary waters, which is in accordance with the monitoring of physico-chemical features (see § 2.1.1). Some species we have recorded without any evidence of autochthony also belong to the brackish temporary water assemblage (*I. elegans*, *A. affinis*, *A. mixta*, *A. parthenope*, *O. cancellatum* and *S. striolatum*). In 2022, we found *Crocothemis erythraea*, a species we forgot to report by mistake. Additionally, we found in 2023 a new species that we expected: *Sympecma fusca*. This species overwinters at the adult stage and emerge during summer. We could not find any autochthony evidence but, as this species was observed in July too, its autochthony is most probable. Contrastingly, we found in basin 1 autochthony evidence for *A. isoceles* and *B. pratense*, two species typical of more permanent and fresh waters, suggesting that the habitat in this basin is slightly different from typical brackish temporary ponds. This is most probably related to the fact that basin 1 is receiving freshwater from the canal, thereby having the lowest salinity level and the longest hydroperiod (Figure 2). Also, we found some differences in specific Lestids abundances over the 2021-23 monitoring, with that of *L. macrostigma* decreasing and that of *L. dryas* increasing, the dominance of these species switching over the duration of the monitoring (Table 2). This suggests that basin 1 was, before the monitoring, more salted and/or temporary. From 2014 to December 2020, the fresh water from Kamenarska River was retained into the swamp western to Pomorie lagoon and diverted to a drainage canal. Basin 1 was then mainly flooded by rainfall, suggesting that it was dry for longer periods, with higher salinity levels, and therefore more favourable to *L. macrostigma*. Now, the drainage canal is blocked and the river's fresh water flows into basin 1, which less favourable to *L. macrostigma*.

Table 1. Abundance and reproductive status of the dragonfly species recorded within Pomorie SAC from 2021 to 2023. Abundances are given as, during one visit, maximal numbers encountered or estimated (9 = few individuals, 99 = dozens, 999 = hundreds…). Species we have detected as autochthonous, autochthony is given from 2021 to 2023 as × = detected, ( ) = not detected; yet, note that autochthony survey was focused on *Lestes* spp. only in 2023, in order to save time to survey the rest of the Black Sea coast. New species (i.e. found in 2023) are indicated in bold characters.

Family	Species	Maximal abundance			Autochthony
		2021	2022	2023	
Lestidae	*Chalcolestes parvidens*	9	9		
	Lestes barbarus	9	9	9	××( )
	Lestes dryas	99	9,999	9,999	×××
	Lestes macrostigma	99,999	99,999	99,999	×××
	Sympecma fusca			9	
Coenagrionidae	*Enallagma cyathigerum*	9			
	Ischnura elegans	9	99	9	( )×( )
Aeshnidae	*Aeshna affinis*	9	9	9	××( )
	Aeshna isoceles	9	9	9	( )×( )
	Aeshna mixta	9			
	Anax ephippiger			9	
	Anax imperator		9	9	
	Anax parthenope	9	9	9	
	Brachytron pratense	9	9	9	( )( )×
Libellulidae	*Crocothemis erythraea*		9		
	Orthetrum brunneum			9	
	Orthetrum cancellatum	9	9		
	Sympetrum fonscolombii	9	9	9	××( )
	Sympetrum meridionale	999	999	99	××( )
	Sympetrum sanguineum		9	9	
	Sympetrum striolatum	9			

Table 2. Abundance of the Lestes species recorded within basin 1 of Pomorie SAC from 2021 to 2023. Abundances are given as, during one visit, maximal numbers estimated when over two individuals: 9 = few individuals, 99 = dozens, 999 = hundreds.

Species	Maximal abundance		
	2021	2022	2023
Lestes barbarus	9		2
Lestes dryas	99	999	999
Lestes macrostigma	999	999	1

2.2.2 – Focus on *Lestes macrostigma* abundance

The year 2023 was marked by the disappearing of *L. macrostigma* from basin 7 because of a lack of water (Figure 2). The very low water levels are most probably also responsible of a lack of observation of the species in basin 6. Further, we recorded a strong decrease of *L. macrostigma* abundance in basin 1 (Table 2), most probably because of the competition with the *L. dryas*, a species inhabiting well vegetated fresh and standing waters, that possibly dry in summer. Also in basin 2, a decrease might have occurred, as we assessed the adult abundance by dozens of thousands on 1st June 2021, thousands on 1st June 2022, and then hundreds on 27 May 2023. Yet, ca. 2,000 adults were observed in basin 2 on 2nd July 2023, with hundreds of tenerals, suggesting that the emergence period was delayed in 2023.

Contrastingly, we assessed the abundance during one visit by thousands of adults in basin 4 both in 2022 and 2023, extrapolating to dozens of thousands adults over the flight season in this basin. So did we in basin 3 in 2023. However, while we

extrapolated *L. macrostigma* population over the whole flying season and the entire Pomorie SAC by hundreds of thousands of adults, possibly exceeding the million individuals, in 2021, and hundreds of thousands of adults in 2022, our estimation in 2023 cannot be as large, as dozens of thousands adults were only assessed from basins 3 and 4. This further illustrates the strong abundance variation the species is typical of and well known for[5], and invite conservationists and wildlife managers to pay their attention to the water management of Pomorie SAC.

2.3 – Training local staff to dragonfly survey and database recording

The training of Stanimira Deleva continued, especially regarding the implementation of the monitoring scheme (see Annexe 1) along the Black Sea coast in order to assess the conservation status of *Lestes macrostigma* at the national level (24–27 May 2023). Her training continued in Macedonia (29 May–1 June 2023) when we visited several temporary and brackish sites seeking for the presence of the species (see part 2.5). Stanimira Deleva is now autonomous in odonatology and continues recording dragonflies across the whole country (see the data base).

2.4 – Conservation status of *Lestes macrostigma* in Bulgaria

Besides the monitoring of Pomorie SAC, we aimed at further establishing the current distribution of the species along coastal Bulgaria and at bringing further details about the conservation status of its populations. In 2023, we surveyed several additional sites with suitable habitats along the Bulgarian Black Sea coast, where the species could potentially be observed. For this, we checked the GIS database and the Natura 2000 information system of the Bulgarian Ministry of Environment and Water to find locations sites with the presence of the species' preferred habitats: 1130 Estuaries, 1150* Coastal lagoons, and 1410 Mediterranean salt meadows (MOEW, 2023a, 2023b). In addition, we checked the sites with historical records[6] and records from citizen science platforms (https://www.gbif.org/, https://observation.org/). We sought for the presence of *L. macrostigma*, realised transect counts of adults when encountered in order to assess the population size. We further recorded reproductive cues in order to establish the species autochthony. The associated species we observed during these surveys were also recorded. All these detailed records are included in the delivered database. We here provide a summary of the current conservation status of the species in Bulgaria through a map (Figure 3). We also provide some pictures and comments

[5] Borisov S.N. (2005) Aperiodic changes in number of *Lestes macrostigma* (Eversmann, 1836) in forest-steppe of West Siberia. *Euroasian Entomological Journal* 4:30-32.

Cano-Villegas F.J., Conesa-García M.Á. (2010) Confirmation of the presence of *Lestes macrostigma* (Eversmann, 1836) (Odonata: Lestidae) in the "Laguna de Fuente de Piedra" Natural Reserve. *Boletín de la Asociación española de Entomología* 33(1-2): 91-99.

Berquier C., Sorba V., Berquez B., Bonnenfant O., Pozzo di Borgo M.-L., Andrei-Ruiz M.-C. (2022) Influence de plusieurs variables environnementales sur les extrêmes variations d'abondance de *Lestes macrostigma* au sein du réseau de mares temporaires méditerranéennes de la Réserve Naturelle des Tre Padule de Suartone en Corse. Ecologia Mediterranea 48(1): 5-15.

[6] Boudot J.-P. & Raab R. (2015) *Lestes macrostigma* (Eversmann, 1836). *In*: Boudot J.-P. & Kalkman V.J. (eds) *Atlas of the European dragonflies and damselflies*. KNNV Publishing, Zeist, The Netherlands: 58-60.

about the sites where the species was present, but Pomorie SAC (that was already detailed in this report) and Shablenska Tuzla (that was detailed in the previous report[7]).

While hundreds of adults were observed in the eastern coastal belt of Southern Atanasovko Lake in 2022, we only observed few of them in 2023, yet with tenerals proving the autochthony of the species. This suggests that the conservation status of *L. macrostigma* there is not so good. However, given that water levels currently depend on rainfall only, the implementation of an active water management, leading to more favourable conditions for the species, could improve its conservation status.

At Shablenska Tuzla, the species was found to be autochthonous again. While we counted on the 4 June 2022 among the *Bolboschoenus maritimus* vegetation 710 adults along a 115 m long transect, abundance seemed even higher in 2023: 1,000 adults were counted along a 40 m walk on the 27 May. Again, we assessed the total population over the whole flying season to consist, at least, in some hundreds of thousands individuals. This confirms that Shablenska Tuzla the importance of this site or the conservation of *L. macrostigma* in Bulgaria, and even throw it as the first major site before Pomorie SAC.

At Nanevska Tuzla, the helophyte vegetation is rare compared to Pomorie peripheral basins or Shablenska Tuzla (see cover picture). The shoots where *L. macrostigma* females could lay eggs only consisted in few patches of *Bolboschoenus maritimus* (Figure 4), while the more abundant *Phragmites australis* is not the preferred oviposition substrate of the species[8]. On the 27 May 2023, water salinity was 12.9 g/L (compatible with *L. macrostigma* larval development). On that day, we counted 576 adults along a 100 m walk. Half of them were tenerals, proving the species autochthony. This led us to estimate that the total population size over the whole flying season should consist in dozens of thousands adults. This makes Nanevska Tuzla the third size of importance for the conservation of the species in Bulgaria, after Shablenska Tuzla and Pomorie SAC then.

Finally, Jean-Paul Siccard took us on the 26 May 2023 to a female he found on the terrestrial bank of Yatata, a very large freshwater pond (Figure 5). This female was apparently immature. Yet, Jean-Paul told us that, in the frame of his personal naturalist activities, he was regularly observing few individuals of the species in this area. This suggests that a breeding population exist nearby, at least closer than the populations of Nanevska Tuzla or Pomorie SAC, which are both 60-70 km far from there (Figure 3), and from where vagrant individuals would regularly fly to Varna area. Hence, we spent the whole day seeking for this hypothetical breeding population. Yet, Yatata's female was the sole *L. macrostigma* individual we observed. And the only site seemingly favourable to the breeding of the species was close to Varna West Port (Figure 5), where we found Ishnura pumilio emerging. There, water salinity was 13.5 g/L (compatible with *L. macrostigma* larval development).

[7] Lambret P., Deleva S., Popov D. & Uzunov S. (2023). LIFE19 BG/NAT/000804 Conservation of Pomorie Lake coastal lagoon – Annual Report 2022: Monitoring of dragonflies & water regime. Tour du Valat Research Institute, Le Sambuc, Arles, 10 pages.

[8] Lambret P., Rutter I., Grillas P. & Stoks R. (2018) Oviposition plant choice maximizes offspring fitness in an aquatic predatory insect. *Hydrobiologia* 823: 1-12. https://doi.org/10.1007/s10750-018-3663-3 | https://rdcu.be/QQ7d

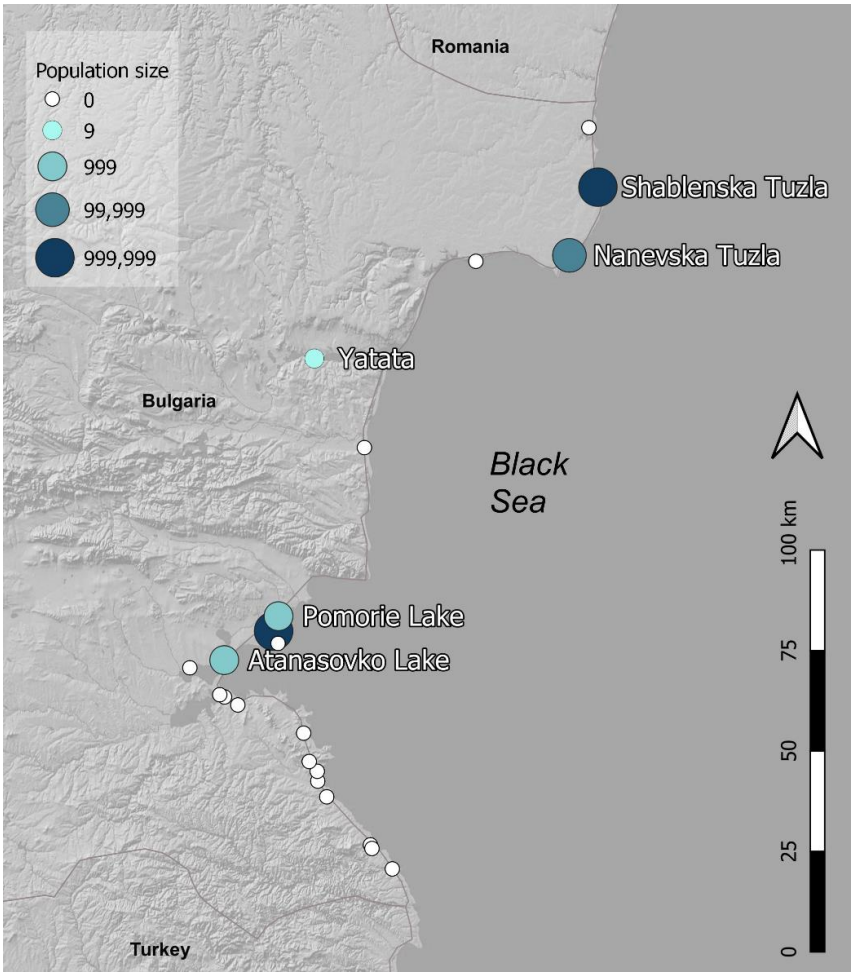


Figure 3. Distribution of *Lestes macrostigma* along the Bulgarian Black Sea coast over the period 2021-2023 together with the population size assessed at the scale of whole site and flight period. The species was found to reproduce successfully at all site with presence but in Yatata (Varna area) where we only observed one vagrant individual and could not identify the source population. Three dots are shown for Pomorie area: the 999 population concerns the northern saltpans, and the 0 population (i.e. absence) concerns the salt museum (© P. Lambret | TdV).



Figure 4. The helophyte vegetation of Nanevska Tuzla (nearby Rusalka resort) mainly consist in *Phragmites australis* reed (left), and only few dense patches of *Bolboschoenus maritimus* (see arrows) were located in the northern part (43.41373°N | 28.50303°E) (© P. Lambret | TdV).



Figure 5. View of the typical habitat of Yatata (Varna area) i.e. permanent freshwater (left; the *Lestes macrostigma* vagrant female was found on the left bank); despite the presence of few Cyperaceae shoots, that may serve as oviposition substrate, no population was found (© P. Lambret | TdV).



Figure 5. View of a temporary shallow brackish water wetland (43.18571°N | 27.63049°E), in Varna West Port area. These water features together with the presence of patches of Cyperaceae shoots make this area a candidate site to seek some more for the presence of a breeding population of *Lestes macrostigma* close to Yatata, where the species is regularly observed in very small numbers (Jean-Paul Siccard comm. pers.) (© P. Lambret | TdV).

2.5 – Communication

2.5.1 – International Congress of Odonatology

The action D3 of the LIFE+ for Pomorie lagoon project and especially the results of the 2021-23 survey to assess *L. macrostigma* conservation status in Bulgaria was summarised on a poster (Figure 6) which was presented at the 13th International Congress of Odonatology. This congress was held from 25 to 30 June 2023 at Paphos, Cyprus. There, 85 dragonfly enthusiasts including conservationists, PhD students and senior professors from 21 countries around the world, had the opportunity to discover the LIFE+ program for Pomorie lagoon and its action D3. The interest of the audience concerned the management of its habitat and its monitoring. This sounds promising regarding the conservation of this dragonfly and the restoration of its habitat in the frame of future projects.



Figure 6. The poster showed at the International Congress of Odonatology ICO2023 held in Paphos, Cyprus (realisation: P. Lambret | TdV).

2.5.2 – Scientific paper

A manuscript using the 2021-23 survey data was written and entitled "Conservation status of *Lestes macrostigma* and its habitats in Bulgaria". It was submitted on the 8 August 2023 to *Odonatologica*, a peer-reviewed international journal dedicated to dragonfly studies (2020 Impact Factor: 0.743). However, given the short time between the last survey (*L. macrostigma* was recorded from Pomorie SAC up to the 3 August 2023) and the end of the LIFE19 NAT/BG/000804, we compiled the 2023 information somewhat in a rush. While the editor underlined the relevancy of our study, which is

well within the scope of the journal, he also asked us to polish the manuscript and to resubmit later on (i.e. decision = major revision and resubmission; see Annex 1). We are fully confident in our ability to do so and in the possibility to see this paper published. This task will be done in the next months.

2.6 – Status of *Lestes macrostigma* in Macedonia

Lestes macrostigma is known from Macedonia in the vicinity of Doiran Lake, with one male observed on the 15 June 1969 and two males on the 14 June 1970[9]. Yet, the species was never observed again in the country, despite the presence of qualified odonatologists. So is Despina Kitanova, from the Macedonian Ecological Society, who invited us to bring our expertise on the species ecology. From the 29 May to the 1st June 2023, she took us to Doiran Lake and to the seemingly most favourable sites for the species (i.e. either with brackish or temporary water), together with some other sites expected to include the Natura 2000 network (Figure 7).

We found the helophyte vegetation of Doiran Lake to be composed of *Phragmites australis* all around the lake (Figure 8), as already described by Kamaran (1981), rather indicating fresh water. The dragonfly assemblage we observed consisted in *Ishnura elegans*, *Erythromma lindenii*, *Aeshna isoceles*, *Anax parthenope*, *Crocothemis erythraea*, *Orthetrum albistylum* and *O. cancellatum*. This assemblage is typical from fresh and permanent waters, a type of habitat that cannot harbour an autochthonous population of *L. macrostigma*. Hence, the males observed in 1969 and 1970 were most probably vagrant individuals coming from a nearby population, likely from the Thessaloniki area (Greek coast) which is only ca. 70 km apart from Doiran Lake. *Lestes macrostigma* is well known for its dispersal abilities[10]. For instance, it was seen at Smolyan Lake (Rhodopes, Bulgaria), which is also ca. 70 – 80 km from the Greek coast, and this record concerned the accidental presence of one male[11].

We also investigated the Bunardzik area (Figure 9), where flows an intermittent river with water salinity increasing during the drying phase (2.96 g/L on the 29 May 2023), and the banks of the Vardar River (Figure 10), in the Bogdanci city area, which are temporarily flooded. However, these habitats (i.e. running or fresh waters) are not typical from *L. macrostigma*.

Hence, we concluded that Macedonia is unlikely to harbour any *L. macrostigma* population because of the lack of its typical habitat, and that any potential record of the species in the country should concern vagrants.

[9] Kamaran B.S. (1981) Contribution à la connaissance de la faune des Odonates du lac Doïran. *Annales de la Faculté de Biologie de l'Université de Skopje* 34: 215-222.
[10] Chelmick D, Lambret P (2020) Species review 11: *Lestes macrostigma* (Eversmann), the Dark spreadwing. *Journal of the British Dragonfly Society* 36(2): 84-108.
[11] Marinov M. (2007) Odonata of The Western Rhodopes, with special reference to the wetlands North of the town of Smolyan, South Bulgaria. *Notulae odonatologicae* 6(9) : 97-108.

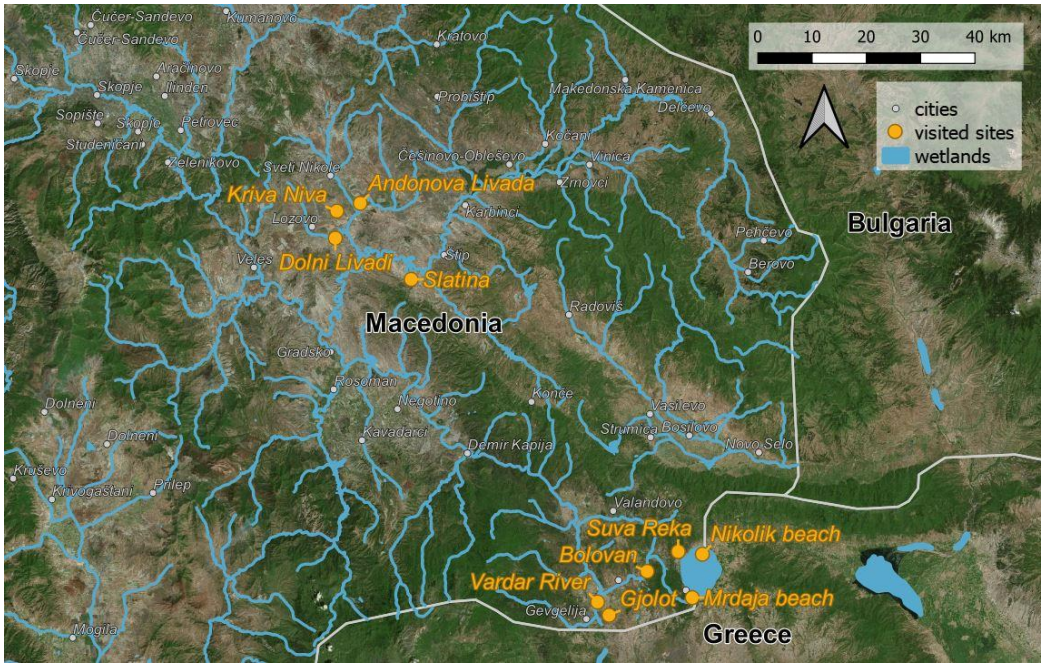


Figure 7. Sites visited in Macedonia in 2023, especially seeking for *Lestes macrostigma* (realisation: P. Lambret | TdV, QGIS with Bing Satellite).



Figure 8. The helophyte vegetation of Doiran Lake consits in *Phragmites australis* reeds, either on the north shore (Nikolik beach, top; S. Delava | BBF) or on the south shore (Mrdaja beach, bottom) (© P. Lambret | TdV).



Figure 9. The Bunardzik area presents intermittent rivers (i.e. running waters) of which salinity increases during the drying phase (© P. Lambret | TdV).



Figure 10. The Varda River may flood its banks temporarily but with fresh water (© P. Lambret | TdV).

3 – After LIFE perspectives

1. Maintaining an optimal water regime in the basins in Honyat and Malak Geren areas of Pomorie SAC: watering in November to levels of 30-50 cm, drying at the end of May-mid-June and maintaining salinity 2–6 ‰ in March and 8–10 ‰ in May; maintaining areas with emergent aquatic vegetation (*Bolboschoenus maritimus* and *Schoenoplectus litoralis*).

2. Revising the scientific paper for *Odonatologica*.

3. Implementing by competent authority at the national level proposed monitoring scheme for the monitoring of the Dark spreadwing *Lestes macrostigma* and associated habitat and dragonfly assemblage (Annex 2).

4. Proposing to restore habitats in favour of the species (e.g. in Poda protected area).

Annex 1

Wolnzach, 25th August 2023

Editor's decision on the ms.

Conservation status of *Lestes macrostigma* and its habitats in Bulgaria
by Philippe Lambret[1], Stanimira Deleva, Spas Uzunov & Dimitar Popov

Submitted for publication in *Odonatologica* on 08.viii.2023

Dear Philippe,

In the meantime, as a start of the official review process, I have read and evaluated the submitted ms. carefully. You are presenting precious data and material on the conservation of *Lestes macrostigma*, an EU-wide 'endangered' damselfly species, in Bulgaria. The conservation approach you are offering in your paper is absolutely within the scope of *Odonatologica* and fits well to our journal. This is also emphasized by the fact that the study was undertaken in the frame of an EU LIFE+ 'Nature and Biodiversity' program. The objective of the study, *i.e.*, to establish the current distribution of the species along coastal Bulgaria and to bring further details about the conservation status of its populations and habitats, and about its local ecology, will be a highly appreciated contribution to our yet only patchy knowledge of the species.

So far, so good. However, the only problem with the ms. It appears to me a bit premature and hastily compiled yet, probably due to time constraints. As this is not the appropriate level of submission of such an important study to an international journal, I am asking you to polish the structural and formal flaws in your ms. as outlined by me (see my comments directly in the ms.). I consider this necessary before giving this important study into the actual review process and sending it to two expert colleagues for peer review. You'll be aware that we should not strain the scarce time of reviewers with unnecessary or redundant work that can be accomplished in advance.

Therefore my decision concerning this ms. is

Major revision and resubmission

of the study to *Odonatologica* in due time. I'm highly optimistic that a more accurate version of the paper will then be able to make its way to publication in our journal.

Hoping for your understanding of this decision, and also hoping to hear from you again soon!

Best regards

Florian

Osmylus Scientific Publishers
Odonatologica Editorial Office
Dr Florian Weihrauch
Postfach 1212
D-85280 Wolnzach
Germany

odonatologica@osmylus.com
www.osmylus.com

Annex 2

Scheme for the monitoring of the Dark spreadwing *Lestes macrostigma* and associated habitat and dragonfly assemblage

Justification and description of object

The use of charismatic "flagship" insect species, in need of conservation effort, may help preserving freshwater habitats, and especially those included in some priority habitats according to the EU Habitats Directive: 1130 Estuaries, 1150* Coastal lagoons, and 1410 Mediterranean salt meadows. The Dark Spreadwing *Lestes macrostigma* (Eversmann, 1836) is restricted in Europe to temporary brackish waters, most often colonised by the Sea Club-rush *Bolboschoenus maritimus*, but also by *Schoenoplectus litoralis* and *Juncus maritimus*. According to the most recent assessment of its extinction risk (to be published by the end of 2023), this species is considered as "Near Threatened" in Europe (Geert De Knijf, pers. comm.) and has been recently proposed to include the Habitats Directive (Kalkman et al. 2018). In Bulgaria, *L. macrostigma* is listed as "Critically Endangered" in the Bulgarian Red Data Book (Popov 2015).

Currently, the presence of species is reported mainly from habitat 1150* "Coastal lagoons". In 2021-23, during the assessment of the species conservation status along the Bulgarian Black Sea coast, it was revealed that the species has disappeared from Poda Protected Area, where it was very abundant 20 years ago. Contrastingly, it was found in large numbers (i.e. from hundreds to at least dozens of thousands adults) in Pomorie Lake and Atanasovko Lake, Nanevska Tuzla (Rusalka resort) and Shablenska Tuzla. A regular assessment of the species conservation status (i.e. breeding status and abundance) at these sites should help to describe its population trends. Monitoring additional habitat parameters and dragonfly assemblage would help understanding the observed trends, in order to design of conservation actions targeting its freshwater habitat when needed. We here propose a scheme for such monitoring.

Description and life-cycle of *Lestes macrostigma*

Following information given after Lambret et al. (2009), Lambret et al. (2023) and observations made during the 2021-23 survey. *Lestes macrostigma* differs from *L. sponsa* (Hansemann 1823) and *L. dryas* (Kirby 1890) by its general darker aspect and its greater blue pruinosity (Figure 1). The pterostigmas are black and cover two to four cells on the fore- or hind-wings. Adults can measure up to 48 mm in length, which makes this species the biggest of the family in Europe, together with *Chalcolestes* spp. Thus, odonatologists are unlike to misidentify and/or to 'miss' this Lestid when encountered.

In Southern France, eggs of *L. macrostigma* hatch between mid-March and the beginning of April; in Bulgaria, given that the species is later on the wings (from mid-May to the beginning of August), hatching period is probably delayed by ca. a couple of weeks. Larval development is fast and lasts ca. 50–70 days. Adults emerge synchronously and about two weeks after emergence, adults are mature and can start mating and laying eggs into plant material (endophytic oviposition) so that egg laying mainly occurs during June and July.



Figure 1. General aspect of *Lestes macrostigma* at the adult stage: note the difference in coloration between a teneral i.e. just after emergence (left) and mature individuals, copulating (right) (© P. Lambret).

Monitored parameters, period and equipment

Parameters	Period and timing	Equipment
Salinity levels	From March to June, with one measure each month (one measure every two weeks preferably).	Waterproof handheld meter (or data logger).
Water levels	Year-round in order to define the water regime (i.e. hydroperiod), with one measure each month (one measure every two weeks preferably).	Gauge (or data logger).
Rainfall	Year round.	Pluviometer (or meteorological data).
Helophytes composition	Once during early June	Gum boots
Helophytes versus open water cover	Once during early June	Drone
L. macrostigma	At least two visits between the end of May (i.e. first adult emergences) and mid-June (i.e. highest adult abundance)	Gum boots, insect net, binoculars, GPS
Dragonfly assemblage	One visit each month from April to October	Identification field guide (Dijkstra et al. 2020, Marinov 2000), gum boots, insect net, binoculars

Methods

Habitat description

Measured salinity level at the seemingly most favourable sites for *L. macrostigma* by deepening the waterproof handheld meter probe 20 cm below the water surface; alternatively, given the fragility of this device, take a water sample into a ca. 50 mL vial and measure salinity level at the office.

To monitor water levels from distance using binoculars, setting of a gauge graduated from 0 to 100 cm at the deepest point of the water body that is to be monitored.

Odonata survey and abundance assessment

Survey odonata only during shiny (clouds covering less than 50% of the sky, without rain) and calm (wind speed below 30 km/h) days.

Walk the sites in and by the water and record each species present with their life stage (adults, exuviae, emergents, tenerals and immatures) and indices of reproduction (tandem, copula, oviposition). Observation of exuviae, emergent or tenerals sensu stricto (i.e. with clumpsy flight, prohibiting dispersal over long distance; see Corbet 2004) can be considered as proofs of successful reproduction at the surveyed site.

Assess *L. macrostigma* population size using adult counts along transects of which coordinates will be recorded. Then extrapolate abundance to the entire sites and season using classes along an exponential scale: dozens, hundreds, thousands, …, hundreds of thousands individuals.

As an aid to the field notes, odonatologists can use the survey application SmartBirds Pro, developed for the need of the National Monitoring (https://smartbirds.org/).

Sites

The sites where to implement the monitoring in priority are those where the species was found in large numbers during the 2021-23 survey (see Table below). Yet, it would be relevant to include in the future any newly discovered autochthonous population (e.g. in the Varna area, near Yatata, where few individuals are regularly observed).

Site	Area	Latitude WGS84	Longitude WGS84	N2000 site
Pomorie Lake	Malak geren	42.592541°	27.617799°	BG0000620 Pomorie
		42.591745°	27.617898°	
		42.590405°	27.612974°	
	Honyat	42.578129°	27.610830°	
Atanasovko Lake	Yuzhno	42.527674°	27.470572°	BG0000270 Atanasovsko ezero
		42.523666°	27.470374°	
Nanevska Tuzla	Northern part	43.413573°	28.503136°	BG0000573 Kompleks Kaliakra
Shablenska Tuzla	Northern part	43.561700°	28.588641°	BG0000621 Ezero Shabla-Ezerets

Potential participants

Bulgarian Biodiversity Foundation, Green Balkans NGO, Bulgarian Academy of Sciences (including National Museum of Natural History and Institute of Biodiversity and Ecosystem Research).

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TOUR DU VALAT - Le Sambuc - 13200 Arles - France
Tél. +33 (0) 4 90 97 20 13 - Fax +33 (0) 4 90 97 20 19 - E-mail : secretariat@tourduvalat.org -