20. Dezember 2015

Status and distribution of *Sympetrum sanguineum* in Sardinia (Odonata: Libellulidae)

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Abstract

Sympetrum sanguineum was recorded in Sardinia in 1990, 2011, and 2013 at 13 locations between 15 and 1,005 m a.s.l. Exuviae or larvae were found at ten locations. Some of these are among the highest reproduction sites for this species in Europe. With records from six of eight provinces, *S. sanguineum* is a native member of the Sardinian dragonfly fauna.

Riassunto

Stato e distribuzione di *Sympetrum sanguineum* in Sardegna (Odonata: Libellulidae) – Il *S. sanguineum* è stato segnalato in Sardegna nel 1990, 2011 e 2013 in 13 località ad una altitudine compresa fra 15 e 1005 mslm. Esuvie o larve sono state trovate in 10 località ed alcune di queste sono i siti di riproduzione a quota più alta per questa specie in Europa. Con citazioni per sei su otto province, *S. sanguineum* è una specie nativa della fauna sarda.

Zusammenfassung

Status und Verbreitung von *Sympetrum sanguineum* in Sardinien (Odonata: Libellulidae) – In den Jahren 1990, 2011 und 2013 wurde *S. sanguineum* in Sardinien an insgesamt 13 Lokalitäten zwischen 15 und 1.005 m ü. NHN nachgewiesen. An zehn Örtlichkeiten konnten Exuvien oder Larven gefunden werden. Einige dieser Lokalitäten zählen zu den höchstgelegenen mit Bodenständigkeitsnachweisen der Art in Europa. Mit Vorkommen in sechs von acht Provinzen ist *S. sanguineum* ein festes Mitglied der Libellenfauna Sardiniens.

Introduction

The history of whether or not *Sympetrum sanguineum* occurs on Sardinia reads like a mystery story, and is a tale over more than a century of 'yes', 'no', question

marks, or contradictions even within the same publication. There might be no other odonate species in Europe which has created as much controversy over its occurrence as *S. sanguineum* for Sardinia.

The first original data comes from Pirotta (1878: 349) who gave under the distribution of »9. *D.*[*iplax*] *sanguinea* (Müll.).« as the last of many Italian locations: »Sardegna (Mus. Torino).« The next record without any detailed information is mentioned by Bentivoglio (1908: 25) as listing »Sardegna« as last entry in a long list of Italian places where the species does occur. But Bentivoglio (1908: 45) contradicts his assertion in a table at the end of the paper, where the presence in the column »Sardegna« is not marked for *S. sanguineum*.

In 1941 the first paper which focused on the Odonata of Sardinia appeared (Nielsen 1941), which exclusively cites Pirotta (1878) and Bentivoglio (1908) for *S. sanguineum*. The first comprehensive publication on Italian Odonata, Conci & Nielsen (1956: 186), does not mention *S. sanguineum* for Sardinia: »Abbastanza comune nell'Italia continentale. Da accertare per le isole«. This is confirmed in Table 1 on page 38, as the columns for Sardinia, Sicily, and Corsica are not checked for *S. sanguineum*. 42 years later, the best understanding of odonatological data from Sardinia up to then appeared (Bucciarelli et al. 1983). Once again, the occurrence of *S. sanguineum* in Sardinia is questioned, because »non è possibile confermare la presenza della specie sulla base di reperti citati anche se non è improbabile che vi estata« (Bucciarelli et al. 1983: 526).

As one of the first field guides of Odonata covering Europe and North Africa, d'Aguilar et al. (1986) indicated *S. sanguineum* to be present in Sardinia (map 111, p. 330). However, no new occurrence data were provided, and the maps in general were often criticized for their inaccuracy. Askew (1988) questioned Sardinia again for the presence of *S. sanguineum*. Just a year later, Burmeister (1989) published the first data of *S. sanguineum* from Sardinia. But maybe because Burmeister claimed (erroneously) to have observed *Ischnura elegans* and *I. graellsi* in Sardinia, his paper was disregarded. In the second edition of d'Aguilar & Dommanget (1998) the maps were based on the data handled by J.-P. Boudot, and were much more accurate than in the 1986 edition. Again, *S. sanguineum* was indicated as present in Sardinia. It seems likely that this information was based on Burmeister (1989), because Boudout et al. (2009: 212) reported those two records without however citing the source. Also, the recent 'Atlante delle libellule italiane – preliminare' (Riservato et al. 2014: 191) shows again three question marks for *S. sanguineum* on the island of Sardinia. Wildermuth & Martens (2014) seem to exclude this species from Sardinia as they draw a line of the southernmost distribution of the densely inhabited area between the north of Spain – Corsica – southern Italy – Greece and Turkey, with isolated populations further south. The last publication on the Italian odonate fauna, Galliani et al. (2015), contemplated the current status quo based on hitherto published data: Sardinia is marked for records of the species between 1930 and 1999 on the map on page 182 (referring to Boudot et al. 2009). Thus, currently it is not

clear whether *S. sanguineum* occurs or occurred in Sardinia. The data presented clearly show that *S. sanguineum* is an autochthonous species in Sardinia and that it occurs in six of the eight provinces.

Methods

During field trips in 1990, 2011, and 2013, imagines of *Sympetrum sanguineum* were observed, photographed, and, if considered important, netted and determined, photographed, and released. Larvae were caught with a kitchen sieve and released after determination and documentation. Exuviae were collected and are mostly in the author's collection. Coordinates and elevations were taken with a hand held device "Magellan GPS 315" or determined with Google Maps. Exuviae of *Sympetrum sanguineum* were determined mainly by the length of the lateral spines on S8, using Heidemann & Seidenbusch (1993) and Brochard et al. (2012), and Brochard & van der Ploeg (2014) for the larvae. Within the four species of *Sympetrum* known to occur in Sardinia, *S. sanguineum* adults are the only ones with complete black legs, and the larvae/exuviae, compared to those of *S. striolatum* and *S. meridionale,* are the only ones with very short lateral spines on S8.

Results

Sympetrum sanguineum was observed at fifteen localities in Sardinia (Fig. 1). Thirteen records are hitherto unpublished, and two (14, 15) were taken from Burmeister (1989). My own data of *S. sanguineum* are specified below in chronological order. Only the two southernmost provinces – Cagliari and Carbonia-Iglesias – are without observation. Abbreviations for the provinces are as follows (north to south): OT – Olbia-Tempio; SS – Sassari; NU – Nuoro; OR – Oristano; OG – Ogliastra; MC – Medio-Campidano. Numbers in brackets refer to geo-reference and altitude of the localities.

1) Rio de Liscia
(OT, 41.1362°N, 9.3076°E, 15 m a.s.l.)
Broad, slow flowing section of this medium sized river, 6.8 km before its estuary.
12-vi-1990: 1 ♀

2) Lago del Coghínas
(OT, 40.7553°N, 9.0581°E, 155 m a.s.l.)
Puddle, ca 30 × 60 cm, < 10 cm deep, at the bottom of the Lago del Coghínas, which had nearly dried out. Disappeared after Lago del Coghínas had a normal water level.
12-vi-1990: 1 ♀ (found dead), 7 exuviae

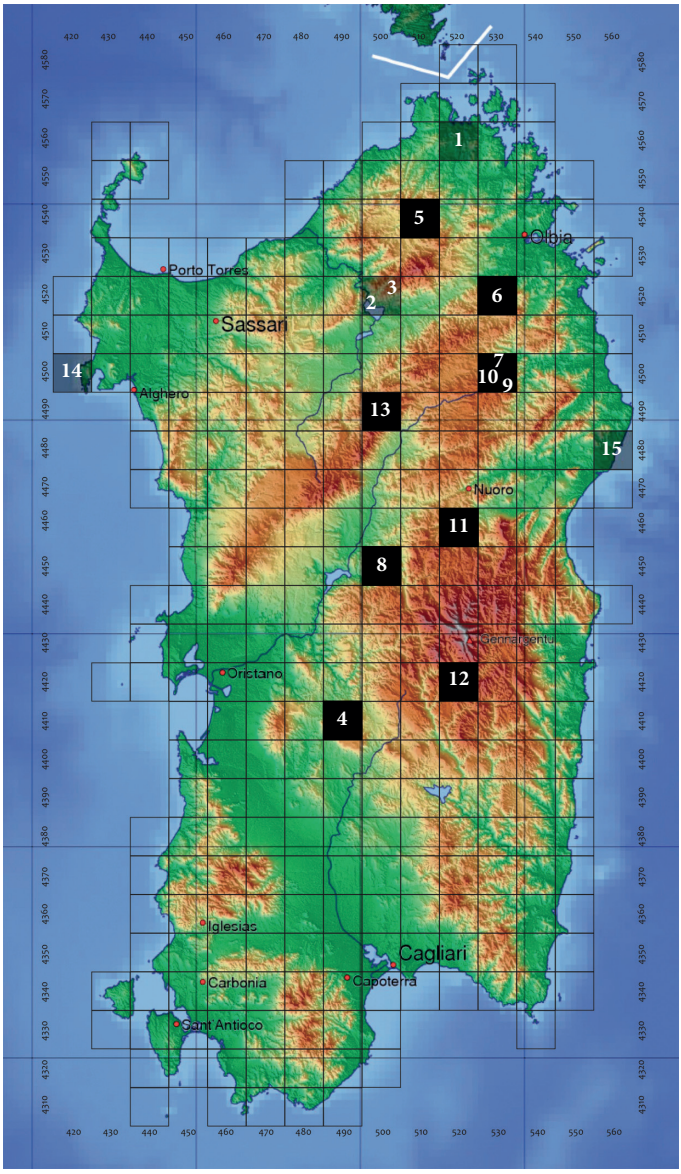

Figure 1. Distribution of *Sympetrum sanguineum* in Sardinia within 10 km UTM squares (WGS84). — Abbildung 1: Verbreitung von *Sympetrum sanguineum* in Sardinien in 10 km UTM Rastern (WGS84). Black squares, schwarze Raster: updated observations 2011 and 2013, aktuelle Beobachtungen 2011 und 2013; grey squares, graue Raster: record prior to 1991, Funde vor 1991. Background map used by courtesy of Zamonin under GNU licence.

3) Rio San Leonardo
(OT, 40.7630°N, 9.0685°E, 175 m a.s.l.)
Small brook with open pools near the shore of Lago del Coghínas.
17-vii-1990: < 5 exuviae

4) Pauli s'Ala di Mangianu, Giarra de Gesturi
(MC, 39.7612°N, 8.9504°E, 565 m a.s.l.)
Temporary shallow swamp, overgrown with *Ranunculus* sp.
8-vi-2011: 1 exuvia (0,1)

5) Rio Murighentis, before entering Rio de Liscia
(OT, 40.9671°N, 9.2068°E, 190 m a.s.l.)
Brook with clear, brown water and lined with alder, very shady, deep pools, containing trout.
10-vi-2011: < 10 larvae (Fig. 2)

Figure 2. Larva of *Sympetrum sanguineum*. Note the short lateral spines on S8, the round abdomen, and the diffuse colour pattern. Rio Tirso Headwaters, 6 km east of Buddosu, Province Olbia-Tempio, Sardinia (11-vi-2011). — Abbildung 2: Larve von *Sympetrum sanguineum*. Beachte die kurzen Lateraldornen an S8, das rundliche Abdomen und die diffuse Färbung. Rio Tirso Quellbereich, 6 km östlich von Buddosu, Provinz Olbia-Tempio, Sardinien (11.06.2011).

6) Small pond along road SS 389, 7 km south of Monti
(OT, 40.7846°N, 9.3613°E, 520 m a.s.l.)
Temporary pond on a pasture, ca 8-12 m in diameter, 1–1.5 m deep, well vegetated with Cattail (*Typha* sp.).
10-vi-2011: 9 exuviae (1,8)

7) Rio Tirso, Headwaters, 6 km east of Buddusò
(OT, 40.5691°N, 9.3341°E, 775 m a.s.l., Fig. 3)
Brook with partly overgrown, partly open sections, pools, swampy shorelines, sandy ground.
11-vi-2011: > 50 emerging individuals, 16 exuviae (2,14), > 100 larvae; 2-viii--2013: > 50 imagines, ovipositing pairs, 4 exuviae (3,1)

8) Small pond south of Diga di Benzone
(NU, 40.1369°N, 9.0408°E, 175 m a.s.l.)
Pond on a pasture, ca 2 × 3 m, sparse vegetation, seems to be temporary
18-vi-2011: 1 exuvia

Figure 3. One of the reproduction habitats of *Sympetrum sanguineum* in Sardinia. Rio Tirso Headwaters, main stream, 775 m a.s.l., ca 6 km east of Buddusò, Province Olbia-Tempio, Sardinia (2-viii-2013). — Abbildung 3: Eines der Reproduktionsgewässer von *Sympetrum sanguineum* in Sardinien. Rio Tirso Quellbereich, Hauptbach auf 775 m ü. NHN, ca. 6 km östlich von Buddusò, Provinz Olbia-Tempio, Sardinien (02.08.2013).

9) Tributary to Rio Tirso Headwaters, 7 km east of Buddusò
(OT, 40.5631°N, 9.3497°E, 790 m a.s.l.)
Temporary brook within thick bushes, some rare open sections, boulders, and swampy areas.
2-viii-2013 (brook completely dry): < 50 imagines, ovipositing pairs, 29 exuviae (17,12); 11-vi-2011: no Odonata (water present)

10) Open forest around Nuraghe Loelle
(OT, 40.5691°N, 9.3341°E, 750 m a.s.l.)
Open forest with mainly oaks (*Quercus suber*, *Q. ilex*), no water close-by.
2-viii-2013: > 5 males perching (Fig. 4a)

11) Small stream south of Nuraghe Sirilo, 4 km south of Orgosolo
(OT, 40.1684°N, 9.3578°E, 1,005 m a.s.l.)
Open brooklet with sandy pools, pebbles, and boulders, sparse vegetation. No larvae and exuviae found.
4-viii-2013: < 10 females perching (Fig. 4b)

12) Seepage along road, ca 800 m east of Nuraghe Ardasai
(OG, 39.8903°N, 9.3523°E, 975 m a.s.l., Fig. 5a)
Seepage ca 20 m^2, moist, trickling surface, permeated by small streams of the main spring, very calcareous, sinter, sparsely vegetated, water flowing together after around 30 m in a ditch beside the road.
5-viii-2013: 8 exuviae (5,3)

13) Riu Paidorzu headwater, 8 km SSW of Pattada
(OT, 40.5103°N, 9.0760°E, 965 m a.s.l., Fig. 5b)
Brook arising from a couple of springs, streaming through open pasture, partly dense vegetation (*Juncus* sp.), partly open, muddy ground with some boulders.
10-viii-2013: 4 exuviae (1,3)

Reproduction of *S. sanguineum* was confirmed for Sardinia by exuviae at nine of the 13 locations in 1990, 2011, and 2013. At one location only larvae were found, and at three locations only adults were observed. Among the latter was the record at the highest altitude for the species at 1,005 m a.s.l. (loc. 11). Oviposition was only observed twice, in August 2013 at locations 7 and 9. It is noteworthy that all early records from the period 1978–1990 are from sites under 200 m a.s.l., whereas in 2011 and 2013 eight out of ten records were made between 520 and 1,005 m a.s.l.

Habitats populated by *S. sanguineum* in Sardinia were mainly rivers, brooks, ditches, and seepages, but also puddles, pools or temporarily flooded fields. Exuviae and larvae were found at four small standing waterbodies and at six (sometimes temporary) lotic habitats.

Figure 4. Fully mature individuals of *Sympetrum sanguineum* in Sardinia. – Abbildung 4: Ausgefärbte Individuen von *Sympetrum sanguineum* in Sardinien. a) male, Nuraghe Loelle, ca 4 km east of Buddusò, Province Olbia-Tempio (2-viii-2013), Männchen, Nuraghe Loelle, ca 4 km östlich von Buddusò, Provinz Olbia-Tempio (02.08.2013); b) female, small stream south of Nuraghe Sirilo, 4 km south of Orgosolo, Province Nuoro (4-viii-2013), Weibchen, kleiner Bach südlich der Nuraghe Sirilo, 4 km südlich von Orgosolo, Provinz Nuoro (04.08.2013).

Figure 5. High altitude reproduction habitats of *Sympetrum sanguineum* in Sardinia. – Abbildung 5: Hoch gelegene Reproduktionsgewässer von *Sympetrum sanguineum* in Sardinien. a) Seepage alongside road, ca 800 m east of Nuraghe Ardesai, 975 m a.s.l., Province Ogliastra (5-viii-2013), Quellaustritt neben der Straße, ca. 800 m östlich der Nuraghe Ardesai, 975 m ü. NHN, Province Ogliastra (10.08.2013); b) Riu Paidorzu Headwaters, main stream, 965 m a.s.l., ca 8 km SSW of Pattada, Province Sassari (5-viii-2013), Riu Paidorzu, 965 m u. NHN, ca. 8 km SS von Pattada, Provinz Sassari (10.08.2013).

S. sanguineum is therefore shown as relatively widely distributed, mainly in the higher parts of Sardinia (> 500 m a.s.l.), often confined to small untypical habitats, and to be a scarce but native species of the island.

Discussion

After Pirotta (1878) had noted Sardinia for *S. sanguineum*, naming his source »Mus. Torino«, the occurence of *S. sanguineum* in Sardinia was unclear for more than 100 years (Bentivoglio 1908; Conci & Nielsen 1956; Bucciarelli et al. 1983; Askew 1988; Dijkstra & Lewington 2006; Riservato et al. 2014). The specimens which had been held at the Museum of Torino (Turin) have never been confirmed. Bentivoglio (1908) did not give any more information than "Sardegna" in the text, but did not indicate *S. sanguineum* as present in the table on page 45. In the following 80 years no new data emerged. Then Burmeister (1989) specified *S. sanguineum* in Sardinia for two locations: »Grabensysteme bei Tramariglio, Capo Caccia (ix-1976, 28-viii-1978, 06-ix-1980) and »Überschwemmte Felder bei Orosei (Bewässerung)« (31-viii-1980). It was not possible to exactly locate these sites. Tramariglio (#14 on Fig. 1) is a village on the small peninsula of Capo Caccia, but wrongly placed in "Abb. 1" in Burmeister (1989). The second record »near Orosei« (#15 on Fig. 1) can be located more precisely by the text given for *Ischnura genei*: »nördl. Orosei, überschwemmtes Melonenfeld (Bewässerung)«. At the ditches near Tramariglio he caught *S. sanguineum* in at least three years (1976, 1978, 1980), which suggests that a stable population was present in the area. Lago Baratz, as the only natural permanent lake of the island, is situated only a few kilometres away, but the species has never been recorded there, although Lago Baratz is the location in Sardinia which has been investigated most thoroughly (e.g., Bucciarelli et al. 1983; Ponel & Papazian 2003; Kunz 2010). Burmeister (1989) did not quantify the collected "mature" specimens, which were preserved in alcohol and determined by Gerd van Rosen. Maybe because Burmeister (1989) erroneously listed *I. elegans* and *I. graellsi* for Sardinia, his paper was ignored. Only Boudot et al. (2009: 212) considered the two records on the 50 × 50 km UTM grid of the distribution map of *S. sanguineum*.

In the territory surrounding Sardinia, *S. sanguineum* is relatively common: from northern continental Italy down to the south, Algeria, Morocco, Portugal, Spain, France, and on the islands of Corsica, Ustica, Sicily, and Majorca (Boudot et al. 2009, most data 1980 onwards, except Sicily). For the Tuscan Archipelago, *S. sanguineum* has recently been recorded by exuviae and larvae on the island of Capraia (Terzani 2005).

The reason why *S. sanguineum* had not been found on Sardinia, despite the increasing intensity of observation within the last decade (e.g., Hardersen & Leo 2010), may be due to its late flight season, the confinement to small mountainous habitats (which are not very attractive to most odonatologists, as only a few species can be expected), as well as its general scarcity. Most foreign odonatologists

travel to Sardinia in May and June, and want to observe the more exotic, African species, rare or absent in Central Europe, and may miss out common species that are not recorded for the island so far (e.g., *Lestes sponsa, Enallagma cyathigerum, Pyrrhosoma nymphula, Platycnemis pennipes, Aeshna cyanea, Cordulia aenea, Libellula quadrimaculata*). The search for larvae and exuviae is beside that an upcoming surplus in faunistical data, as Terzani (2005) has shown.

In Central Europe, *S. sanguineum* is found mainly at permanent or temporary pools, ponds, lakes, or swamps, and rarely found in slow flowing streams, brooks, or ditches (Wildermuth & Martens 2014). In Portugal it was found at several habitat types such as temporary ponds, streams, and dams, with a sufficient variation of the water table and acidic waters (Maravalhas & Soares 2013). Habitat choice of this species in Sardinia seems to be slightly different, and lotic habitats seem predominant. Despite the low number of habitats known from Sardinia, it may be too early for a conclusion. The most interesting habitat is location 12, the seepage (Fig. 5a), with most water only trickling over the surface and not much space for larvae. Nevertheless, eight exuviae of *S. sanguineum* were collected from this habitat, together with *Orthetrum anceps* and *O. brunneum.* At location 7 oviposition was observed over dense vegetation within the water course (Fig. 3). Another noteworthy habitat is location 9: in June 2011 it was flowing well, but not a single dragonfly was found. In August 2013 the brook was dry, but five species were found, three of them ovipositing (*Lestes barbarus, Aeshna affinis, S. sanguineum*), plus some individuals of *S. meridionale*, a few exuviae of *Chalcolestes viridis*, and 29 exuviae of *S. sanguineum*, the highest number collected in Sardinia.

Sympetrum sanguineum is considered a lowland species, its reproduction sites mainly being situated lower than 600 m a.s.l. (Wildermuth & Martens 2014). In Bavaria, for example, 85 % of all records originate from locations under 500 m a.s.l. (Schreiber 1998) and in the Czech Republik 96 % from localities lower than 599 m a.s.l. (Holuša 2008). Single individuals can be found up to 3,100 m a.s.l. in the Alps (Liston & Leslie 1983), but records of reproduction over 600 m a.s.l. are scarce. Certain records of established populations are reported at 775 m a.s.l. from the Eastern Alps (Ehmann 2000), at 812 and 813 m a.s.l., respectively, in Baden-Wuerttemberg (SGL Database, T. Benken pers. comm.), at 898 m a.s.l. from the Western Alps (Schleicher et al. 2008), and at 1,030 m a.s.l. from the Massif Central (Leroy 2005). Two of the Sardinian localities (12, 13: Figure 5) are therefore within the highest known breeding habitats confirmed by exuviae in Europe.

The few data presented here could suggest an alteration in the preferred altitude of the species, from habitats under 200 m a.s.l. between the late 1970s and early 1990s to much higher elevations (> 520 m a.s.l.) at the beginning of the 21st century. This thesis might be supported by Leroy (2005), who did not find *S. sanguineum* in the 1980s, but 25 years later at the same habitats at around 1,000 m a.s.l. investigated in the French Central Massif. In Morocco, however, *S. sanguineum* is

only found at altitudes between 800 and 1,525 m a.s.l., with breeding records up to ca 1,200 m a.s.l. in the Rif (Jacquemin 1994; Jacquemin & Boudot 1999).

For Sardinia the lack of data is evident and the mountainous areas of Sardinia are worth further investigations, particularly in the summer and autumn, and may reveal more surprises in the future.

Acknowledgements

I am grateful to Sönke Hardersen for sending the "Atlante-preliminare" just in time, to him and to Hansruedi Wildermuth for critical reading of an earlier version of the manuscript, Alida Piglia for the translation of the riassunto, many colleagues like Jean-Pierre Boudot, Hansruedi Wildermuth, and Theo Benken for information and discussions about this topic. Last but not least a great 'thank you' to all my highly valued travel companions: Martin Lemke, Martin Waldhauser, Reinhard Jödicke (all 2011), and especially my daughter Paula (2013).

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Manuskripteingang: 15. Oktober 2015