A small saline spring-fed pond as habitat for *Aeshna cyanea* and *Pyrrhosoma nymphula* (Odonata: Aeshnidae, Coenagrionidae)

Malte Seehausen[1] & Lavinia Schardt[2]

[1] Museum Wiesbaden, Friedrich-Ebert-Allee 2, 65185 Wiesbaden; malte.seehausen@museum-wiesbaden.de

[2] Naturkundemuseum Stiftung Schloss und Park Benrath, Benrather Schlossallee 102–106, 40597 Düsseldorf; Lavinia.Schardt@schloss-benrath.de

Abstract. Reproduction of *Aeshna cyanea* (Müller, 1764) and *Pyrrhosoma nymphula* (Sulzer, 1776) in a small saline spring-fed pond near the village Eltville (Hesse, Germany; 50.056971° N, 08.084431° E) is documented. The maximum conductivity within larval habitat was 12,400 µs/cm [25°C] and the salinity was 7–8 PSU. These and other values such as chloride, sodium, potassium and calcium are considerably higher than in habitats previously reported for these two species.

Key words. Odonata, salinity, *Aeshna cyanea*, *Pyrrhosoma nymphula*, Germany

Introduction

Several species of Odonata are known to breed in brackish water systems. Cannings & Cannings (1987) for instance found larvae of *Aeshna interrupta* in Canadian salt lakes with conductivity values of 9,083 µs/cm [25°C] and larvae of *Lestes congener* and *Enallagma boreale* tolerating conductivity values of about 15,500 µs/cm [25°C]. Catling (2009) recorded larvae of *Enallagma hageni*, *Sympetrum internum*, and *Sympetrum* sp. in brackish pools in Quebec (Canada) with salinity values up to 17 PSU (1 PSU = 1ppt [parts per thousand] = 1g/l).

Records of larvae of *Aeshna cyanea* (Müller, 1764) in saline habitats are given by Lindberg (1948) who found this species tolerating salinity up to 6.64 ‰ (≈ 6.64 PSU) in the Baltic Sea. Further data for *A. cyanea* are given by Mauersberger (1989) from the brackish Rostocker Bodden (Germany), by Lotzing (2000) for »NSG Salzstelle von Hecklingen«, a saline region in Saxony-Anhalt (Germany) and by Burkart & Burkart (2007) who listed *A. cyanea* together with 16 other species from the brackish coastal waters of Gotland (Sweden). Unfortunately none of these authors provided details of water chemistry. Data concerning *Pyrrhosoma nymphula* (Sulzer, 1776) occurring in brackish water systems seem to be especially scant. Most detailed data available concerning water chemistry for *A. cyanea* and *P. nymphula* are provided by Sternberg (1999: 372, 2000: 73) who documented the complex requirements for successful larval growth of both species.

Study site and methods

The spring was located at 200 m a.s.l. within a forest north of the village Eltville, Hesse, Germany (50.056971° N, 08.084431° E, 200 m a.s.l.). The saline water ran throughout the year with a mean temperature of about 14°C, emptying into a small pond and further on into a small stream (Fig. 1). The pond was about 18 m^2 and 30–50 cm deep and except for some stands of halophilic *Apium nodiflorum* almost completely covered with *Lemna* sp. The ground was muddy and coated with fallen leaves mostly from the surrounding beech trees. Conductivity and temperature in the larval habitat were measured at each visit. Due to the nearly constant temperature and conductivity of incoming water, pool-water composition was constant near the inflow but decreased due to an influx of rain water on its way towards the lower stream. Distinct differences in temperature occurred during winter e.g. with an air temperature of about 4°C and that for water at about 14°C at the inflow and 8°C at a distance of about 3 m downstream.

Results

The water of the pond was brackish with a salinity of 7–8 PSU and very hard. The studied habitat thus represents the highest measured values of salinity and other parameters like chloride, sodium, potassium and calcium for breeding habitats of *Aeshna cyanea* and *Pyrrhosoma nymphula* so far. Measured values of water conductivity and their range are given in Table 1. During our first visit on ix-2011 we observed a territorial male *A. cyanea*. During several visits between xii-2013 and iii-2014 we found up to ten larvae of *A. cyanea* at different developmental stages and one larvae of *P. nymphula*. On 05-iv-2014 we noticed the first freshly emerged *P. nymphula* and on 22-vi-2014 the first freshly emerged *A. cyanea*. By vii-2014 we had collected a total of 56 exuviae of *A. cyanea*.

Discussion

Our water chemistry measurements of the spring are considerably higher for some parameters than those given by Sternberg (1999: 372, 2000: 73), especially the

Fig. 1. Saline spring-fed pond north of the village Eltville, Hesse, Germany (1-viii--2014). Photo: MS

Tab. 1. Water analysis of the saline spring-fed pond at Eltville, Hesse, Germany compared to corresponding data for *Aeshna cyanea* and *Pyrrhosoma nymphula* habitats given by Sternberg (1999: 372, 2000: 73). The value for salinity marked with an asterisk refers to Lindberg (1948) and was not considered by Sternberg (1999: 372, 2000: 73).

	Saline spring-fed pond, Eltville, Germany (this study)	*Aeshna cyanea* (Sternberg 2000)	*Pyrrhosoma nymphula* (Sternberg 1999)
Conductivity [25°C]	10,670–12,400 µs/cm	25– > 1,000 µs/cm	38–1,040 µs/cm
pH value	6.5	3.7–9.7	3.8–9.45
Total hardness	> 36 °d	0.1–36°d	1.7–36°d
Salinity (1 PSU = 1g/l ≈ 1‰)	7–8 PSU	2.02–6.64‰*	–
Sodium (Na^+)	1,845 mg/l	< 0.1–48 mg/l	18–27 mg/l
Potassium (K^+)	167 mg/l	1–6 mg/l	7–10 mg/l
Magnesium ($Mg^{+1–7}$)	20 mg/l	1.8–20.7 mg/l	8–12 mg/l
Calcium (Ca^{2+})	269 mg/l	7–104 mg/l	28–81 mg/l
Chloride (Cl^-)	3,120 mg/l	2–131 mg/l	2–66 mg/l
Sulfate (SO_4^{2-})	82 mg/l	3.3–218 mg/l	35–37 mg/l

readings of conductivity, chloride, sodium, potassium and calcium (Tab. 1). Lindberg (1948) gives a maximum of 6.64‰ (≈ 6.64 PSU) for *A. cyanea* in the Baltic Sea which almost approximates to our measurements in the pond. The salinity readings of 7–8 PSU may be near the upper tolerance limit for *A. cyanea* and *P. nymphula*. In laboratory tests conducted by Komnick (1978) the larval haemolymph of *A. cyanea* was isotonic at a saline concentration of 300 mosM/l, that is equivalent to approximately 9 PSU. Hypotonic concentration could not be compensated and the larvae died immediately when placed in concentrations of 600 mosM/l.

Fig. 2. Larvae of *Aeshna cyanea* eating an aquatic sowbug (Asellidae). Eltville, Hesse, Germany (3-i-2014). Photo: MS

The constant temperature of about 14°C at the inflow especially in winter appeared to be conducive for the development of larvae of *A. cyanea* since nearly all of them were found within this comparatively warm zone. At this temperature we observed active hunting and it seems that winter prey consists mostly of aquatic sowbugs (Asellidae) which are abundant (Fig. 2). Despite the possible presumption of a faster development and therefore earlier time of emergence due to the constantly warm habitat conditions the phenology of both species at the studied site did not differ from mean values known from Central Europe.

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