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Trithemis annulata (Insecta, Libellulidae) reaches the northernmost Italian region Trentino-Alto Adige/Südtirol

Abstract

Trithemis annulata (Palisot de Beauvois, 1807) is first reported for the Region of Trentino-Alto Adige/Südtirol in the southern Alps. A large breeding population was observed at Lake Caldaro from August to October 2023, along with two solitary males at other lakes. No other records of *T. annulata* were made at 16 other locations within the region. This represents the first record of this species within the Alps and thus exemplifies the rapid range expansion this species has undertaken across Europe during recent years.

Keywords: Dragonflies, range expansion, distribution, climate warming, biodiversity monitoring

Introduction

Trithemis annulata (Palisot de Beauvois, 1807), a dragonfly of the family Libelluidae, showed an impressive range expansion during the past decades (Deliry 2009; Gheza et al. 2019). As with many other species of Odonata, climate warming is the most likely driver of this expansion (Ott 2010; Termaat et al. 2019). Until the second half of the 20th century, *T. annulata* was only known from Africa, Sicily, Sardinia and parts of southern Italy (Morton 1924; Conci & Nielsen 1956). It was first recorded for the Iberian Peninsula in the 1970s (Ferreras Romero 1980) and from there expanded into northern Spain (Asensio-González 2018) and southern France in the 1990s (Deliry 2009). A similar northward expansion took place in Italy where *T. annulata* was restricted to the central and southern regions until the 1980s (Carchini et al. 1985) but expanded northward into Liguria (Ottonello & Fabrizio 2013) and the Po plain of Northern Italy (Fabbri 2011) during the 2000s. In 2018, multiple larger populations, exuviae and freshly emerged adults were reported from Lombardy (Gheza et al. 2019) and Veneto (Chiari et al. 2020) making a year-round presence in the Po plain evident (Ornitho.it 2023).
Generally, *Trithemis annulata* prefers large warm water bodies, like man-made reservoirs, open lakes and even lowland rivers, but seems to avoid smaller water bodies (Brochard & Chelmick 2013). Quarry lakes especially have been colonized frequently by the species in Northern Italy (Gheza et al. 2019). In the Mediterranean the species is bivoltine, which enables it to colonize temporary water bodies (Wildermuth & Martens 2018) or to establish large populations at one site in the course of a single summer (Gheza et al. 2019).
Here we report the observation of a newly discovered, large population of *Trithemis annulata* as the first population within the Alps and the northernmost occurrence in Italy.

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Material and Methods

In 2023 the Biodiversity Monitoring South Tyrol (Hilpold et al. 2023) was extended by an odonate monitoring scheme. This scheme included eight sites in the Adige/Etsch valley between Meran/Merano and Salurn/Salorno (Table S2), which were surveyed five times between May and September 2023. During each survey odonate species were identified and their abundances were estimated along 100 m of shoreline over the course of one hour.
After *Trithemis annulata* was first spotted at a monitoring site at Lake Caldaro, target searches were conducted along the western, northern and eastern shore of the lake on 9th September. On ten other suitable sites in the Adige/Etsch valley target searches for the species were carried out between 1st and 20th September 2023 (Table S2). Finally, three online databases reporting species observations, GBIF (GBIF.org 2023), iNaturalist (iNaturalsit.org 2023) and Ornitho.it (Ornitho.it 2023), were screened for further records of *T. annulata* within the entire region of Trentino/South Tyrol.

Results

The first two observations of *Trithemis annulata* were made during surveys at the monitoring site on the northern shore of Lake Caldaro (Fig. 1, Table 1). At this site three males were first counted on 18th July and two further males on 31st August 2023. The species was not recorded during two prior surveys at this site on 18th May and 16th June.

During the first target search on Lake Caldaro, on 9th September 2023, more than 50 males and three females were counted (Fig. 2, Table 1). Additionally, mating and subsequent guarded oviposition were observed (Fig. 3). During this search, *Trithemis annulata* was found to be by far the most abundant dragonfly on the lake (Table S1). On 11th October, the species was still observed in high abundances on the northern shore of the lake.

Fig. 1: The northern shore of Lake Caldaro is so far the only known location within the Alps with a larger population of *Trithemis annulata*. On 9th September 2023 dozens of males and three ovipositing females, along with mating behavior, were observed here.

One solitary male was found during a target search at a different lake, the 'Franck Lack', on 15th September 2023. Finally, an observation of one male from Lake Caldonazzo in Trentino was discovered on iNaturalist (Valcanover 2023) making it the first record for this province (Table 1). The species was not recorded during all other surveys and target searches in the Adige/Etsch valley in South Tyrol (Table S2).

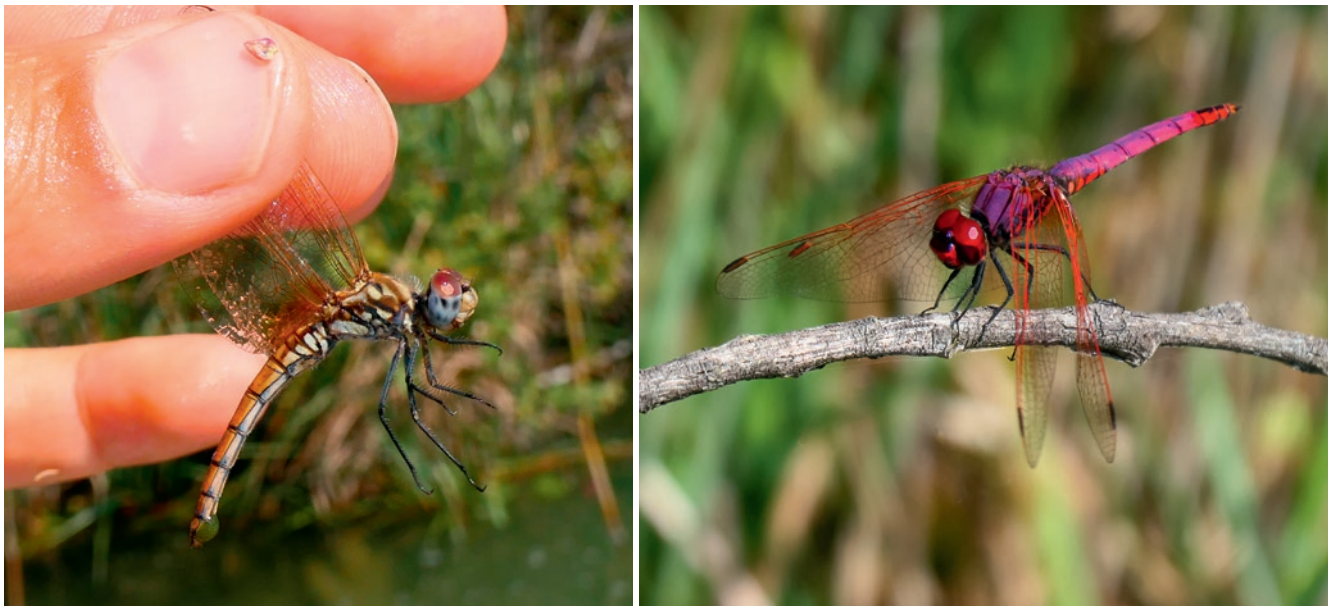

Fig. 2: Right: male *Trithemis annulata*. Left: female *T. annulata*, caught on the northern shore of Lake Caldaro. Note the mass of green eggs on the ovipositor at the back of the abdomen (9th September 2023, Felix Puff).

Fig. 3: Guarded ovipositing of *Trithemis annulata* observed on 9th September 2023 on the northern shore of Lake Caldaro. Ovipositing female at the bottom left and guarding male on the top right.

Table 1: Observations of *Trithemis annulata* in the region of Trentino/South Tyrol during the summer of 2023.

Locality	Coordinates (EPSG 3857)	Date	Source	Abundance
Lake Caldaro (BZ)	N 46.3862, E 11.2660	18th July 2023 31st August 2023 9th September 2023 11th October 2023	5 monitoring surveys & 2 target searches	> 50 individuals mating & oviposition
Franck Lack, Siebeneich (BZ)	N 46.5096, E 11.2701	15th September 2023	1 target search	1 male
Lake Caldonazzo (TN)	N 46.0378, E 11.2397	2nd October 2023	Citizen Science observation (Valcanover 2023)	1 male

Discussion

The presence of *Trithemis annulata* in South Tyrol represents a significant northward range expansion (> 80 km from occurrences near Bassano del Grappa) for this species and the first record of a larger population within the Alps. The first records of *T. annulata* from the Po plain, from which this population most likely originates, are from 2007 (Fabbri 2011) and larger breeding populations were reported from Lombardy only by the late Summer 2018 (Gheza et al. 2019). Similar to the latter, we observed the first individuals of *T. annulata* in July, with no earlier observations in the region. Therefore, a similar scenario as hypothesized by Gheza et al. (2019), that *T. annulata* may not be able to overwinter and the observed individuals are the summer offspring from individuals flying in from the south in spring, could be expected for Lake Caldaro as well. Although we observed many individuals, as well as mating and oviposition at Lake Caldaro, no exuviae or fresh individuals were found. Thus, although there is no direct evidence of reproduction, the fact that we observed over 50 individuals leads us to infer that *T. annulata* is reproducing at Lake Caldaro.

Lake Caldaro is a large but relatively shallow lake and therefore reaches mean water temperatures of around 25 °C in Summer (data from water temperature measured 4 times between June and August at 5 cm depth during monitoring surveys). This fits well with the habitat preferences of *Trithemis annulata* as described by Brochard & Chelmick (2013). Out of 16 other locations visited, we only observed one solitary male at a smaller pond, 'Frank Lack' near Settequerce/Siebeneich and from Trentino only one casual observation of a single male at Lake Caldonazzo is known so far (Valcanover 2023). Most other lakes in the region of Trentino-Alto Adige seem less suitable for larval development of *T. annulata,* because they are either at higher altitudes, deeper or significantly smaller and are therefore less likely to provide the high-water temperatures during summer months favorable for the larvae. Therefore, it is possible that, for the time being, larger populations of *T. annulata* within the region will be restricted to Lake Caldaro. However, additional surveys in the region in the coming years are needed to record the probable further spread of the species. Furthermore, it seems likely that the species has already been present before in Trentino, as the record of a single male at Lake Caldonazzo suggests. Since a year-round permanent occurrence of *T. annulata* in the region cannot yet be confirmed we propose, according to the criteria of the IUCN Red List (IUCN 2001), to apply the category "Data Deficient" (DD) for the species in the Trentino-Alto Adige/South Tyrol region for the time being.

With this new population in the Southern Alps, the expansion of *Trithemis annulata* has now reached a potential obstacle, the Alps. It is likely that due to climate warming, sooner or later, the species will also establish populations north of the Alps. It is interesting to speculate which colonization route will be taken first: To the west *T. annulata* is slowly gaining ground along the Rhone valley (Deliry 2009), to the east single individuals have been observed as far north as north-eastern Slovenia (Vinko et al. 2022) and Hungary (Farkas 2017). However, an alpine crossing, alleviated by Föhn winds, as has been speculated for *Orthetrum albystilum* (Weihrauch et al. 2003), and further colonization of suitable habitats in the northern alpine foreland could also be a possibility.

The impressive range expansion of *Trithemis annulata* into Europe is by far not the only case of a southern odonate species expanding its range northward. *Brachythemis impartita*, *Crocothemis erythraea* and *Erythromma viridulum* also exhibited and continue to exhibit the same pattern of range expansion (Ott 2010, Condello et al. 2017). Also, *T. annulata* most likely will not be the last odonate species expanding its range in Europe. In recent years, *Slesiothemis nigra* has colonized the Po plain (Uboni et al. 2015) and, very reminiscent of the initial spread of *T. annulata* in Europe, *Trithemis kirby* has expanded its original distribution in Afrika to Spain, France and Italy (Holuša 2008, Polette et al. 2017, Asensio 2019, Janni et al. 2020). We are witnessing a major shift in the dragonfly community on a continental scale, and this is not only true for odonates (e.g., Gottfried et al. 2012, Vitasse et al. 2021). Where this change will lead is still uncertain, but in the future colorful examples like *Trithemis annulata* will be a lasting reminder of this change.

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Riassunto

Trithemis annulata (Palisot de Beauvois, 1807), anche chiamata Obelisco violetto, è stata segnalata per la prima volta nella regione del Trentino-Alto Adige. Una grande popolazione riproduttiva è stata osservata al Lago di Caldaro da agosto ad ottobre 2023, insieme a due maschi solitari rilevati su altri laghi. La specie non è stata osservata in altre 16 località della regione. Questa popolazione è la prima segnalazione di questa specie nelle Alpi e rappresenta l'ampia espansione di areale che questa specie sta compiendo recentemente in Europa.

Zusammenfassung

Trithemis annulata (Palisot de Beauvois, 1807), auch Violetter Sonnenzeiger genannt, wird erstmals für die Region Trentino-Südtirol in den Südalpen gemeldet. Eine größere Population wurde von August bis Oktober 2023 am Kalterer See beobachtet, zusammen mit zwei einzelnen Männchen an zwei weitere Seen. An 16 weiteren Standorten in der Region konnten keine zusätzlichen Nachweise erbracht werden. Dies stellt den ersten Nachweis dieser Art in den Alpen dar und zeigt die rasche und rezente Ausbreitung des Areals dieser Art in ganz Europa.

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Appendix

Table S1: All cooccurring odonate species recorded during the target searches and monitoring on Lake Caldaro in 2023. Abundance classes show the maximum number of individuals recorded per species (modified after Chovanec et al. 2015).

Species	Abundance class
Aeshna isoceles	rare
Aeshna mixta	frequent
Anax imperator	rare
Anax parthenope	rare
Chalcolestes viridis	frequent
Crocotheis erythraea	abundant
Erythromma lindenii	rare
Ischnura elegans	abundant
Libellua fulva	rare
Orthetrum cancellatum	abundant
Orthetrum coerulescens	abundant
Platycnemis pennipes	abundant
Sympetrum sanguineum	rare
Sympetrum striolatum	frequent
Trithemis annulata	abundant

Table S2: Sites of monitoring and target searches for *Trithemis annulate* visited for this study. Sitenames highlighted in bold indicate that *T. annulata* was observed at the location.

Site	Coordinates	Date(s)	Method
Lake Caldaro, north shore	N 46.3862 E 11.2660	18th May, 16th June, 18th July, 7th August, 31st August, 9th September, 11th October	Monitoring & target search
Lake Caldaro, reed on southern shore	N 46.3737 E 11.2680	18th May, 3rd June, 22nd June, 13th July, 6th August, 30th August	Monitoring
Lake Montiggl	N 46.4202 E 11.2879	18th May, 16th June, 8th July, 1st August, 31st August	Monitoring
Rennermoos	N 46.4478 E 11.3435	8th July, 25th July, 26th July, 12th August, 30th August	Monitoring
Kagollbach	N 46.4468 E 11.3271	25th May, 17th June, 12th July, 4th August, 9th August, 30th August	Monitoring
Courtyard of Eurac research	N 46.4940 E 11.3467	1st June, 19th June, 11th July, 2nd August, 6th September and many casual visits	Monitoring
Falschauer Au	N 46.6270 E 11.1755	26th May, 17th June, 19th July, 7th August, 31st August	Monitoring
Schloss Englar	N 46.4515 E 11.2499	10th June, 30th June, 19th July, 7th August, 31st August	Monitoring

Site	Coordinates	Date(s)	Method
Schlafender Riese	N 46.3212 E 11.2776	5th September, 9th September	Target search
Großer Kalterer Graben	N 46.3630 E 11.2575	5th September, 9th September	Target search
Ades vècio	N 46.2876 E 11.2336	9th September	Target search
Klösterleau	N 46.2914 E 11.2441	9th September	Target search
Großes Loch	N 46.2987 E 11.2505	9th September	Target search
Frank Lack	N 46.5096 E 11.2701	15th September	Target search
Biotopo Rio Piave	N 46.4339 E 11.3463	16th September	Target search
Auffangbecken Höllentalbach	N 46.3440 E 11.2543	1st September	Target search
Biotop Krebsbach	N 46.5855 E 11.1705	17th September	Target search
Bachau	N 46.5537 E 11.2235	20th September	Target search