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First update of the Atlas of the Odonata of the Mediterranean and North Africa: *Orthetrum machadoi* new to the Palaearctic and *Agriocnemis sania* new to the Egyptian Nile Valley

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Abstract

Twenty-four species of Odonata were found in the Egyptian Nile Valley and Western Desert in May 2009, which represents 71 % of the fauna confirmed for African Egypt. *Agriocnemis sania* Nielsen, 1959 was recorded in the lower valley and delta of the Nile. This suggests that a doubtful old record of a damaged *Agriocnemis exilis* Selys, 1872 from Port Said referred to *A. sania*, and that *A. exilis* should be removed from the checklist of Egyptian, North African and Mediterranean Odonata. *Agriocnemis sania* is new to African Egypt and should be downgraded from «Regionally Extinct» to «Endangered»on the IUCN North African Red List. *Orthetrum machadoi* Longfield, 1955 was discovered in the Siwa Oasis and is new for Egypt and the Palaearctic at large. The site is over 2600 km from the nearest known locality in Ethiopia, and, like the sympatric and sometimes syntopic *Acisoma panorpoides* Rambur, 1842, can be considered as a tropical relict from (a) pluvial period(s), more than 6,000 years ago, when the Sahara was considerably wetter. The overall proportion of observed Afrotropical species was 71 %, whereas the Palaearctic element was only 25 %.

Zusammenfassung

Erste Aktualisierung des «Atlas of the Odonata of the Mediterranean and North Africa»: *Orthetrum machadoi* neu für die Paläarktis und *Agriocnemis sania* neu für das ägyptische Niltal – Im Mai 2009 wurden im nördlichen Niltal und in der Westlichen Wüste 24 Libellenarten nachgewiesen, was 71 % der aus dem afrikanischen Teil Ägyptens eindeutig nachgewiesenen Arten entspricht. *Agriocnemis sania* Nielsen, 1959 wurde im Unteren Niltal und im Nildelta nachgewiesen. Damit sollte ein alter Nachweis eines beschädigten Exemplars von Port Said, das bisher als *Agriocnemis exilis* Selys, 1872 angesehen wurde, *A. sania* zugeordnet werden und *A. exilis* von den Check-Listen Ägyptens, Nordafrikas und

des Mittelmeergebietes gestrichen werden. *Agriocnemis sania* ist neu für die Fauna des afrikanischen Teils von Ägypten und sollte entsprechend in der Roten Liste der nordafrikanischen Libellen des IUCN unter «gefährdet» statt unter «regional ausgestorben» geführt werden. *Orthetrum machadoi* Longfield, 1955 wurde in der Oase Siwa entdeckt und ist damit sowohl neu für Ägypten als auch für die gesamte Paläarktis. Diese Stelle liegt mehr als 2600 km vom nächsten bekannten Fundort in Äthiopien entfernt. Zusammen mit der sympatrisch und manchmal syntop vorkommenden Libelle *Acisoma panorpoides* Rambur, 1842 kann *O. machadoi* als tropisches Relikt einer bzw. mehrerer niederschlagsreicher Perioden vor mehr als 6.000 Jahren angesehen werden, als die Sahara bedeutend feuchter war. Bei der Untersuchung betrug der Anteil der afrotropischen Arten 71 %, während die paläarktischen Elemente nur 25 % ausmachten.

Introduction

Egypt has been rather poorly investigated for Odonata and in this respect is hardly known better than nearby Libya. Major papers are those by Andres (1928), Kimmins (1950), Dumont (1974, 1978a, 1980), Dumont & Fossati (1990) and Geene (1994). This situation is surprising considering the touristic attractiveness of the country that results from its archaeological heritage. Following an IUCN workshop in Cairo dedicated to the evaluation of red lists of African Odonata in May 2009, we undertook a field trip south of Cairo with Jens Kipping and Frank Suhling, subsequently proceeding to the Nile Delta and, with Kevin Smith and Sarah Ferriss, to Siwa Oasis in the Western Desert. The latter lies 50 km east of the Libyan border and 255 km south of the Mediterranean coast (29°12'N 21°31'E) in a depression that is largely below sea level and was visited with the purpose of updating data obtained by Kimmins (1950). As a result of these efforts, the knowledge presented in the recent «Atlas of the Odonata of the Mediterranean and North Africa» (Boudot et al. 2009) must be updated for some species. Data from a workshop trip to the Fayum are also included in the present account, although no important discoveries were made.

Methods

Forty localities were visited from 5 to 14 May 2009. All collected insects are deposited in the Netherlands Centre for Biodiversity (formerly National Museum of Natural History) Naturalis, Leiden. Many species were photographed in the field by JPB and pictures were automatically georeferenced with the Geopic II camera geotagging system (<www.customidea.com>). The coordinates and altitude are stored in the Exif information section of the photos and cannot be changed, providing proof of species' occurrence at an exact locality. As a complement to voucher specimens, this is important for the validation of records of taxa outside their previously known range.

List of localities

The localities visited (Fig. 1) are listed below together with their geographic coordinates in decimal degrees in the international geodetic system WGS84, their altitude in metres and the date of the visit. Locality names agree primarily to the 1:250,000 US maps of Egypt, freely available at <http://www.lib.utexas.edu/maps/ams/north_africa/>. Names from the 1:800,000 Berlitz, from the 1:1,000,000 Marco Polo road maps or from local sign roads are indicated in brackets where relevant. For the El-Rayan area, locality names agree to the «Visitor Discovery Guide 2008» of the Wadi El-Rayan Protected Area available there. For the Western Desert area, locality names agree mostly to both the 2007 Geodia «Map of the Western Desert: oases of Egypt» and the «2009 Siwa Oasis» maps available there, as well as to local road signs. Otherwise the 1:250,000 US maps of Egypt are used. Minor places not indicated on maps (Loc. 7, 12 and 19) are named according to the «World Geographic Names» gazette (Fugawi version, Northport systems, inc.).

Loc. 1. Al Fayyūm (el-Faijûm) oasis between Shakshūk and ash Shawashinah (el Shawashna, aš-Šawāšna); grassy ditches near Lake Qarun. 29.4355556°N, 30.6469444°E; 39 m a.s.l.; 05-v-2009.

Loc. 2. Wadi El-Rayan; waterfall and surroundings. 29.2145334°N, 30.4221605°E; 29 m a.s.l.; 05-v-2009.

Loc. 3. Wadi El-Rayan; swamp between the two lakes. 29.2252731°N, 30.4433224°E; 15 m a.s.l.; 05-v-2009.

Loc. 4. Nile river east bank and marshes near al Ma'şarah between al Ma'adi and Hilwān (Helwan, Heluân) (facing el Hawâmidîya). 29.8935392°N, 31.2862461°E; 10 m a.s.l.; 08-v-2009.

Loc. 5. Nile river east bank near Hilwān (Helwan, Heluân), facing al Baarshayn (el-Badrashain, al-Badrašayn). 29.8580556°N, 31.2933333°E; 11 m a.s.l.; 08-v-2009.

Loc. 6. Nile river east bank just south of the ferry landing at aş Şaff (el Saff). 29.5719444°N, 31.2736111°E; 11 m a.s.l.; 08-v-2009.

Loc. 7. Puddle at Sidi el Arbain, 19 km NW of Port Said (Bûr Sa'îd). 31.3311311°N, 32.114631°E; 2 m a.s.l.; 09-v-2009.

Loc. 8. Brackish canal in Lake Manzala area, 13 km ESE of Damietta (Dumiat, Dumyāt). 31.3875211°N, 31.9429423°E; 1 m a.s.l. . 09-v-2009.

Loc. 9. Ditch east of Damietta (Dumiat, Dumyāt). 31.4175222°N, 31.8336131°E. 1 m a.s.l. . 09-v-2009.

Loc. 10. Brackish swamps 7 km NNE Damietta (Dumiat, Dumyāt). 31.475°N, 31.8438889°E; 4 m a.s.l. . 09-v-2009.

Loc. 11. Pools and basins in dunes near Ashtûm Gamasa (Ezbet Gamasah el-Gharbîya, 'Izbat Qamāsa al-Ġarbīya, 22.5 km west of Damietta (Dumiat, Dumyāt). 31.4372222°N, 31.5697222°E;3 m a.s.l. . 09-v-2009.

Loc. 12. Brackish swamps and pools NW el Qara Coast Guard outpost, 39 km west of Damietta (Dumiat, Dumyāt). 31.4880556°N, 31.4030556°E; 1 m a.s.l. . 09-v-2009.

Loc. 13. Nile river bank between Jiddīya (al Jiddīya) and al Hammād, 6.5 km SSE of Rashîd (Rosetta, Rašîd). 31.3503632°N, 30.4522312°E; 1 m a.s.l.; 10-v-2009.

Loc. 14. Canal in orchards 9 km SSE of Rashîd (Rosetta, Rašîd. 31.3311111°N, 30.4711111°E; 7 m a.s.l.; 10-v-2009.

Loc. 15. Northern reedy and grassy edge of Lake Idku (Buhairat Idkū), 11 km WSW of Idku. 31.2652778°N, 30.1952778°E; 0 m a.s.l.; 10-v-2009.

Loc. 16. Fishponds on edge of Lake Idku (Buhairat Idkū) at Jazîrat Hasan (Kafr Hassam), 4 km S of Idku. 31.2670611°N, 30.3133632°E; 6 m a.s.l.; 10-v-2009.

Loc. 17. Pool at petrol station at Ras el Kanâyis (Ras el Hekma) junction, between Matrûh (Marsā Matrūh) and el Alamein (al-'Alamain). 31.1105556°N, 27.8263889°E; 101 m a.s.l.; 11-v-2009, 16-v-2009.

Loc. 18. Basin and ditch in Siwa oasis, 2.8 km SE of Siwa centre on the way to Cleopatra's Bath. 29.1952778°N, 25.5483333°E; 21 m a.s.l.; 12-v-2009.

Loc. 19. Ditch and path in Siwa oasis on the way to Almaza hot spring. 29.1938889°N, 25.5636111°E; 10 m a.s.l.; 12-v-2009.

Loc. 20. Concrete basin in Siwa oasis on the way to Almaza hot spring. 29.1938889°N, 25.5644444°E; 10 m a.s.l.; 12-v-2009.

Loc. 21. Ditches near Almaza hot spring on southern edge of Birket Azmoun salt lake, 4.5 km east of Siwa centre. 29.1916667°N, 25.5669444°E; 10 m a.s.l.; 12-v-2009.

Loc. 22. Brackish swamps and ditches surrounding Birket Azmoun near Almaza hot spring, 4.8 km east of Siwa centre. 29.1922222°N, 25.5694444°E; 11 m a.s.l.; 12-v-2009.

Loc. 23. Basin 3 km SE of Siwa centre, at town output at foot of Gebel Takrur (Geber Dakrur). 29.1908333°N, 25.5461111°E; 0 m a.s.l.; 12-v-2009.

Loc. 24. Between Siwa city and Birket Azmoun. 29.19076°N, 25.549605°E. 0 m a.s.l.; 12-v-2009.

Loc. 25. Shore of Birket Azmoun and ditches, 7 km SE of Siwa centre. 29.1825°N, 25.5894444°E; 11 m a.s.l.; 12-v-2009.

Loc. 26. Dunes at the southern edge of Birket Azmoun near the tomb of Sidi 'Ali Abu Hilâl Marabout, 10 km ESE of Siwa centre. 29.1624034°N, 25.6144247°E; 5 m a.s.l.; 12-v-2009.

Loc. 27. Ain Abu Shuruf spring, 21 km east of Siwa; concrete basin and ditch. 29.1844444°N, 25.7413889°E; 11 m a.s.l.; 12-v-2009.

Loc. 28. Zeitûn (Zaytun) abandoned village 26 km ESE of Siwa centre. 29.152389°N, 25.78898°E; 11 m a.s.l.; 12-v-2009.

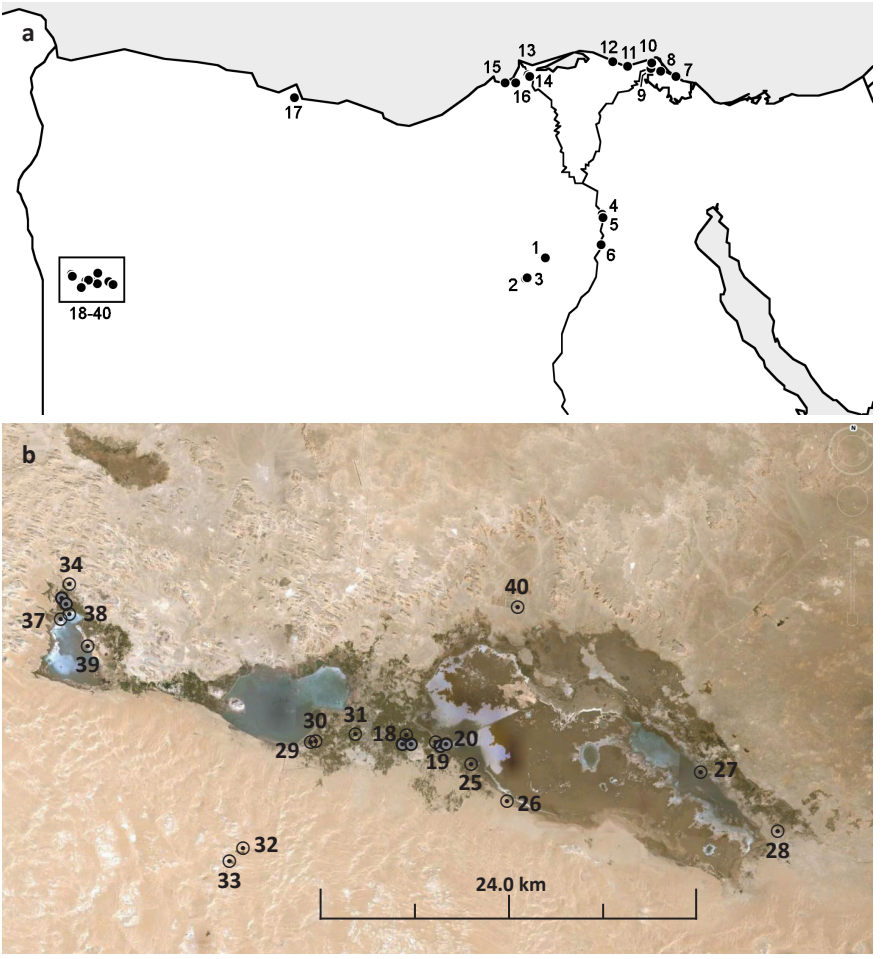

Figure 1: (a) Localities visited in northern Egypt during this study; (b) details of localities 18-40. – Abbildung 1: Lokalitäten im nördlichen Ägypten, die im Rahmen dieser Arbeit besucht wurden; (b) Detailübersicht der Lokalitäten 18-40. (picture © DigitalGlobe and Google™ Earth service)

Loc. 29. Ditches and shore of Birket Siwa salt lake, 3.9 km WSW of Siwa centre. 29.1927778°N, 25.4838889°E; 11 m a.s.l.; 13-v-2009.

Loc. 30. Pond largely grown with reeds 4 km WSW of Siwa centre. 29.1933333°N, 25.4858333°E; 10 m a.s.l.; 13-v-2009.

Loc. 31. Spring and swampy pond on SW edge of Siwa city. 29.199905°N, 25.512499°E; 10 m a.s.l.; 13-v-2009.

Loc. 32. Bir Wahed cold lake, 11.6 km SW of Siwa centre; lake with reeds in sand dune desert. 29.1277778°N, 25.4402778°E. 14 m a.s.l.; 13-v-2009.

Loc. 33. Bir Wahed hot spring. Hot sulphurous spring (concrete basin) and abandoned oasis 12.7 km SW of Siwa centre. 29.1219444°N, 25.4322222°E. 50 m a.s.l.; 13-v-2009.

Loc. 34. Ditches near the water tower of Bahaj el Din, 21 km WNW of Siwa centre. 29.2761111°N, 25.3177778°E; 9 m a.s.l.; 14-v-2009.

Loc. 35. Concrete basin in Bahaj el Din oasis, 21 km WNW of Siwa centre. 29.2683333°N, 25.3147222°E; 10 m a.s.l.; 14-v-2009.

Loc. 36. Ain Abd el Gabbâr, ditches and orchards at Bahaj el Din, 21 km WNW of Siwa centre. 29.2653013°N, 25.3178011°E; 11 m a.s.l.; 14-v-2009.

Loc. 37. Brackish and salted swamps beyond the dyke on NW shore of the Birket Maraqi salt lake, 21 km WNW of Siwa centre. 29.2580556°N, 25.3144444°E; 12 m a.s.l.; 14-v-2009.

Loc. 38. Surroundings of the dyke on northern shore of the Birket Maraqi, 21 km WNW of Siwa centre. 29.26°N, 25.32°E; 12 m a.s.l.; 14-v-2009.

Loc. 39. Eastern shore of Birket Maraqi and brackish ditch above and at mouth, 19 km WNW of Siwa centre. 29.2405556°N, 25.3330556°E; 12 m a.s.l.; 14-v-2009.

Loc. 40. Pond with reeds in military area along the road from Siwa to Bahariya (al-Bahriya) on the northern side of the Birket Azmoun, 12 km NE of Siwa centre. 29.2744444°N, 25.6172222°E; 0.5 m a.s.l.; 14-v-2009.

Annotated list of recorded species

Twenty-four species pertaining to four families were recorded and are listed below together with the corresponding localities and relevant comments.

Agriocnemis sania Nielsen, 1959

Loc. 4 (1m 1f), 15 (6m 3f).

Agriocnemis sania (Fig. 2) was found both along the Nile south of Cairo and in the Nile Delta on the edge of Lake Idku, a marshy lake surrounded by reeds and tall

herbage. The species was found within tall floating grasses, a habitat still common in parts of the delta and typical for the species (Dumont 1974). However, it is lost by the development of fish farms just south of this area (Fig. 3). The range of this species extends from Kenya and Ethiopia (Pinhey 1974; Odonata Database of Africa, see Kipping et al. 2009) to the Jordan Valley (Dumont 1974) and southwestern Libya (Ghat oasis; Nielsen 1959) (Fig. 4). It was abundant in the Jordan Valley at the beginning of the 1970s (Dumont 1974) but is now much reduced or extinct due to the conversion of swamps into fish farms (last record 1972; Katbeh-Bader et al. 2004). In Libya, it was probably extirpated by *Gambusia* fish introduced to control *Anopheles* mosquitoes (Dumont 1991). The status of *A. sania* in Ethiopia and Kenya is poorly known; the last record is from 2005 (H.-J. Clausnitzer leg.). Until now, the last record of *A. sania* in the Mediterranean was of a single copula at Wadi Gharandal in the Sinai (Geene 1994).

Agriocnemis sania is new to African Egypt and its regional status should be downgraded from Regionally Extinct to Endangered on the North African Red List [criteria B2ab(i)(ii)(iii)(iv)(v), IUCN 2003]. Its presence supports the view that the record of *A. exilis* Selys, 1872 from Port Said in the northeastern Nile Delta by Martin (1915), based on a male without the last abdominal segments, refers to the similar *A. sania*, which was not described at the time. Therefore *A. exilis* should be removed from the checklist of the Egyptian, North African and Mediterranean Odonata.

The treatment of *A. sania* as distinct from *A. pygmaea* (Rambur, 1842) follows Dumont (1974), who only compared specimens of the latter from Thailand. Simultaneously, however, Pinhey (1974) suggested that *A. pygmaea* was a 'superspecies', i.e. a complex of similar taxa, and *sania* at most a subspecies that, moreover, differed morphologically in the Sinai and eastern Africa. Because this complex is widespread between the locations of Dumont's 'typical' *A. sania* and *A. pygmaea* (Fig. 4), a taxonomic reassessment of the variability of African and Asian members of this group is needed. For example, a male collected in Dhofar, Oman, agreed in most features with Egyptian material (KDBD in Reimer 2009). *Agriocnemis pygmaea* is a well-dispersing (wind-borne?) and polymorphic species (van Tol 1990) and *A. sania* may well be synonymous with it.

Ischnura evansi Morton, 1919

Loc. 18 (common), 20 (common), 21 (common), 23 (common), 24 (mf), 25 (1m), 29 (uncommon), 30 (rare), 34 (rather common), 35 (mf), 36 (common), 37 (mf) (common); copula, 38 (2m 3f), 39 (mf).

Ischnura evansi is a salt-tolerant species that is common in the Siwa depression, where brackish water is frequent. It was already recorded by Kimmins (1950). Homochromatic females (colour similar to males) were more numerous than heterochromes, which are brown and black and always have a black humeral stripe (see Schneider 1986). The species is not known further west, but it may occur in oases like Giarabub (al Jaghbūb) in northeastern Libya. From northwestern Egypt it extends to western Iran through the Levant and the Arabian Peninsula, but no

Figure 2: *Agriocnemis sania*, male, Lake Idku (Buhairat Idkū), Egypt (10-v-2009). – Abbildung 2: *Agriocnemis sania*, Männchen, Idku-See (Buhairat Idkū), Ägypten (10.05.2009). Photo: JPB

Figure 3: Fish farms south of Lake Idku (Buhairat Idkū), Egypt, showing the destruction of potentially favourable areas for *Agriocnemis sania* (10-v-2009). – Abbildung 3: Fischzuchten südlich des Idku-Sees (Buhairat Idkū), Ägypten, ein Beispiel für die Zerstörung potentieller Habitate von *Agriocnemis sania* (10.05.2009). Photo: JPB

records are known from the Nile Valley. However, as the species shows migratory tendencies (Waterston & Pittaway 1991), it may occasionally occur there.

Ischnura fountaineae Morton, 1905

Loc. 18 (2f), 25 (1m), 31 (uncommon), 39 (mf), 40 (common).
Like *I. evansi*, *I. fountaineae* is salt-tolerant, but in Siwa it is much less common and is dominant only at the most saline waters. Females are always heterochromatic – orange, brown or dirty green, depending on age, and black – and lack a black humeral stripe. Like the previous species, *I. fountaineae* was recorded for

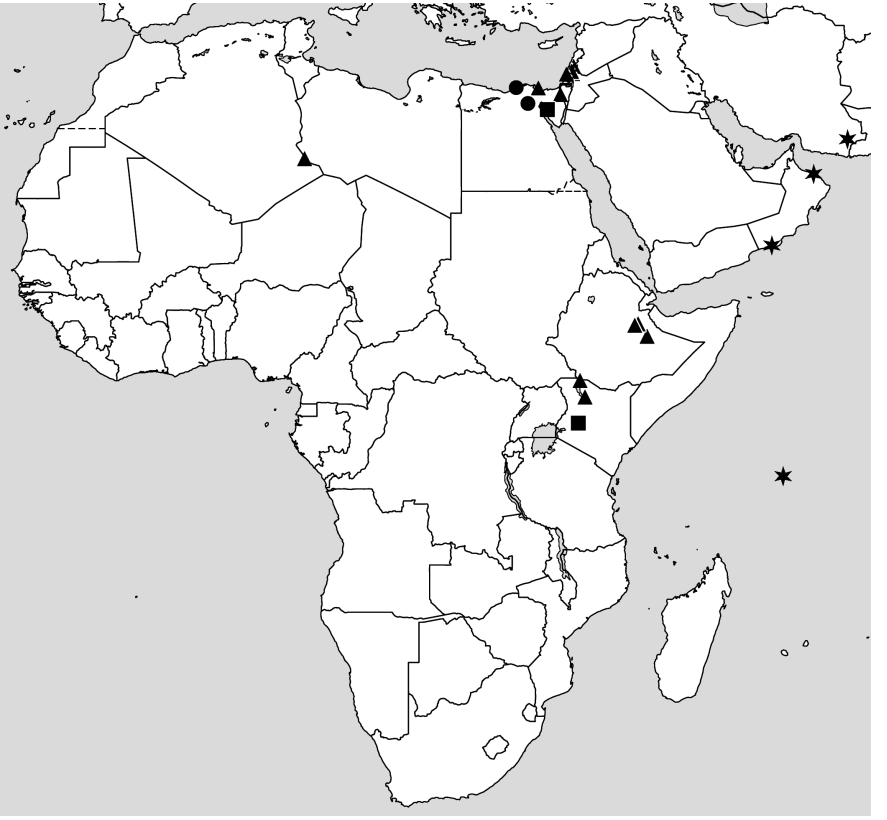

Figure 4: Distribution of *Agriocnemis sania*. – Abbildung 4: Verbreitung von *Agriocnemis sania*. ▲ data < 1980, partly extinct (Libya and Near East), Nachweise vor 1980, Vorkommen z.T. erloschen (Libyen und Naher Osten); ■ records from 1990 (Sinai) and 2005 (Kenya), Nachweise von 1990 (Sinai) und 2005 (Kenia); ● new data 2009, neue Nachweise 2009; ✶ nearest records assigned to *Agriocnemis pygmaea*, nächste Nachweise, die *Agriocnemis pygmaea* zugerechnet werden.

the first time from Egypt by Kimmins (1950) and is absent in the rest of the country except the Sinai. The species is scattered from western Morocco to Central Asia north of the 24th parallel.

***Ischnura senegalensis* (Rambur, 1842)**
Loc. 1 (3m), 3 (common) 4 (common), 5, 7, 8, 9, 10 (mf), 11 (common), 12 (1m), 14, 15 (common), 16 (very common), 17 (2mf).
Ischnura senegalensis is the most widespread *Ischnura* in Egypt, being recorded throughout the Nile Valley and Delta, as well as in the Western Desert (Dahkla oasis), the Sinai and on the Red Sea coast. The westernmost locality is now near Ras el Kanâyis, 265 km east of the Libyan border on the Mediterranean coast. Further west, the records of *I. genei* by Ris (1911) from Dernah, 261 km west of the Egyptian border, most likely refer to *I. saharensis*, but their verification is required.

***Pseudagrion nubicum* Selys, 1876**
Loc. 4 (m), 5 (mf), 6 (mf), 14 (m).

***Pseudagrion torridum* Selys, 1876**
Loc. 4 (1m), 5 (m), 6 (5m 1f), 14 (uncommon)

***Mesocnemis robusta* (Selys, 1886)**
Loc. 5 (mf), 6 (1m).

***Anax ephippiger* (Burmeister, 1839)**
Loc. 6 (1m), 35 (1f ovipositing).

***Anax imperator* Leach, 1815**
Loc. 10 (1m).

***Anax parthenope* Selys, 1839**
Loc. 2 (2m), 6 (1m), 21 (1m), 30 (1f), 33 (1f).

***Acisoma panorpoides* Rambur, 1842**
Loc. 20 (1f), 22 (1m 1f), 29 (1m, 1f emergence), 30 (>100 mf, tandems), 31, 34 (1m), 40 (1m).
In North Africa, this widespread Palaeotropical species has a string of isolated populations from northeastern Algeria to the oases of the Western Desert in Egypt. The most recent records from Egypt are from the oasis of Dakhla, between December 1977 and January 1988 (Geene 1994). The present records show that the species still flourishes in parts of the Siwa depression. African populations are often referred to as the subspecies *A. p. ascalaphoides* Rambur, 1842 and differ from Asian nominotypic populations by the more frequently incomplete distal antenodal cross-vein in the forewing and more extensive black markings (Ris

1911). Although these differences seem consistent (KDBD, unpubl.), the name *ascalaphoides* refers to a distinct Madagascan taxon (K. Schütte, pers. comm.). Siwan populations are 'African' in character, but we refrain from naming them at the subspecies level until *Acisoma* taxonomy is resolved.

***Brachythemis impartita* (Karsch, 1890)**
Loc. 1 (m), 2 (common), 4 (2m), 5, 6, 7, 8, 11 (common), 12 (1m), 13 (common), 14, 15 (5m), 16 (common).
The northern populations of *B. leucosticta* auct. are considered a distinct species, *B. impartita* (Dijkstra & Matushkina 2009). The true *B. leucosticta* (Burmeister, 1839) reaches north to the Sahel and might occur in Egypt. However, all checked Egyptian specimens pertain to *B. impartita*. Strangely, while the species is common in the Nile Valley and Delta, it remains unknown from the Western Desert oases as well as most of the rest of the Central Sahara, suggesting a limited ability to survive arid periods and/or to reach remote water bodies. However, in eastern Morocco it has spread southwards into the northern Sahara in the 1990s, taking advantage of the construction of lakes (JPB, unpubl. obs., 2009).

***Crocothemis erythraea* (Brullé, 1832)**
Loc. 1 (2m), 2 (mf), 4, 6, 9, 10 (mf), 11, 14, 15 (common), 16 (common), 17 (1f), 18 (common), 20, 21 (common), 23 (common), 25 (1m), 27 (1m), 30 (common), 31, 34, 35 (mf), 36 (mf), 37 (common), 39, 40 (1m), 17 (1f).

***Diplacodes lefebvrii* (Rambur, 1842)**
Loc. 4 (1f teneral), 5, 8 (1f teneral), 16 (1m), 18 (common), 20 (common), 21 (common), 22 (1m), 23, 24 (1m), 30 (common), 31, 32 (rather common), 33 (uncommon), 34, 36, 38 (1f), 39, 40 (common).

***Nesciothemis farinosa* (Förster, 1898)**
Loc. 1 (1m fully coloured), 14 (4m immatures).
Our records are from the Nile Delta and al Fayyūm, two areas in which it was already known. No records from the remote oases in the Sahara are known.

***Orthetrum coerulescens anceps* (Schneider, 1845)**
Loc. 18 (2m), 20, 21 (2m), 24 (1m), 35 (1m), 36 (4m), 38 (3m).
This taxon has relict southern populations in Siwa and scarce additional oases in the Western Desert, being absent in the rest of Egypt except the Sinai.

***Orthetrum machadoi* Longfield, 1955**
Loc. 21 (3m adults), 30 (2m immatures, 1m adult).
Orthetrum machadoi (Fig. 5) was the most significant find of the trip, as the species is new for Egypt and the entire Palaearctic. It occurred at ponds and slow-flowing channels with reeds (Fig. 6). The species is widespread in eastern and southern

Figure 5a and 5b: *Orthetrum machadoi*, male, Siwa Oasis, Egypt (12-v-2009). – Abbildung 5a und 5b: *Orthetrum machadoi*, Männchen, Oase Siwa, Ägypten (12.05.2009). Photos: JPB

Figure 6a and 6b: Habitat of *Orthetrum machadoi* in the Siwa Oasis, Egypt (12-13-v-2009). – Abbildung 6a und 6b: Habitat von *Orthetrum machadoi* in der Oase Siwa, Ägypten (12./13.05.2009). Photos: JPB

Africa (Fig. 7). Records from western Africa are considered misidentifications of similar species like *O. hintzi* and *O. guineense*. The nearest locality known is in Ethiopia, 2667 km to the south (Clausnitzer & Dijkstra 2005). Males can easily be identified by their rather small size, slender abdomen, large yellow pterostigmas and details of markings and hamule.

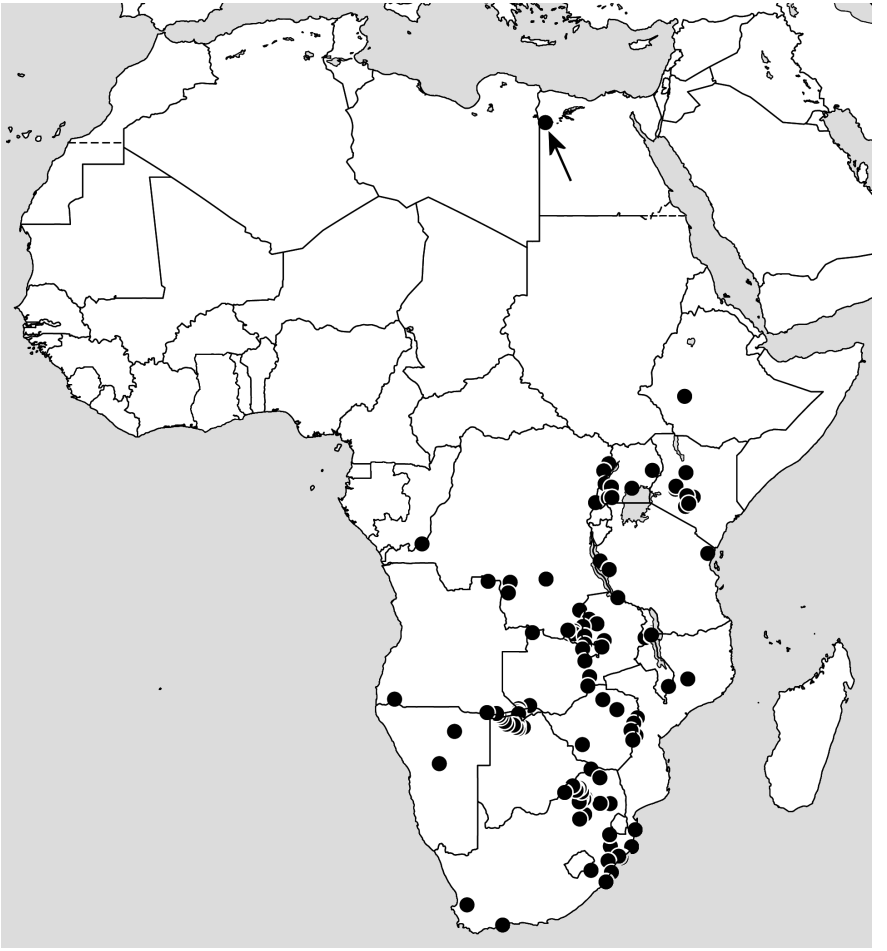

Figure 7: Distribution of *Orthetrum machadoi.* The arrow indicates Siwa Oasis in Egypt. – Abbildung 7: Verbreitungsgebiet von *Orthetrum machadoi.* Der Pfeil zeigt die Oase Siwa in Ägypten.

***Orthetrum sabina* (Drury, 1770)**
Loc. 1 (1 adult), 2 (2 adults), 11 (1 adult), 12 (1 adult), 18 (1 adult), 22 (2 adults), 32 (1 adult), 34 (3 adults), 37, 39 (1 adult), 40 (1 adult).

***Orthetrum trinacria* (Selys, 1841)**
Loc. 1 (1m), 2 (common), 8 (1m), 10 (1m), 11 (1f), 12 (1m), 14 (1m), 15 (1m), 23 (mf), 30 (2m), 31, 35 (2m), 36 (1m).
New to Siwa. This widespread Afrotropical *Orthetrum* is another salt-tolerant species that often occurs close to the sea, as well as in Saharan oases from south-eastern Morocco (Figuig area, JPB, unpubl. obs. 2009) to southern Algeria, Libya and Egypt, both in brackish and soft waters.

***Pantala flavescens* (Fabricius, 1798)**
Loc. 19 (3 yellow adults hovering and hunting), 20 (1 red male patrolling over a concrete basin).
New to Siwa. This is a well known migrant, which can be present in swarms in Lower Egypt from May to January (J. Burrell, pers. comm.).

***Selysiothemis nigra* (Vander Linden, 1825)**
Loc. 18 (emergence), 21 (1m), 23 (2m), 25 (2m), 27 (2m), 28 (1m), 31, 32 (rather common), 33, 35 (common), 36 (common), 40.
Tenerals were recently photographed at Kattamaya in the Nile Valley near Cairo and very mature males at Ain Sukhna on the Gulf of Suez (J. Burrell, pers. comm.).

***Sympetrum fonscolombii* (Selys, 1840)**
Loc. 11 (1m teneral).
Remarkably scarce during our trip, possibly because we were in a gap between two generations.

***Sympetrum sinaiticum* Dumont, 1977**
Loc. 18 (1m immature), 26 (1m immature), 34 (1f teneral), 36 (1m immature), 37 (mass emergence), 38 (3f immature), 39 (immature).
This species is new for the African part of Egypt. Until now it was known only from «Suez», without more precision and thus possibly from the Asian side of the canal, and from the Sinai to the Dead Sea. It also occurs from the northwest of Libya to the Ahaggar Mountains, Morocco and Mediterranean Spain. The present records thus close a 1,200 km gap between the previously known eastern and western populations, although it is likely that this gap is due to a lack of spring and autumn surveys in Libya and Egypt, where the species is probably more widespread.

***Trithemis annulata* (Palisot de Beauvois, 1807)**
Loc. 4 (uncommon), 5 (1f), 6 (uncommon), 14 (1m), 19 (common), 20 (mf), 21 (common), 30 (mf), 31 (2m), 34 (common), 35 (common), 36 (common), 39 (1m).
This widespread Afrotropical species is new for the Siwa Oasis, where it is common.

Discussion

Twenty-four species were recorded, which represents 71 % of the 34 species confirmed for the African part of Egypt and 61 % of the 39 species recorded for the whole Egypt (see Boudot et al. 2009). Of the identified species, 58 % are Afrotropical, Paleotropical or circumtropical with adjacent populations in tropical Africa: *Ischnura senegalensis*, *P. nubicum*, *P. torridum*, *M. robusta*, *A. ephippiger*, *A. panorpoides*, *B. impartita*, *D. lefebvrii*, *N. farinosa*, *O. machadoi*, *O. trinacria*, *T. annulata* and *P. flavescens*, as well as *A. sania* that we include here on account of its close but unresolved affinity to *A. pygmaea*. The Palaearctic component (25 %) is much smaller: *A. parthenope*, *O. c. anceps*, *S. sinaiticum*, *I. evansi*, *I. fountaineae* and *S. nigra*, the last three being typical Irano-Turanian or Mesasiatic species adapted to temporary and brackish waters. Only *O. sabina* is Indomalayan (4 %). *Anax imperator*, *C. erythraea* and *S. fonscolombii* are widespread in both the Afrotropics and the Palaearctic, but are probably of Afrotropical origin, bringing the tropical element to 71 %. Remarkably, *A. imperator*, *Trithemis arteriosa* and *Orthetrum chrysostigma* have not been found in Siwa, both now and in the past. These are conspicuous species that are typically widespread and common throughout the Sahara in similarly remote habitats. Their apparent absence could be an island effect, i.e. the stochastic outcome of random events leading to extinction or colonisation in a highly isolated locality.

The distribution and composition of the Egyptian odonate fauna is determined by the Nile, as well as by past climatic conditions. For *I. senegalensis*, *P. nubicum*, *P. torridum*, *M. robusta*, *B. impartita*, *N. farinosa* and possibly *A. sania*, the Nile Valley appears to have served as a corridor from tropical Africa to the Mediterranean shore. These species, however, are absent in the oases, implying either recent dispersal along the Nile or extinction in the Western Desert, e.g. with the disappearance of rivers or larger swamps. The northern and eastern species *I. evansi*, *I. fountaineae*, *O. c. anceps*, *O. sabina*, *S. nigra* and *S. sinaiticum* may have taken advantage of past pluvial periods to spread across North Africa, sometimes up to the Atlantic coast. However, with the possible exception of *O. c. anceps*, all are mobile and/or adapted to temporary and brackish water, allowing recent dispersal as well. Two tropical African species recorded in Siwa, *A. panorpoides* and *O. machadoi*, only have isolated populations in North Africa. Such fragmentation is usually ascribed to palaeoclimatic oscillations, with northward expansion during the Early Holocene pluvial period (8,000-10,000 yr BP). Due to the persistence of ice in northern Europe, the Mediterranean was an area of low barometric pressure, influencing weather patterns and giving the Saharan belt around 400-500 mm of annual rainfall. Thus the Sahara and Sahel were wetter, with rivers originating from the Central Saharan mountains flowing north and south through savannah and grassland. Although available vegetation reconstructions (Anhuf et al. 2000) imply that the central Egyptian Western Desert remained rather arid, the river network extending from the Ahaggar to the Tibesti provided expansion routes for Afrotropical species to the Mediterranean. Subsequent range fragmentation

occurred during arid periods in the second half of the Holocene (Dumont 1978b, 1982). *Pseudagrion sublacteum*, *P. hamoni*, *Crocothemis sanguinolenta*, *Orthetrum abbotti*, *Rhyothemis semihyalina* and *Urothemis edwardsii* in North Africa and the Near East are other typical examples of Afrotropical species with relict populations well north of their present continuous ranges (e.g. Dumont 1975, 1977, 1982; Samraoui et al. 1993).

The presence of a relict odonate fauna emphasizes the importance of the Siwa Oasis as a 'natural archive' of palaeobiology and palaeoclimatology. It lies in a depression with numerous springs feeding a complex of lakes, ponds and swamps. The salt content of the upper aquifers ranges from 1.6 to 8 ‰, but deeper drilling provides less salty water for agriculture (0.2-0.4 ‰). Due to high daily evaporation (5-17 mm, depending on season) and low annual rainfall (average 8 mm, maximum 28 mm), most lakes and swamps are brackish, with salt concentrations reaching saturation in some areas. Due to the recent prolific digging of springs, much extracted water is not used for agriculture, making lake levels rise and flooding nearby fields and plantations. To preserve agricultural land, the authorities are now plugging superfluous springs. The described history and developments show that conditions for Odonata have varied constantly and will continue to change, necessitating their continued monitoring. Our results show that this area retains a uniquely diverse assemblage of relicts that has survived 6,000 years of aridity in tiny pockets of habitat. This uniqueness is exemplified by the genus *Orthetrum*: nowhere else in the world the Palaearctic *O c. anceps*, the Indomalayan *O. sabina*, and the Afrotropical *O. machadoi* can be found together, while *O. chrysostigma*, the species one most expects, is absent. *Orthetrum machadoi* is not known elsewhere in the Palaearctic, while *O. c. anceps* is at the southern limit of its range. Similarly, the Mesasiatic *I. evansi*, which 'skips' the Nile Valley and only reappears 600 km further east, has its westernmost outpost here. Also, *A. panorpoides* is common here, but survives in only a few additional isolated localities in northeastern Algeria and in Dakhla Oasis, also in the Egyptian Western Desert. The fate of relict populations in Libya (1906-1936) and Egypt (Bahariya and Kharga oases; <1928) is unknown. To retain these species as testimony of past climatic oscillations, the traditional channels and ponds that they inhabit must be preserved.

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