Odonata in southern Morocco, with first records of *Orthetrum ransonnetii* and *Sympetrum sinaiticum* (Odonata: Libellulidae)

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Abstract

On several field trips between 2001 and 2008 to southern Morocco, 26 species were recorded in 24 localities. *Orthetrum ransonnetii* and *Sympetrum sinaiticum* were recorded for the first time in April 2003 and April 2007 respectively. Both are new for the Moroccan fauna, increasing the number of odonate species for this country to 61.

Résumé

Odonates au sud du Maroc, avec les premières mentions d'*Orthetrum ransonnetii* et *Sympetrum sinaiticum* (Odonata: Libellulidae) – Au cours de plusieurs voyages dans le sud du Maroc réalisés entre 2001 et 2008, 26 espèces ont été observées en 24 localités. *Orthetrum ransonnetii* et *S. sinaiticum* ont été découverts en avril 2003, respectivement avril 2007. Tous deux sont nouveaux pour la faune odonatologique marocaine qui compte à ce jour 61 espèces.

Zusammenfassung

Libellen im südlichen Marokko, mit Erstnachweisen von *Orthetrum ransonnetii* und *Sympetrum sinaiticum* (Odonata: Libellulidae) – Bei verschiedenen Aufenthalten im südlichen Marokko wurden zwischen 2001 und 2008 an insgesamt 24 Fundorten 26 Libellenarten festgestellt. *Orthetrum ransonnetii* und *S. sinaiticum* wurden dort zum ersten Mal im April 2003 beziehungsweise April 2007 gefunden. Beide sind neu für die marokkanische Libellenfauna, die damit 61 Arten umfasst.

Introduction

The odonate fauna of Morocco has been well studied in the last decades. JACQUEMIN & BOUDOT (1999) summarised the literature and compiled a large amount of unpublished data. Since then a few publications (HILFERT-RÜPPELL et al. 1999; GRAND 2003; MEURGEY 2004; FAUCHEUX et al. 2005) gave information of regional interest.

More recently, BOUDOT (2008) provided an important complement with 34 species recorded in 39 locations. During this prospecting trip he discovered *Selysiothemis nigra* at Lake of Merzouga on the fringe of the Sahara, the 59th species for Morocco.

The southern part of the country, south of the High Atlas, lacks good prospecting. JÖDICKE (1995) has shown spring aspects of the odonate fauna of this region and listed 16 species from eleven localities. Other information was provided by AGUESSE & PRUJA (1958a, 1958b), DUMONT (1972, 1976), CARCHINI (1981), JACQUEMIN (1991), CONESA GARCÍA (1995) and JACQUEMIN & BOUDOT (1999). BOUDOT (2008) visited only six localities in this area.

As shown by JÖDICKE (1995), this region is particularly interesting in the fact that it represents an overlapping zone between Palaearctic and Afrotropical fauna. Water bodies are rare, often not permanent and under strong human pressure. The presence of water depends on the amount of precipitation during the winter period and on the accumulation of snow on the Atlas Mountains.

In this study, we present the results of two spring trips in southern Morocco in 2003 (April 14-20) and 2007 (April 18-28). Some additional punctual records from 2001, 2002, 2004, 2008 (CM) and 2006 (LJ) are also considered. We primarily visited the surrounding regions of the Anti-Atlas Mountains, the Drâa and Ziz valleys.

Study region and localities

Our study region was the Moroccan drainage basins located south of the High Atlas Mountains. The region is delimited by the watershed lying along the High Atlas in the north, by the border with Algeria in the east and in the south and by the parallel 27°40'N in the south-west, which, according to United Nations specifications, constitutes the border with Western Sahara.

For each locality (Fig. 1), a brief ecological description, geographical coordinates, altitude and bioclimatic stage (SAUVAGE 1963 following EMBERGER 1930) are given, as well as date(s) of visit and number of observed species.

1. Oued Ben Jelil in the town of Tan-Tan; 28°26'23.0''N, 11°06'15.00''W, 40 m alt.; Saharan with temperate winters; small pool in the dried-up riverbed; 12-iv-2004; 2 spp.
2. Oued Drâa near the N1 road bridge, ca 18 km NE of Tan-Tan; 28°32'N, 10°58'W, 10 m alt.; Saharan with temperate winters; bodies of standing waters in the sandy riverbed, grown with *Potamogeton* sp., *Phragmites australis* and *Holoschoenus romanus*; 12-iv-2004; 6 spp.
3. Mouth of Oued Massa; 30°02'43''N, 09°38'50''W, 0 m alt.; arid with warm winters; estuarine area, pool with a developed vegetation belt; 29-xi-2002; 2 spp.
4. Oued Massa downstream N1 road bridge, S of Ait-ou-Mribete; 29°53'50.2''N, 09°35'43.3''W, 30 m alt.; arid with warm winters; trickles of running water and ponds in the sandy and gravelly riverbed; 20-iv-2003; 3 spp.

5. Youssef Ben Tachfine reservoir lake, near the dam; 29°50'27.5''N, 09°29'28.5''W, 100 m alt.; arid with temperate winters; silty shoreline of the artificial lake, without vegetation; 20-iv-2003; 5 spp.
6. Asif Tamrakht, along 7002 road; 30°33'14.1'', 09°33'08.0''W, 190 m alt.; semiarid with temperate winters; rapid stream in a steep-sided gorge, with rocky, gravelly and sandy banks and several rapids; 10-iv-2004, 28-iv-2007; 8 spp.
7. Reservoir lake near Had ait Nzal, 4.5 km SE of Aït Baha; 30°03'16.4''N, 09°06'37.3''W, 620 m alt.; arid with cool winters; mouth of the oued in the drying lake, floating and submerged vegetation; 27-iv-2007; 3 spp.
8. Oued Sous, near the N10 road bridge, 4 km NE of Aoulouz; 30°41'48.1''N, 08°09'12.2''W, 710 m alt.; arid with cool winters; wide riverbed with shallow stream, trickles of running water and sand tongues; 17-iv-2003; 10 spp.
9. Oued Tata, 4 km SW of Tata; 29°42'30.6''N, 07°59'48.6''W, 630 m alt.; Saharan with temperate winters; large variety of habitats, stretch of oued with running water, sandy, gravelly and rocky riverbed, rock pools, reservoir, irrigation ditch with running water, massive development of algae caused by washing activities; 19-iv-2003, 24-25-iv-2007, 26-vi-2008; 14 spp.
10. Oued El Maleh, between Tissint and Mrhimima; 29°49'16.8''N, 07°11'44.0''W, 500 m alt.; Saharan with temperate winters; wide oued with a quite strong current, sandy riverbed, secondary channels with slow current; 24-iv-2007, 26-vi-2008; 9 spp.
11. Around pass on N10 road, ca 11 km NW of Tazenakht; 30°39'46.7''N, 07°16'05.3''W, 1670 m alt.; semiarid with cool winters; streamlet running out of a fen; 14-iv-2003; 1 sp.
12. Oued Tarkal near Zawyat Sidi Blal; 30°28'08.3''N, 06°58'37.9''W, 1064 m alt.; Saharan with cool winters; dried up oued with a short stretch of running water, rock pools, small reservoir, irrigation ditches; 23-iv-2007; 5 spp.
13. Oued Dadès tributary between Skoura and Mansour Eddahbi reservoir lake; 30°59'59.6''N, 06°38'46.1''W, 1160 m alt.; Saharan with cool winters; trickles of slowly running water grown with small Cyperaceae and pools in the riverbed; 15-iv-2003; 5 spp.
14. Small oued N of Mansour Eddahbi reservoir lake; 30°58'24.7''N, 06°45'58.3''W, 1120 m alt.; Saharan with cool winters; streamlet with slow current on silty substrate; 15-iv-2003, 07-x-2006; 6 spp.
15. Oued crossing N9 road between Ouarzazate and Agdz, SW of Issougrid; 30°49'57.3''N, 06°47'05.4''W, 1210 m alt.; Saharan with cool winters; pools in the dried-up riverbed, no vegetation; 18-iv-2007; 2 spp.
16. Oued Drâa, 5 km SE of Agdz, near Tamnougalt; 30°40'12.7''N, 06°23'53.5W, 910 m alt.; Saharan with cool winters; large oued with a considerable flow, sandy banks and pools due to sand and pebble extraction; 16-iv-2003, 22-iv-2007; 6 spp.

17. Oued Drâa, NW of Taalkilt; 30°37’18.5’’N, 06°09’55.7’’W, 830 m alt.; Saharan with temperate winters; small dam on oued Drâa, sandy banks and presence of fish; 19-iv-2007; 1 sp.
18. Oued Drâa, SE Tinfo, beneath 6958 road bridge; 30°10’41.8’’N, 05°34’28.3’’W, 650 m alt.; Saharan with temperate winters; nearly still water with *Potamogeton* sp., sandy banks; 20-iv-2007; 4 spp.
19. Dadès Gorges, upstream Aït Ouffi; 31°31’17.0’’N, 5°55’47.2’’W, 1790 m alt.; semi-arid with cold winters; rapid oued, mouth of a dried-up tributary; 09-x-2006; 1 sp.
20. Oued Hamza at Boua Sidi; 32°19’04.3’’N, 04°32’58.4’’W, 1390 m; arid with cold winters; flowing oued with lateral irrigation ditches; 22-vi-2008; 2 spp.
21. Mouth of Oued Ziz in Hassan Addakhil reservoir lake; 32°00’42.0’’N 4°25’37.0’’W, 1100 m alt.; Saharan with cool winters; very slow running oued and artificial lake, the low water level had left some remaining pools; 01-vii-2001; 2 spp.
22. Oued Rheris, crossing with 3451 road, ca 6 km W of Erfoud; 31°25’53.7’’N, 4°18’12.1’’W, 780 m alt.; Saharan with cool winters; bodies of still water in the dried-up riverbed; 03-vii-2001; 2 spp.

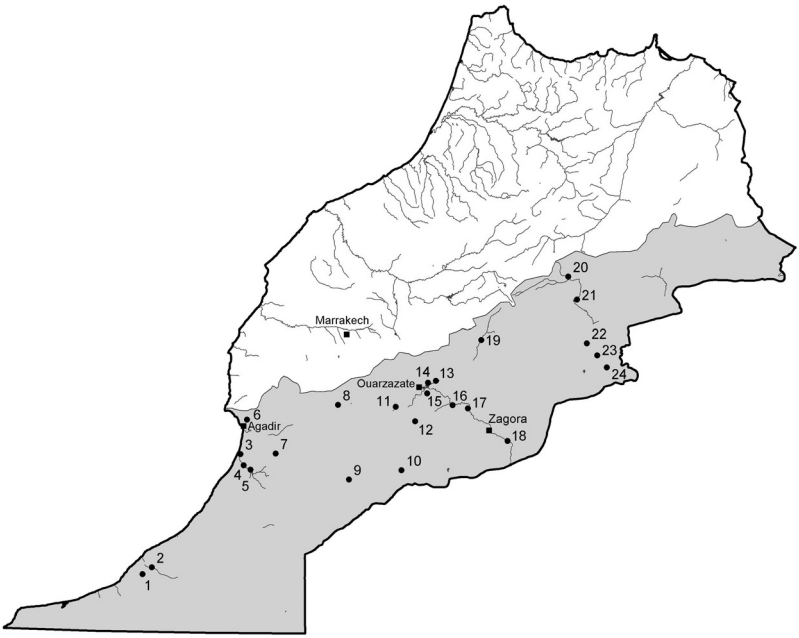

Figure 1: Map of Morocco, with the study region southern Morocco (grey) and situation of collecting sites (1–24). — Abbildung 1: Karte von Marokko, mit dem Untersuchungsgebiet Südmarokko (grau) und der Lage der Fundstellen (1–24).

23. Oued Ziz, ca 11 km SE of Rissani; 31°15'56.1''N, 04°09'11.3''W, 740 m alt.; Saharan with temperate winters; pool in the dried up sandy riverbed; 23-vi-2008; 4 spp.
24. Palm grove of Merzouga; 31°06'05.0''N, 4°00'42.0'', 700 m alt.; Saharan with temperate winters; 02-vii-2001; 1 sp.

Annotated list of records

All numerals refer to mature adults (male, female) except where otherwise indicated. In some cases numerals in square parentheses are given, which pertain either to an estimation of mature adults present at the site, or to an observation of unsexed individuals. Abbreviations: **im** immature; **te** teneral; **ex** exuviae; **td** tandem; **ov** oviposition; ^{c} collected specimen. All collected specimens have been deposited in the collection of the Muséum d'Histoire naturelle de Neuchâtel (MHNN).

Calopteryx haemorrhoidalis (Vander Linden, 1825)
Loc. 8: 17-iv-2003 (1^c, 0; [10]; 2^c im)

Coenagrion caerulescens (Fonscolombe, 1838)
Loc. 8: 17-iv-2003 (3^c, 2^c; [50]), loc. 9: 25-iv-2007 (1^c, 0), loc. 13: 15-iv-2003 ([10]), loc. 14: 15-iv-2003 (1^c, 2^c; 1 td)
The record in locality 9, where *C. caerulescens* developed in permanent running water, fills a gap in the species' range south of the Anti-Atlas (Dumont 1976; Jacquemin & Boudot 1999).

Enallagma deserti (Selys, 1871)
Loc. 2: 12-iv-2004, (1^c, 0)
This is the second record south of the High Atlas for this damselfly and the southernmost known to date. The species was firstly discovered in the upper Ziz valley by J. Kählert and A. Wendler (Jacquemin & Boudot 1999). Another population is known at the boundary of our study region in the Oued Tamri basin (Couret in Jacquemin & Boudot 1999), about 300 km to the north-east. The only male that we collected was malformed (S4-S9 shortened). This way we can reasonably exclude vagrancy. The habitat was largely grown with *Potamogeton* sp. and matches with ecological information given by Jacquemin & Boudot (1999) and Jödicke et al. (2000a).

Erythromma lindenii (Selys, 1840)
Loc. 5: 20-iv-2003 (2^c, 0), loc. 6: 10-iv-2004 (2, 0) 28-iv-2007 (4, 0), loc. 7: 27-iv-2007 (5, 1^c; 1 im; 1 td), loc. 8: 17-iv-2003 (10, 5; 5 ov), loc. 9: 19-iv-2003 (1^c, 0), 25-iv-2007 (1^c td)
This species was observed on reservoirs of various sizes or on slowly running stretches of streams. At Tata (loc. 9) on the fringe of the Sahara, the habitat was a small irrigation reservoir (Fig. 2).

Ischnura fountaineae Morton, 1905
Loc. 23: 23-vi-2008 (1^{c} im)
A new locality on Oued Ziz, downstream of the sites mentioned by JACQUEMIN (1991).

Ischnura saharensis Aguesse, 1958
Loc. 2: 12-iv-2004 (1^{c}, 1^{c}), loc. 4: 20-iv-2003 (1^{c}, 1^{c}), loc. 8: 17.4.2003 (0, 2^{c}; [20]), loc. 9: 19-iv-2003 (1^{c}, 1^{c}), 24-iv-2007 (0, 2^{c}), 25-iv-2007 ([50]; 1 te; 1 ex; 1 ov), 26-vi-2008 (1^{c}, 0), loc. 10: 24-iv-2007 (1^{c}, 0; [50]; 20 td; 20 ov), 26-vi-2008 (10^{c}, 0), loc. 12: 23-iv-2007 (1^{c}, 1^{c}), loc. 13: 15-iv-2003 (2^{c}, 0), loc. 14: 15-iv-2003 (2^{c}, 3^{c}; [20]), loc. 16: 16-iv-2003 (1^{c}, 0; [20]; 1 ov), 22-iv-2007 (0, 1^{c}), loc. 17: 19-iv-2007 (2^{c}, 0), loc. 18: 20-iv-2007 (2^{c}, 1^{c}; [50]; 2 ov), loc. 20: 22-vi-2008 (1^{c}, 0), loc. 22: 03-vii-2001 (2^{c}, 1^{c}), loc. 23: 23-vi-2008 (50^{c}, 5), loc. 24: 02-vii-2001 (0, 1^{c})
Undoubtedly the most common and widespread damselfly in the area, observed in a large variety of lotic and lentic environments.

Platycnemis subdilatata Selys, 1849
Loc. 6: 10-iv-2004 (0, 1), 28-iv-2007 (1^{c} te ; 1^{c} ex), loc. 20: 22-vi-2008 (20 td)

Anax ephippiger (Burmeister, 1839)
Loc. 1: 12-iv-2004 ([1]), loc. 2: 12-iv-2004 ([1]), loc. 3: 29-xi-2002 ([2]), loc. 9: 25-iv-2007 (1, 1; 1 ov; 1 te; 4^{c} ex), loc. 10: 24-iv-2007 ([2]), loc. 13: 15-iv-2003 (0, 2^{c}; [10]), loc. 14: 15-iv-2003 (1, 0), loc. 16: 16-iv-2003 (1^{c}, 1; 1 ov)

Figure 2: Small reservoir near Oued Tata, 4 km SW of Tata, Morocco, 26-vi-2008. — Abbildung 2: Kleiner Stausee bei Oued Tata, 4 km SW Tata, Marokko, 26.06.2008. Photo: CM.

The discovery of exuviae and the observation of a failed emergence in April prove that this species can pass the winter season at larval stage on the Saharan fringe of Morocco. This record seems to be the first one confirming emergence of the spring generation north of the Sahara (R. Jödicke pers. comm.). Moreover, a female was observed at locality 16 ovipositing in an old floating stem of *Typha* sp.

Anax imperator Leach, 1815
Loc. 3: 29-xi-2002 (5, 0), loc. 4: 20-iv-2003 (0, 1), loc. 5: 20-iv-2003 (1, 0), loc. 7: 27-iv-2007 (1, 1), loc. 8: 17-iv-2003 (10, 10; 1 ov), loc. 9: 19-iv-2003 (0, 1), 25-iv-2007 ([10]), 26-vi-2008 (5, 2)

Anax parthenope Selys, 1839
Loc. 9: 25-iv-2007 (1, 0; 1^{c} ex), 26-vi-2008 (10^{c}, 2), loc. 10: 26-vi-2008 (0, 1)
The observations in two localities south of the Anti-Atlas complete the distribution area of *A. parthenope* in Morocco. The development in locality 9 is attested by an exuvia.

Boyeria irene (Fonscolombe, 1838)
Loc. 19: 09-x-2006 (0, 1)
A female was still active in October at the Dadès where *B. irene* had already been recorded by Jacquemin & Boudot (1999) and Boudot (2008).

Onychogomphus costae Selys, 1885
Loc. 10: 24-iv-2007 (1^{c} ex), 26-vi-2008 (0, 1^{c}), loc. 21: 01-vii-2001 (1^{c} ex), loc. 23: 23-vi-2008 (2, 0)
Locality 10 is a new locality south of the Anti-Atlas on the fringe of the Sahara. *Onychogomphus costae* reproduced there, as is proven by the exuvia found at the end of April. Our two other records are from the Ziz basin where it was already known (Jacquemin & Boudot 1999). At locality 23 the observed individuals were resting in the shade on low branches of *Tamarix* bushes in more than 40°C ambient temperature.

Onychogomphus uncatus (Charpentier, 1840)
Loc. 6: 28-iv-2007 (3^{c}, 0; 5^{c} ex)
Confirmation of the westernmost known population of this western Mediterranean species (Hilfert-Rüppell et al. 1999).

Paragomphus genei (Selys, 1841)
Loc. 9: 25-iv-2007 (1, 0), loc. 10: 24-iv-2007 (2^{c} te; 1^{c} ex)
Previously *P. genei* was known from only one locality south of the High Atlas, in the Drâa valley (Jacquemin & Boudot 1999). We confirm the presence of this species in two other localities south of the High Atlas. There the reproductive season may already start in April, but the species could emerge throughout the year as in Southern Tunisia (Jödicke 2001, 2003).
As an addition to our records, a male specimen from Oued Massa near Tiznit is deposited at the Musée de Zoologie de Lausanne (MZL), Switzerland (leg. J. de

Beaumont, 25-iv-1947). It is possible that the place where de Beaumont caught this specimen tallies with our locality 4.

Brachythemis leucosticta (Burmeister, 1839)
Loc. 2: 12-iv-2004 (1^{c} im), loc. 5: 20-iv-2003 (10^{e}, 10^{e})
Our two observations attest that *B. leucosticta* may already start to emerge in the first half of April. The number of individuals at locality 5 shows that this artificial lake is still attractive for the species, eight years after the discovery by JÖDICKE (1995). Locality 2 is the southernmost known in Morocco to date. The next known population is situated in the mountains of southern Mauritania where this Afrotropical species was not rare in 1975 (DUMONT 1976).

Crocothemis erythraea (Brullé, 1832)
Loc. 7: 27-iv-2007 (2, 1; 1 ov), loc. 8: 17-iv-2003 (1^{c}, 0; 5 te), loc. 9: 19-iv-2003 ([20]), 25-iv-2007 (2, 0; 1 im), 26-vi-2008 ([100]; 100 im), loc. 10: 26-vi-2008 (2 im), loc. 12: 23-iv-2007 (1, 0), loc. 14: 15-iv-2003 (2, 1; 1 ov), loc. 16: 16-iv-2003 (0, 1^{c}; 1 ov), loc. 18: 20-iv-2007 (1, 0), loc. 21: 01-vii-2001 (2, 0), loc. 22: 03-vii-2001 (2, 0)

Figure 3: *Orthetrum ransonnetii*, mature male. Wadi Syyagh, Petra, Jordan, 21-iv-2008. — Abbildung 3: *Orthetrum ransonnetii*, matures Männchen. Wadi Syyagh, Petra, Jordanien, 21.04.2008. Photo: CM.

This Afrotropical species is one of the most frequently encountered Anisopterans in the study area.

Orthetrum brunneum (Fonscolombe, 1837)
Loc. 14: 15-iv-2003 (1 te)
Orthetrum brunneum is quite rare in North Africa (BOUDOT et al. 2009). JACQUEMIN & BOUDOT (1999) mention it from 12 localities in Morocco and only one south of the High Atlas, in the high Ziz Valley. Our single capture is therefore the first record for the Drâa basin. Moreover, this spring record extends the known flight period in the study area (JACQUEMIN & BOUDOT 1999) for more than one month. Our sighting confirms a development in running waters in Morocco.

Orthetrum chrysostigma (Burmeister, 1839)
Loc. 6: 10-iv-2004 (1 im), 28-iv-2007 (10, 0), loc. 8: 17-iv-2003 (2^{c}, 1^{c}; 10 te), loc. 9: 19-iv-2003 ([1]), 25-iv-2007 (1, 0; 2 im), 26-vi-2008 (1, 0), loc. 10: 26-vi-2008 (2, 0), loc. 11: 14-iv-2003 (1^{c} im), loc. 12: 23-iv-2007 (1^{c}, 0; 1^{c} im), loc. 15: 18-iv-2007 (1^{c} im), loc. 16: 16-iv-2003 (1^{c} im)
As *C. erythraea*, *O. chrysostigma* is one of the commonest Anisopterans in southern Morocco.

Orthetrum nitidinerve (Selys, 1841)
Loc. 13: 15-iv-2003 (1^{c} im)
This record defines the beginning of the flight period for *O. nitidinerve* in Morocco.

Orthetrum ransonnetii (Brauer, 1865)
Loc. 9: 19-iv-2003 (1^{c}, 0), loc. 12: 23-iv-2007 (2^{c}, 1)
A new species for Morocco (Fig. 3). The nearest known populations are found at the Mouydir Plateau, North Central Sahara, Algeria, about 1200 km to the southeast (KIMMINS 1934; DUMONT 1978a, 2007). DUMONT (2007) found it widespread there in 2007, on any type of desert water. Other data from Central Sahara are from the Ahaggar Mountains (LE ROI 1915; KIMMINS 1934; DUMONT 1978a, 2007), Tassili n'Ajjer (SAMRAOUI & MENAÏ 1999) and south-eastern Libya (S.V. Ober pers. comm.). It is also known from Aïr Mountain in northern Niger (DUMONT 1978b), Tibesti Mountains (LONGFIELD 1955; DUMONT 1978b), Red Sea Hills in northern Sudan (DUMONT & MARTENS 1984) and Egypt (ANDRES 1929). The species is also present in the entire Middle East, from Sinai (BRAUER 1865) to Afghanistan (SCHMIDT 1961).

The two Moroccan sites showed some similarities. The water bodies were supplied with running water throughout the year. Rock pools dug by the stream in conglomerates (Fig. 4) could guarantee the presence of water in case of extreme drought.

Selysiothemis nigra (Vander Linden, 1825)
Loc. 9: 26-vi-2008 (3^{c}, 1^{c})
The sighting of *S. nigra* on a reservoir on Oued Tata is only the second record for

Morocco after its discovery in June 2007 (BOUDOT 2008). This species had already been expected in Morocco according to its global distribution and to its presence in the neighbouring countries of Spain and Algeria (JACQUEMIN & BOUDOT 1999). We attribute its late discovery to the weak odonatological prospecting in southern Morocco. Particular events like the abundant rains of the winters 2006/2007 and 2007/2008 probably had a positive influence on the population dynamics of the species. The Lake of Merzouga, where BOUDOT (2008) found *S. nigra*, was dried up between 1997 and the autumn of 2006. The site of Tata was on the other hand full of water in April 2003 and we assume that the reservoir is supplied with water all year round. It is therefore likely that the locality was occupied for a long time. The species has recently expanded on the northern margin of its distribution area, as in Armenia, Bulgaria or Ukraine (BESCHOVSKI & GASHTAROV 1997; BOUDOT 2008). However, we think that the records on the Saharan fringe of Morocco are not the result of a recent expansion but of better hunting. Only monitoring of the three Moroccan populations (BOUDOT et al. 2009) will confirm the status of this well-known migrant (SCHNEIDER 1981; CORBET 1999). The perches were *Schoenoplectus lacustris* stems near the bank, sometimes in the centre of the pond.

Figure 4: Rock pools on Oued Tarkal near Zawyat Sidi Blal, Morocco, 23-iv-2007. — Abbildung 4: Felsentümpel am Oued Tarkal bei Zawyat Sidi Blal, Marokko, 23.04.2007. Photo: LJ.

S*ympetrum fonscolombii* (Selys, 1840)
Loc. 1: 12-iv-2004 (1 im), loc. 2: 12-iv-2004 (20 im), loc. 4: 20-iv-2003 (100 te), loc. 13: 15-iv-2003 (0, 2^{c})
This species is the most widespread of the genus *Sympetrum* in Morocco. Its flight period extends all year round in the coastal regions (JACQUEMIN & BOUDOT 1999). We only recorded it a few times during our visits to southern Morocco, however sometimes in considerable numbers.

S*ympetrum sinaiticum* Dumont, 1977
Loc. 12: 23-iv-2007 (2^{c} te)
A new species for Morocco. Like *Selysiothemis nigra*, *S. sinaiticum* was already expected there (JACQUEMIN & BOUDOT 1999). Our sighting (Fig. 5) completes the distribution of this species known in particular in Algeria and Spain. The nearest known population is situated in Andalusia near Málaga (MARTENS et al. 1996), about 700 km to the north. In Algeria it was captured near Ouargla (LE ROI 1915; GEYR VON SCHWEPPENBURG 1917), about 1200 km to the east. The particular biology of this *Sympetrum* explains that this species has gone unnoticed until now. According to the literature, emergence occurs in May and June (JÖDICKE et al. 2000b; DUMONT 2007). Sexual maturation is exceptionally postponed and immature individuals spend several months far away from water bodies. In Tunisia, reproductive activities have been recorded between October and March (JÖDICKE 2003). Our sighting confirms this pattern and extends the emergence period. An autumn/winter prospecting should clarify the status of this species in Morocco. Furthermore, K.D.P. Wilson (pers. comm.) observed a mature male *S. sinaiticum* on 29 September 2007 along a series of pools near the headwaters of a small oued around Ouarzazate. He didn't notice any reproductive behaviour although this male was on a potential reproductive site.

Trithemis annulata (Palisot de Beauvois, 1805)
Loc. 2: 12-iv-2004 (5^{c}, 0; 1 im), loc. 5: 20-iv-2003 (0, 1^{c}; [50]), loc. 6: 10-iv-2004 (5, 0), 28-iv-2007 (1, 0), loc. 8: 17-iv-2003 (1^{c}, 1^{c}), loc. 9: 19-iv-2003 (2^{c}, 1^{c}; [10]), 25-iv-2007 ([2]), 26-vi-2008, ([100]; 10 im), loc. 10: 24-iv-2007 (3, 1^{c}; 1 td), 26--vi-2008 (0, 1^{c}; [300]; 1 im), loc. 14: 07-x-2006 (2, 0), loc. 16: 16-iv-2007 (2^{c}, 0; [10]), loc. 18: 20-iv-2007 (1, 0), loc. 23: 23-vi-2008 (2, 5)
We have recorded *T. annulata* in a large number of localities from the first half of April. Our data extend the flight period in Morocco of this Afrotropical species, although in southern Tunisia it is on the wing throughout the year (JÖDICKE 2003). *Trithemis annulata* has been recorded at ponds and reservoirs.

Trithemis arteriosa (Burmeister, 1839)
Loc. 6: 10-iv-2004 (2, 0), loc. 8: 17-iv-2003 (1^{c}, 0), loc. 9: 26-vi-2008 (5^{c}, 0; 1 im)
Our sightings show that *T. arteriosa* is already on the wing during the first half of April. It was not recorded in the Ziz or High Drâa basin. This Afrotropical species seems to be restricted to the south-eastern parts of the country, as already shown by JACQUEMIN & BOUDOT (1999).

Trithemis kirbyi Selys, 1891

Loc. 5: 20-iv-2003 (1, 0), loc. 6: 28-iv-2007 (0, 1ᶜ), loc. 8: 17-iv-2003 ([5]), loc. 9: 19-iv-2003 (1ᶜ, 0; [20]), 25-iv-2007 (6, 0), 26-vi-2008 (5, 0; 5 im), loc. 10: 24-iv--2007 (3, 0; 1 im), 26-vi-2008 (1, 0), loc. 15: 18-iv-2007 (1ᶜ, 0), loc. 16: 16-iv--2003 (1ᶜ, 1ᶜ), loc. 18: 20-iv-2007 (1, 0)

This widespread species seems to be actually expanding northwards, with recent records in the Mediterranean basin in Spain (CHELMICK & PICKESS 2008) and Sardinia (HOLUŠA 2008). Under consideration of the large number of fully mature adults

Figure 5: *Sympetrum sinaiticum*, teneral female. Oued Tarkal near Zawyat Sidi Blal, Morocco, 23-iv-2007. — Abbildung 5: *Sympetrum sinaiticum*, frisch geschlüpftes Weibchen. Oued Tarkal bei Zawyat Sidi Blal, Marokko, 23.04.2007. Photo: LJ.

seen in mid-April, the flying period begins in April or at the end of March. However, we also observed two mature males close to our study region, at Oued Tamri on 27 November 2002. This record suggests that *T. kirbyi* could be on the wing throughout the year along the southern coast of Morocco, as in southern Tunisia (JÖDICKE 2003).

Zygonyx torridus (Kirby, 1889)
Loc. 6: 28-iv-2007 (3^c, 0; 10^c ex)
Our record confirms the presence of *Z. torridus* in the running waters of Asif Tamrakht (OCHARAN 1992). Exuviae were found about 50 cm above water against a shadowed rock wall grown with *Adiantum capillus-veneris*, and on boulders in the middle of the stream. This sighting matches with the Moroccan data compiled by KUNZ et al. (2006), who also mention an April record by J. Arlt from the same stream.

Discussion

This study contributes to the knowledge of the Odonata of southern Morocco with records of 26 species. *Orthetrum ransonnetii* and *Sympetrum sinaiticum* are new for Morocco, increasing the number of species known from the country to 61. The last additions for Morocco had been the sub-cosmopolitan migrant *Pantala flavescens* (JÖDICKE 1995) and *Selysiothemis nigra* (BOUDOT 2008), both in the southern part of the country.

Although the southern part of Morocco has been poorly studied, JACQUEMIN AND BOUDOT (1999) already list 35 species south of the High Atlas. Recent odonatological expeditions (BOUDOT 2008; BOUDOT et al. 2009, this study) have brought the list to 40 species (Tab. 1). This number is quite high for an arid region predominantly covered by semi-desert and desert and represents about two thirds of the Moroccan fauna. In comparison, the well studied and more humid region of the Rif in northern Morocco hosts 50 species (JACQUEMIN 1994). Major differences between the faunas of these two regions are mainly due to the presence of additional Mediterranean species and Euro-Siberian relict elements in the Rif, and of desert species in the south. Further comparisons with the Algerian Sahara and southern Tunisia (Tab. 1) show that southern Morocco is much richer. Three main reasons can explain this higher odonate diversity. Firstly, southern parts of Morocco are irrigated by streams originating in the High Atlas Mountains, where winter precipitation accumulates as snow. The melting of the snow supplies streams during the summer dry season. Some long stretches of rivers are in this way permanently supplied and host species like *Onychogomphus uncatus* and *Boyeria irene*. However, the building of dams in the last decades disrupted the hydrology of many streams. For example, floods of Oued Drâa do not reach the Atlantic Ocean any more. Secondly, a milder climate favours the Atlantic coastal region. Winter is

Table 1. Comparative list of Odonata in Morocco south of the High Atlas (Jacquemin & Boudot 1999; Boudot 2008; Boudot et al. 2009; this study), in the Algerian Sahara (Samraoui & Menaï 1999; Dumont 2007; Boudot et al. 2009) and in southern Tunisia, as defined by Jödicke et al. (2000a) (Jödicke et al. 2000a; Kunz et al. 2006; Boudot et al. 2009). — Tabelle 1. Vergleichende Liste der Libellen in Marokko südlich des Hohen Atlas (Jacquemin & Boudot 1999; Boudot 2008; Boudot et al. 2009; diese Arbeit), in der algerischen Sahara (Samraoui & Menaï 1999; Dumont 2007; Boudot et al. 2009) und im südlichen Tunesien nach der Definition von Jödicke et al. (2000a) (Jödicke et al. 2000a; Kunz et al. 2006; Boudot et al. 2009). **sMor** southern Morocco, **AlgS** Algerian Sahara; **sTun** southern Tunisia.

Taxon	sMor	AlgS	sTun
Calopteryx exul Selys, 1853	X		
Calopteryx haemorrhoidalis (Vander Linden, 1825)	X	X	X
Lestes viridis (Vander Linden, 1825)	X		
Sympecma fusca (Vander Linden, 1820)	X		
Ceriagrion tenellum (Villers, 1789)	X		X
Coenagrion caerulescens (Fonscolombe, 1838)	X	X	X
Enallagma deserti (Selys, 1871)	X		
Erythromma lindenii (Selys, 1840)	X	X	X
Ischnura fountaineae Morton, 1905	X	X	X
Ischnura saharensis Aguesse, 1958	X	X	X
Pseudagrion hamoni Fraser, 1955		X	
Platycnemis subdilatata Selys, 1849	X	X	
Aeshna mixta Latreille, 1805	X		
Anax ephippiger (Burmeister, 1839)	X	X	X
Anax imperator Leach, 1815	X	X	X
Anax parthenope Selys, 1839	X	X	X
Boyeria irene (Fonscolombe, 1838)	X		
Gomphus simillimus marrocanus Lieftinck, 1966	X		
Onychogompus costae Selys, 1885	X		
Onychogompus forcipatus unguiculatus (Vander Linden, 1823)	X		
Onychogompus uncatus (Charpentier, 1840)	X		
Paragompus genei (Selys, 1841)	X	X	X
Oxygastra curtisii (Dale, 1834)	X		
Brachythemis leucosticta (Burmeister, 1839)	X		
Crocothemis erythraea (Brullé, 1832)	X	X	X
Diplacodes lefebvrii (Rambur, 1842)		X	X
Orthetrum brunneum (Fonscolombe, 1837)	X		X
Orthetrum cancellatum (Linnaeus, 1758)	X	X	
Orthetrum chrysostigma (Burmeister, 1839)	X	X	X
Orthetrum coerulescens anceps (Schneider, 1845)	X	X	X
Orthetrum nitidinerve (Selys, 1841)	X	X	X

Taxon	sMor	AlgS	sTun
Orthetrum ransonnetii (Brauer, 1865)	X	X	
Orthetrum sabina (Drury, 1770)		X	X
Orthetrum trinacria (Selys, 1841)	X	X	X
Pantala flavescens (Fabricius, 1798)	X	X	X
Selysiothemis nigra (Vander Linden, 1825)	X	X	X
Sympetrum fonscolombii (Selys, 1840)	X	X	X
Sympetrum meridionale (Selys, 1841)	X		X
Sympetrum sinaiticum Dumont, 1977	X	X	X
Sympetrum striolatum (Charpentier, 1840)			X
Trithemis annulata (Palisot de Beauvois, 1805)	X	X	X
Trithemis arteriosa (Burmeister, 1839)	X	X	X
Trithemis kirbyi Selys, 1891	X	X	X
Zygonyx torridus (Kirby, 1889)	X		X
Total	**40**	**27**	**28**

considered to be relatively warm (Sauvage 1963), while due to cold oceanic winds spring is cool and long (Dumont 1976). Many species, like *Ceriagrion tenellum*, *Coenagrion caerulescens*, *Enallagma deserti*, *Calopteryx haemorrhoidalis*, *Oxygastra curtisii* or *Orthetrum cancellatum* have their southernmost populations here. And thirdly, several species that are chiefly distributed north to the High Atlas Mountains seem to have crossed this natural boundary and have reached the upper Ziz valley. The Tizi-n-Tairhemt pass (1907 m) seems to be a gateway to the south for taxa like *Calopteryx exul*, *Enallagma deserti, Onychogomphus forcipatus unguiculatus* or *Orthetrum brunneum*. Only four species found in southern Algeria and/or Tunisia are missing in southern Morocco. From *Diplacodes lefebvrii* and *Sympetrum striolatum*, which are reproducing in Morocco north of the High Atlas, only the first species is likely to be found in the south. Dumont (2007) recorded it at a permanent guelta in Central Sahara at the Mouydir Plateau. *Pseudagrion hamoni*, a relict from pluvial periods during the early Holocene, has several isolated populations in super-permanent gueltas of the Tassili n'Ajjer (Dumont 1982), Mouydir and Ahaggar Mountains (Dumont 2007). It is not unlikely that this Afrotropical species may be found in permanent sites of southern Morocco. The westernmost population of *Orthetrum sabina*, an Oriental species reaching eastern Algeria, is found at Ouargla (Samraoui & Menaï 1999), about 600 km from the Moroccan border. Jacquemin & Boudot (1999) list other potential species like *Ischnura senegalensis* and *Tramea basiliaris* based on captures from Mauritania (Dumont 1976). There is no doubt that some species are still to be discovered.

Some localities at the fringe of the Saharan desert have shown that odonatological diversity can be relatively high in places where the amount of precipitation is very low. The best sites have permanent waters, diversified aquatic habitats and are supplied with running waters. However, human pressure is generally strong and leads to considerable negative effects: eutrophication by washing activities (Fig. 6), overgrazing of vegetation belts, taking water for irrigation, etc. Conservation measures are urgently needed to preserve this Moroccan natural heritage.

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Figure 6: Massive development of algae caused by eutrophication because of washing activities. Oued Tata, 4 km SW of Tata, Morocco, 24-iv-2008. — Abbildung 6: Massive Entwicklung von Algenwatten nach Eutrophierung durch das Waschen von Wäsche. Oued Tata, 4 km SW Tata, Marokko, 24.04.2008. Photo: LJ.

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