original scientific paper/izvorni znanstveni rad
DOI 10.20302/NC.2025.34.23

THE SPREAD OF *TRITHEMIS ANNULATA* (PALISOT DE BEAUVOIS, 1807) (ODONATA: LIBELLULIDAE) IN THE WESTERN PART OF THE BALKAN PENINSULA

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Kulijer, D., Kogovšek, P. & Tivadar, N.: The spread of *Trithemis annulata* (Palisot de Beauvois, 1807) (Odonata: Libellulidae) in the western part of the Balkan Peninsula. Nat. Croat., Vol. 34, No. 2, _____, 2025, Zagreb.

Trithemis annulata (Palisot de Beauvois, 1807) is a widespread Afrotropical species that substantially expanded its range in Mediterranean Europe in the second part of 20th century and most recently in the West Balkan region. A field study was carried out from June to September 2024 in the southern parts of Bosnia and Herzegovina and the Neretva River delta in Croatia in order to investigate the species presence in this area. During the survey, *T. annulata* was found at 14 locations, seven in each country. The observations from Bosnia and Herzegovina represent the first record of this species for the country. It was found in a wide variety of habitats, both lentic and lotic, including lakes, reservoirs, rivers, larger ponds and canals. Considering that at several of these locations, the species was not found during surveys in 2022 and 2023, it most likely spread to this area recently. Additionally, two observations of *T. annulata* from North Macedonia that were found in the online databases Observation and iNaturalist represent the first documented reports for this country. These findings represent a substantial increase in species range and abundance in the region. The species' distribution and spread in the Balkan Peninsula is also outlined and discussed.

Keywords: Bosnia and Herzegovina, Croatia, dragonflies, Mediterranean, Neretva River delta, violet dropwing

Kulijer, D., Kogovšek, P. & Tivadar, N.: Širenje vrste *Trithemis annulata* (Palisot de Beauvois, 1807) (Odonata: Libellulidae) u zapadnom dijelu Balkana. Nat. Croat., Vol. 34, No. 2, _____, 2025, Zagreb.

Trithemis annulata (Palisot de Beauvois, 1807) je široko rasprostranjena afrotropska vrsta koja je znatno proširila svoj areal u mediteranskoj Europi u drugoj polovici 20. stoljeća, a nedavno i u regiji Zapadnog Balkana. Terensko istraživanje provedeno je od lipnja do rujna 2024. godine u južnim dijelovima Bosne i Hercegovine i delte rijeke Neretve u Hrvatskoj, kako bi se istražila prisutnost vrste na ovom području. Tijekom istraživanja *T. annulata* pronađena je na 14 lokacija, po sedam u svakoj državi. Zapažanja iz Bosne i Hercegovine predstavljaju prvi lokalni nalaz ove vrste. Zabilježena je u širokom spektru staništa, kako lentičkih tako i lotičkih, uključujući jezera, akumulacije, rijeke, veće bare i kanale. S obzirom da na nekoliko ovih lokacija vrsta nije pronađena tijekom istraživanja 2022. i 2023. godine, najvjerojatnije se nedavno proširila na ovo područje. Dodatno, dva opažanja *T. annulata* iz Sjeverne Makedonije koja su pronađena u online bazama podataka Observation i iNaturalist predstavljaju prve dokumentirane nalaze za tu državu. Ovi nalazi predstavljaju značajno povećanje areala i brojnosti ove vrste u regiji. Također je prikazano i raspravljeno rasprostranjenje i širenje vrste na Balkanskom poluotoku.

Ključne riječi: Bosna i Hercegovina, Hrvatska, vretenca, Mediteran, delta rijeke Neretve, ljubičasta skitnica

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INTRODUCTION

Trithemis annulata (Palisot de Beauvois, 1807) is a widespread Afrotropical species that is common throughout the African continent and most of the Arabian Peninsula to the south Turkey and eastern Iran. It is a ubiquitous and pioneer species that inhabits a wide variety of sunny and warm, stagnant or slow flowing waters, both natural and artificial, including lakes, sluggish streams and rivers, ditches, reservoirs, gravel pits, quarry and barrage lakes (KALKMAN *et al.,* 2015; GHEZA *et al.,* 2019; DIJKSTRA *et al.,* 2020). As its nymphs develop fast, this species can also breed in temporary waters (WILDERMUTH & MARTENS, 2019). The quarry lakes and large reservoirs are reported as its important reproductive habitats in Europe (BROCHARD & VAN DER PLOEG, 2013; GHEZA *et al.,* 2019). In some areas in the Mediterranean part of Europe, *T. annulata* is a bivoltine, while in Africa it is a multivoltine species (BOUDOT *et al.,* 2017). The species flight period in Europe is between mid-April and the end of October (KALKMAN *et al.,* 2015).

It is one of the species that is favoured by climate warming in Europe (KALKMAN *et al*., 2015). In the second part of 20th century, it substantially expanded its range in Mediterranean Europe, particularly in the western Mediterranean, but remained rare in southwestern Europe (BOUDOT *et al.,* 2009; KALKMAN *et al.,* 2015). In recent decades its range is also significantly expanding in the Balkan Peninsula (KALKMAN *et al.,* 2015). In the west Balkan region, it was found for the first time in 2008 in Montenegro (GLIGOROVIĆ *et al.,* 2010), with the first proof of reproduction in 2011 (DE KNIJF *et al.,* 2013). Until 2021, there was no data from other countries, but since then, the species was reported from several regions of Slovenia (VINKO & ŠALAMUN, 2021; VINKO *et al.,* 2022; DOBOVIŠEK *et al.,* 2023), Croatia (KOREN *et al.,* 2022) and most recently in 2023 from Serbia (ĐURĐEVIĆ *et al.,* 2024).

Although the intensity of the dragonfly research in Bosnia and Herzegovina and Croatia is lower than in most of other parts of Europe (KULIJER *et al.,* 2013; VILENICA *et al.,* 2021; KOREN *et al.,* 2022), in the last two decades considerable increase of local studies and engagement of local experts resulted with much better knowledge of local dragonfly fauna (BOUDOT & KALKMAN, 2015). This is especially evident when it comes to Bosnia and Herzegovina for which most of data on dragonfly fauna was collected in recent 15 years (KULIJER *et al.,* 2013, BOUDOT *et al.,* 2009, BOUDOT & KALKMAN, 2015), including several studies in the southern Mediterranean region of the country (KULIJER, 2014; BUKVIĆ & KULIJER, 2021; VILENICA *et al.,* 2021).

Trithemis annulata is an easily recognizable species based on its body and wing pattern and

coloration, particularly in males which are vividly violet due to the pruinosity that covers red colored body, red wing veins and large yellow patches at the hindwing base. Females are yellow-brown with the large yellow wing patches at the hindwing base (DIJKSTRA *et al.,* 2020).

Here we report the first observations of the species in Bosnia and Herzegovina and North Macedonia, and several additional observations from Croatia. The species' areal extension and distribution in the Balkan Peninsula is outlined.

MATERIALS AND METHODS

The field surveys were conducted from June to September 2024 in Neretva River delta, Trebišnjica and Trebižat river valleys, and Imotsko /Bekijsko polje. In Imotsko/Bekijsko Polje three locations were investigated on 23rd June and 7th July, Vrutak artificial Reservoir (Loc. 2, Fig. 1b) in Popovo polje was investigated on 28th June and 21st September, while several locations in Hutovo Blato were visited on 28th June, 6th July and 21st September. Mostarsko Lake, an artificial hydroaccumulation on Neretva River was visited on 28th June, 6th July, and 24th August. On 13th and 29th June, and 25th August the locations in the southeastern part of Herzegovina were investigated, including Trebišnjica River and several ponds and artificial lakes near Trebinje, and one location at Bilećko Lake, one of the largest artificial water accumulations in Bosnia and Herzegovina. Finaly, the study in the Neretva River delta was conducted on 23rd September at 10 locations in Croatia and one in Bosnia and Herzegovina (Fig. 1c,d). The list of locations at which *T. annulata* was found is presented in Tab. 1.

Tab. 1. The list of locations at which the *Trithemis annulata* (Palisot de Beauvois, 1807) was observed.

	Location	Date	N	E	Altitude (m a.s.l.)	Habitat type
Bosnia and Herzegovina						
1	Grude, Krenica Lake	23. vi 2024, 7. vii 2024	43.375191	17.332956	250	Lentic, lake
2	Vrutak Lake (artificial reservoir)	28. vi 2024, 21. ix 2024	42.927531	17.830736	235	Lentic, reservoir
3	Ljubuški, Kravice Waterfall	19. vii 2024	43.156319	17.608869	45	Lotic, river
4	Grude, Kostimančica pond	7. vii 2024	43.390215	17.309090	260	Lentic, large pond
5	Svitava village	21. ix 2024	43.015017	17.800767	1	Lentic, lake
6	Škrka Lake	21. ix 2024	43.082733	17.741381	4	Lentic, lake
7	Glibuša, Gabela polje	23. ix 2024	43.072624	17.650267	0	Lotic, canal
Croatia						
8	Glibuša canal 1, Metković	23. ix 2024	43.075200	17.640100	0	Lotic, canal
9	Glibuša canal 2, Metković	23. ix 2024	43.071537	17.649485	0	Lotic, canal
10	Nokat, oxbow, Metković	23. ix 2024	43.044800	17.629200	0	Lentic, oxbow
11	Neretva River, Kula Norinska	23. ix 2024	43.028787	17.606856	0	Lotic, river

	Location	Date	N	E	Altitude (m a.s.l.)	Habitat type
12	Mala Neretva River, Novo naselje, Opuzen	23. ix 2024	43.008300	17.544900	0	Lotic, river
13	Mala Neretva River, Vlaka, Opuzen	23. ix 2024	43.001500	17.520500	0	Lotic, river
14	Pižnovac, Opuzen	23. ix 2024	42.986100	17.539200	0	Lentic, pond

Fig. 1. The examples of the main habitat types where *Trithemis annulata* (Palisot de Beauvois, 1807) was observed: **a)** Krenica Lake, Loc. 1 (23. Vi 2024), **b)** Vrutak Lake, Loc. 2 (21. ix 2024), **c)** Glibuša canal 2, Loc. 9 (23. ix 2024), **d)** Mala Neretva River, Novo naselje, Opuzen, Loc. 12 (23. ix 2024), (photo: D. Kulijer).

At surveyed locations a wide variety of habitats was inspected, seven lentic and seven lotic ones, including lakes (Fig. 1a), artificial reservoirs (Fig. 1b), rivers (Fig. 1d), larger ponds and canals (Fig. 1c). At all these locations adults were investigated, while nymphs and exuviae were not sampled, except the search for exuviae at Krenica Lake in July. Several voucher adult specimens were collected and deposited in the collections of the National Museum of Bosnia and Herzegovina (NMBiH). The Biologer android application was used for collecting records in the field (POPOVIĆ *et al.,* 2020). The records from the Balkan region that were uploaded to the online databases Biologer, iNaturalist and Observation were also analysed (BIOLOGER, 2025; iNATURALIST, 2025; OBSERVATION, 2025).

RESULTS

During the field survey conducted from June to September 2024 *T. annulata* was recorded at a total of 14 locations, seven in Bosnia and Herzegovina and seven in Croatia (Tab. 1, Fig. 2). The records from Bosnia and Herzegovina represent the species' first observation in this country (KULIJER *et al.,* 2013; KULIJER & MILJEVIĆ, 2015).

In total, 31 other dragonfly species were found with *T. annulata* at the surveyed locations. The most common were: *Ischnura elegans* (Vander Linden, 1820) present at 14 locations, *Anax parthenope* (Sélys, 1839) and *Aeshna mixta* Latreille, 1805 present at six locations.

Material examined:

Trithemis annulata (Palisot de Beauvois, 1807)

Bosnia and Herzegovina: **1)** Grude, Krenica Lake, 23. vi 2024, obs., leg. & det. D.Kulijer, 15♂,1♀ (1♂ coll. NMBiH); 7. vii 2024, obs., leg. & det. D.Kulijer, 20♂ (1♂ coll. NMBiH); **2)** Vrutak Lake (artificial reservoir), 28. vi 2024, obs. & det. D.Kulijer, 1♂; 21. ix 2024, obs. & det. D.Kulijer, 25♂,1♀ (1♂ coll. NMBiH); **3)** Ljubuški, Kravice waterfall, 19. vii 2024, obs. & leg. P.Kogovšek, N.Tivadar, det. D.Vinko, 2♂; 10. viii 2024, obs. Alexandre Fonseca, 1♂; **4)** Grude, Kostimančica pond, 7. vii 2024, obs., leg. & det. D.Kulijer, 3♂; **5)** Svitava village, Svitava Lake, 21. ix 2024, obs. & det. D.Kulijer, 5♂,1♀; **6)** Škrka Lake, 21. ix 2024, obs. & det. D.Kulijer, 6♂,2♀; **7)** Glibuša, Gabela polje, 23. ix 2024, obs. & det. D.Kulijer, 2♂;

Croatia: **8)** Glibuša canal 1, Metković, 23. ix 2024, obs. & det. D.Kulijer, 6♂,1♀; **9)** Glibuša canal 2, Metković, 23. ix 2024, obs. & det. D.Kulijer, 3♂; **10)** Nokat, oxbow, Metković, 23. ix 2024, obs. & det. D.Kulijer, 4♂; **11)** Neretva River, Kula Norinska, 23. ix 2024, obs. & det. D.Kulijer, 30♂ (app. 1♂ per 2m of of the bank); **12)** Mala Neretva River, Novo naselje, Opuzen, 23. ix 2024, obs. & det. D.Kulijer, 20♂ (app. 1♂ per 2m of of the bank); **13)** Mala Neretva River, Vlaka, Opuzen, 23. ix 2024, obs. & det. D.Kulijer, 10♂ (app. 1♂ per 2m of of the bank); **14)** Pižnovac, Opuzen, 23. ix 2024, obs. & det. D.Kulijer, 5♂,1♀.

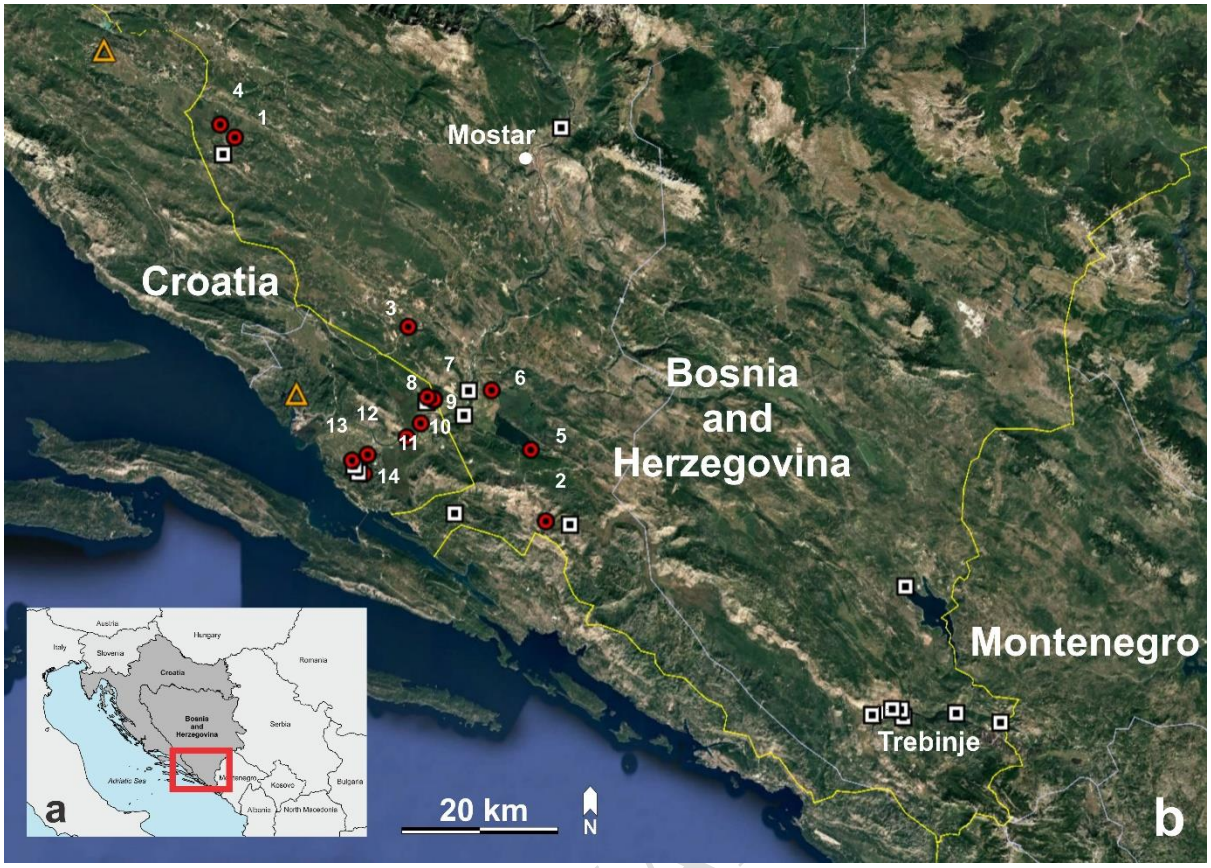

Fig. 2. a) The location of the study area within the western Balkan region, and **b)** The distribution of *Trithemis annulata* (Palisot de Beauvois, 1807) in southwestern part of Bosnia and Herzegovina, and Croatia with the locations visited in 2024 and the previously published data (red numbered dots – locations with *T. annulata* records, white squares – surveyed locations with no records, orange triangles – published records (KOREN *et al.* 2022)).

On 23rd June 2024 *T. annulata* was observed at Krenica Lake near Drinovci (Loc. 1, Fig. 2 & 3) in the west Herzegovina region of Bosnia and Herzegovina. A total of 15 males and one female were observed in mid-day, during the warm and sunny weather with slight breeze. Krenica is a shallow lake, app. 300 m in diameter, with dense reed bordering the water surface. Other vegetation is sparse and mostly developed only at the places where the reed was cleared by the fisherman. Males were observed perching on rocks in water or on short streaks of old reed close to the water surface or on tall reed steams at the inner side of dense read beads along the water margin, making a short flight from their perching positions or patrolling low above the water surface along the water edge. They were occasionally interacting with other species that were patrolling at the same locations, mainly *Orthetrum cancellatum* (Linnaeus, 1758) that was the most numerous species at this location, but also with *Orthetrum albistylum* (Selys, 1848), *Crocothemis erythraea* (Brullé, 1832) and *Anax Imperator* Leach, 1815. The only

female that was observed made several circles above the reeds and nearby vegetation on the lake shore at the northern part of the lake, before flying away. All observed individuals were adults, no teneral or juvenile specimens were observed, while nymphs and exuviae were not investigated at this time. At other two nearby locations that were investigated during this survey, Kostimančinca Pond and Nuga Lake, the species was not observed.

Fig. 3. *Trithemis annulata* (Palisot de Beauvois, 1807) male from Krenica Lake (23. vi 2024) (photo: D. Kulijer).

On 7th July 2024 these locations were visited again, and the species presence was confirmed for Krenica Lake in similar numbers. The exuviae were searched for without success, but the water level at the lake was substantially higher than during the previous visit. At this time three males were also observed at the Kostimačica Pond, located app. 2.4 km northwest from the Krenica Lake. The Kostimančinca Pond is app. 100 m long pond with dense bushes and trees overgrowing large part of the pond margin. As it is used for irrigation of nearby agricultural surfaces and its water level varies greatly, the marshland vegetation at the margins is only partially developed.

Vrutak Lake (Loc. 2) is an artificial water reservoir (Fig. 1b) on Trebišnjica River above the Hutovo Blato Wetland. It is a concrete pool with fluctuating water level without any vegetation along the banks apart from few small shrubs. During the first visit of this location on 28th June,

a single male *T. annulata* was observed flying over the lake from Popovo polje. Several kilometres of canalized Trebišnjica River upstream from the lake was also inspected at this time, but the species was not observed, while *O. cancellatum*, *Orthetrum brunneum* (Fonscolombe, 1837), *C. erythraea* and *Sympetrum sanguineum* (Müller, 1764) were abundant. Three months later, on 21st September 25 males and one female were recorded at western side of the lake. Adult males were present all along the inspected stretch of the lake margin, patrolling low above the water and perching on scarce vegetation, or on bare concrete banks when vegetation was not present. During patrols they interacted with other males, while interactions with other dragonflies that were present, *Anax* spp. and ovipositing *Sympetrum striolatum* (Charpentier, 1840), were rare. A single female was observed briefly hovering a few meters above the water margin and leaving the location.

On 19th July and 10th August additional two observations of total of three males were made on Trebižat River below the Kravice Waterfall (Loc. 3).

Hutovo Blato Wetland is a large and diverse Mediterranean wetland located at the northern edge of the Neretva River delta representing one of the most valuable wetlands in Bosnia and Herzegovina. The dragonfly fauna of Hutovo Blato is one of the best-known in the country with 43 registered species until now (BUKVIĆ & KULIJER, 2021). Although regularly visited by the first author in the last 15 years, due to its large size and vast reedbeds with many canals and small lakes, the wetland is still underexplored. In 2024, this area was visited on several occasions, but *T. annulata* was observed only during the last visit on 21st September when the species was observed at both visited locations situated at the opposite sides of the wetland, including several females, individuals in copulation and oviposition. At both locations only a small part of the shore was accessible due to dense reedbed, but the species was observed instantly and was the most numerous one. The oviposition was observed at the southeastern corner of the Svitava Lake near the water inflow from hydro powerplant (Loc. 5). The male and female briefly copulated in flight over the water near coastal vegetation, and after separating from the male, she circled above the water surface closely followed by the male, lightly touching the water surface with the tip of her abdomen at intervals of 1-2 seconds. The male seemed to be trying to catch her again, and after he did, they quickly flew away. This behaviour is similar as the oviposition of this species described by BOUDOT *et al.* (2017).

On 23rd September 2024, survey was also conducted in the Neretva River delta in Bosnia and Herzegovina and Croatia, resulting in many new records of *T. annulata*, which was the most observed dragonfly species at most of the locations in both countries. At all three locations

at the Neretva and Mala Neretva rivers (Loc. 11-13) *T. annulata* was an abundant species with the frequency of one male per app. two meters of the riverbank. The only other species recorded at these locations was *I. elegans*. After short patrols and occasional interactions with other males, *T. annulata* rested on stone and concrete riverbanks near water. Other inspected locations included oxbows and canals, at most of which the species was also frequent, being absent only at some smaller ones.

Additionally, two observations of *T. annulata* from North Macedonia were found in the online databases Observation and iNaturalist: Ohrid Lake, Ohrid, 41.1067°, 20.8072°, 21.ix.2023, Erika Seidel, id: 288631189 (OBSERVATION, 2025), Smilkovci Lake, 42.03115°, 21.48500°, 24.v.2024, Vivien Ordanoska, id: 217971692 (iNATURALIST, 2025). As we could not find any report of the species presence in North Macedonia, these are most likely the first documented records for North Macedonia.

DISCUSSION

In the late 20th century, *T. annulata* considerably spread its range in the Mediterranean Europe, however, the situation between the western and eastern parts is significantly different (BOUDOT *et al.,* 2009; LOPAU, 2010; BOUDOT & KALKMAN, 2015). In the western Mediterranean, *T. annulata* spread much faster. After the first discovery of the species presence on Iberian Peninsula in 1978, it took only 16 years for it to spread across the whole Peninsula in areas with suitable climate, reaching the southwest France in 1994. In Italy, the species areal expansion was slower than in Iberian Peninsula. It gradually increased its range in the southern and central regions and dispersed slowly to the north and east until it reached Po Valley in 2016, when its expansion accelerated (LA PORTA & HARDERSEN, 2024). The species is now widespread in the Po Valley inhabiting even some alpine valleys and northernmost Italian regions (PUFF *et al.,* 2023; LA PORTA & HARDERSEN, 2024). Most probably it spread from Italy to Slovenia in 2021 (VINKO & ŠALAMUN, 2021). The data from Italy collected over last 43 years suggest that the species extended its northern range margin at an average rate of approximately 12 km per year, mainly along the Tyrrhenian and Adriatic coast, and 34 km/year after the species had reached the Po Plain when the expansion did no longer follow the coastline (LA PORTA & HARDERSEN, 2024). The observations in the Neretva River delta 14 years after species discovery at Skadar Lake were (GLIGOROVIĆ *et al.,* 2010) located app. 150 km to the northwest practically confirms the rate of spread of the species of 12 km per year reported from Italy (LA PORTA & HARDERSEN, 2024).

During the same period, the species spread much more slowly and remained scarce for a long time in the Balkan Peninsula (BOUDOT *et al.,* 2009; LOPAU, 2010; BOUDOT & KALKMAN, 2015) (Fig. 4). Although observations from two Greek islands date back to the first half of 19th century, and the species reached mainland (Peloponnese) in 1977 (the same time it was observed in Spain) it remained scarce until 1990s (BOUDOT & KALKMAN, 2015). Before 2008, when it was recorded in Montenegro, it was known only from some islands and coastal part of Greece to the Albanian border (BOUDOT *et al.,* 2009; LOPAU, 2010).

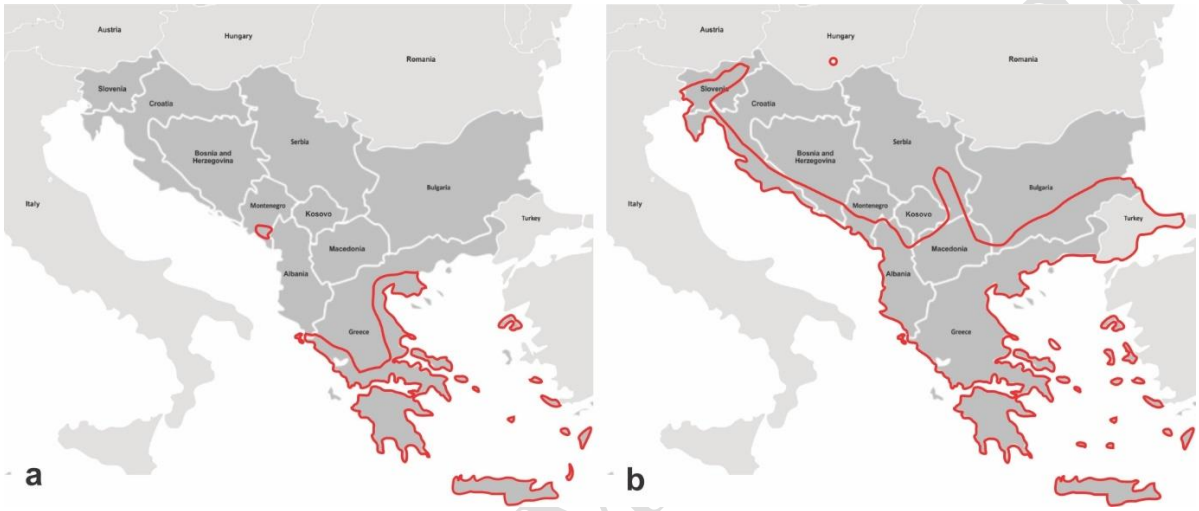

Fig. 4. The range of *Trithemis annulata* (Palisot de Beauvois, 1807) in the Balkan Peninsula countries: **a)** until 2015, and **b)** 2016 - 2024. The record from is Hungary also marked on the map. The countries of the Balkan Peninsula are shown in dark grey color.

After the first record of the species occurrence in the Western Balkans, at the Skadar Lake in Montenegro in 2008, it was expected that the species will spread soon to other (neighbouring) countries, particularly Croatia and Bosnia and Herzegovina (KALKMAN *et al.,* 2015). However, it took 14 years for the species to be observed in Croatia (KOREN *et al.,* 2022) and 16 for Bosnia and Herzegovina, although available habitats were present and the climate was suitable, particularly along the east Adriatic coast. The lack of any observations prior to 2020s in the west Balkan region, followed by numerous observations in a short period of time afterwards (KOREN *et al.,* 2022; DOBOVIŠEK *et al*., 2023; ĐURĐEVIĆ *et al*., 2024; iNATURALIST, 2025; OBSERVATION, 2025; current results), suggests rapid growth and spread of the species populations in this region in recent years.

Trithemis annulata is not a typical migrant, but rather nomadic and vagrant species and a good flyer that can cover large distances (GHEZA *et al.,* 2019; WILDERMUTH & MARTENS, 2019). The closest populations to locations in Croatia (see also KOREN *et al*., 2022) and Bosnia

and Herzegovina are in Montenegro (even though the vagrants from Italy flying over the Adriatic Sea cannot be excluded). Individuals observed in Slovenia in 2021 (VINKO & ŠALAMUN, 2021), most likely originate from nearby populations in Italy. Individuals observed in Serbia (ĐURĐEVIĆ *et al*., 2024) and North Macedonian (iNATURALIST, 2025; OBSERVATION, 2025) probably originate from closest populations in Albania, Greece, and/or Montenegro (LOPAU, 2010; DE KNIJF *et al.,* 2013; BOUDOT & KALKMAN, 2015; SHKËMBI, 2019; iNATURALIST, 2025; OBSERVATION, 2025).

The single record from Hungary in 2016 (FARKAS, 2017) situated north of Balkan Peninsula is interesting as it is far from the Mediterranean (the nearest populations at that time were in Italy app. 560 km to the west (LA PORTA & HARDERSEN, 2024) and Montenegro app. 450 km to the south (DE KNIJF *et al.,* 2013), as the crow flies). To our knowledge, a local population was not confirmed afterwards, and in 2024, eight years after this observation, the closest known location is in Slovenia, app. 290 km to the west from this area, as the crow flies. It is possible that this was a vagrant individual or a result of an accidental introduction, i.e. transfer of eggs or nymphs with vegetation from the Mediterranean, similar to the single record of *Trithemis arteriosa* (Burmeister, 1839) in Hungary (MÓRA & SEBTEOUI, 2020).

Following the reports on the discovery of *T. annulata* in Croatia in 2022 in the bordering regions with Bosnia and Herzegovina (KOREN *et al.,* 2022), several field studies were conducted in southern and southwestern part of the Herzegovina region from 2022 to 2024 to investigate the species presence in Bosnia and Herzegovina. The lack of observations of this species before summer/autumn 2024 suggests its recent areal spread to Bosnia and Herzegovina, probably from nearby locations (< 20 km distance) in Croatia (KOREN *et al.,* 2022). Our results confirm much wider presence of the species in a range of different habitats in the Neretva River delta in Croatia; so far it was only known from the Bačinska Lakes (KOREN *et al.,* 2022; iNATURALIST, 2025; OBSERVATION, 2025).

There is no direct proof of the species successful reproduction / life cycle completion in Bosnia and Herzegovina and Croatia. However, a large number of adult males displaying territorial behaviour at several investigated locations, and ovipositing females recorded in Hutovo Blato indicate the presence of a local population.

All the locations surveyed are situated in the Mediterranean region of both countries, including several lakes and reservoirs (Loc. 1-2,5-6) the habitats preferred by the species (BROCHARD & VAN DER PLOEG, 2013; GHEZA *et al*., 2019), and reported from the region

(VINKO & ŠALAMUN, 2021; KOREN *et al.,* 2022). It was also recorded at Neretva and Mala Neretva rivers in Croatia (Loc. 11-13, Fig. 1d) and Trebižat River in Bosnia and Herzegovina (Loc. 3), at sluggish and deep stretches of these rivers that provide suitable habitat (KALKMAN *et al.*, 2015). Additionally, it was observed at oxbows (Loc. 10), canals with slow flowing water (Loc. 8-9) and ponds (Loc. 4, 14). All these habitats are open and sunny which is in agreement with the preferences of the species that favours warm conditions, particularly at the border of it range (KALKMAN *et al.*, 2015; DIJKSTRA *et al.*, 2020). In addition to the locations with sparse vegetation (Fig. 1 b,d), the species was most often recorded at the locations with scarce or well-developed reed beds along the banks (Fig. 1a), similar as it was observed in Croatia in 2022 (KOREN *et al.,* 2022). *Trithemis annulata* is a ubiquitous species (KALKMAN *et al.*, 2015), and given this, its occurrence in various habitat types is not surprising. However, the presence in a wide range of habitats does suggests significant abundance of the species in the study area.

At several locations the number of individuals was certainly much higher than recorded, e.g. at Krenica Lake (Loc. 1) a large part of the lake shore was inaccessible due to the dense reed beds, while patrolling and perching males were observed at all locations where it was possible to access the water margin. At Vrutak Lake (Loc. 2) only part of the shore was inspected, and considering the lake size there were probably over a hundred males present. This especially applies to the delta of the Neretva River, where *T. annulata* was registered at almost all locations visited, regardless of the type of habitat.

In addition to the locations where the species was recorded, several other suitable habitats were also inspected, particularly artificial lakes north of Trebinje near the Montenegrin border and Mostarsko Lake north of Mostar (Fig. 2). However, despite targeted surveys, the species was not detected at these locations. It is interesting that the species was not observed at the accumulations near Trebinje that are located between the Neretva River delta and Skadar Lake representing large artificial waterbodies, habitats preferred by the species (BROCHARD & VAN DER PLOEG, 2013; GHEZA *et al.,* 2019). One of the reasons could be the fact that these locations were not visited in September when the species was recorded in abundance in the Neretva River delta, suggesting the possibility that autumn migration could be a reason for our numerous species observations in that period.

The total number of 31 other species of dragonflies recorded with *T. annulata* is comparatively low considering the habitats richness at investigated locations, particularly in the Neretva River delta (BUKVIĆ & KULIJER, 2021). The only species present at all *T. annulata* habitats in our study was *I. elegans*. This is not surprising as it is a common and widespread

species in Bosnia and Herzegovina and Croatia and habitat generalists present in wide range of stagnant and slow flowing water habitats (BOUDOT & KALKMAN, 2015). The reasons for the small number of species are time restrictions of the survey at some locations and the late season of the survey (10 of 14 locations were visited in late September). This resulted in the dominance of late summer and autumn species, like *A. parthenope* and *A. mixta* that prefer larger open stagnant or slow flowing waters, with reedbeds and are abundant in the Mediterranean in autumn months (BOUDOT & KALKMAN, 2015).

Our observations of the species flight season from late June to late September are in accordance with the available data from other sources for the Balkan and Europe. According to KALKMAN *et al.* (2015) the flight season of *T. annulata* in Europe is from late April to the end of October, while WILDERMUTH & MARTENS (2014) reported the range from March to October for the same area. GAUCI (2018) reported the range from mid-April to late December in Malta, BOUDOT *et al.* (2017) from May to October for southern France, and LOPAU (2010) from mid-April to mid-November in Greece. In the Western Balkans, the species was observed from May (North Macedonia) to November (Albania), with most records from July to September (VINKO & ŠALAMUN, 2021; KOREN *et al.,* 2022; DOBOVIŠEK *et al.,* 2023; ĐURĐEVIĆ *et al.,* 2024; iNATURALIST, 2025; OBSERVATION, 2025).

This sudden appearance and dominance in numbers at most of surveyed locations in September could mean a large influx of vagrants in late summer and autumn or a huge increase in the size of a recently established small local population. As several of the locations where the species was recorded in 2024, were inspected earlier the same year as well as in recent years, it is almost impossible that any substantial population could be overlooked at these locations. But, a local outbreak of a small, recently established population cannot be excluded, as exuviae were searched for at only one location. In addition, mild winters in recent years could be favourable for the establishment of local population in the area. Further research, particularly in early summer 2025 focusing on exuviae, should be conducted to confirm this.

Considering the species expansion in Europe, particularly the most recent new data in the region, the species discovery in Bosnia and Herzegovina was only a matter of time. Nevertheless, this finding is interesting to track the recent fast spread of this species in the Balkans. Further studies should focus on species reproduction in the region and potential impact on local fauna.

ACKNOWLEDGEMENTS

We are grateful to Alexandre Fonseca, Filipe J. Ribeiro, Galin Ivanov, Vivien Ordanoska and Observation.org for allowing the use of their records.

Received February 15, 2025

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