

New data on the distribution of *Orthetrum trinacria* in the Algarve, southern Portugal (Odonata: Libellulidae)

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Abstract

Data on the occurrence of *Orthetrum trinacria* in the Algarve were published for the first time in 2002, and since then the species was considered uncommon and showing a limited distribution in the region. Between March and October 2011 I carried out a systematic survey, gathered unpublished records from different sources dating from 2007 to 2011, and concluded that the species is nowadays widespread in the Algarve, living in many permanent lentic systems. A large number of artificial ponds recently built and scattered throughout the region, plus the dispersion capacity of the species, as well as global warming, are potential causes to explain this apparent colonization, but additionally an increase in field research should not be underestimated.

Zusammenfassung

Neue Daten zur Verbreitung von *Orthetrum trinacria* in der Algarve, Südpotugal (Odonata: Libellulidae) – Daten zur Verbreitung von *O. trinacria* im südportugiesischen Distrikt Algarve wurden erstmals 2002 publiziert. Bislang galt die Art mit einer begrenzten Verbreitung in der Region als nicht häufig. Zwischen März und Oktober 2011 führte ich systematische Erhebungen durch, die durch bislang unpublizierte Beobachtungen aus unterschiedlichen Quellen zwischen 2007 und 2011 ergänzt wurden. Diese Ergebnisse lassen den Schluss zu, dass *O. trinacria* in der Algarve aktuell weit verbreitet ist und viele permanent wasserführende Stillgewässer besiedelt. Das Vorhandensein zahlreicher Teiche, die erst vor kurzer Zeit angelegt wurden und über die gesamte Region verstreut zu finden sind, das Dispersionsvermögen der Art sowie die Klimaerwärmung sind mögliche Gründe für diese Besiedlungen. Der Zusammenhang zwischen der Erfassungsdichte und der Fundorthäufigkeit der Art darf jedoch auch nicht unterschätzt werden.

Resumo

Novos elementos sobre a ocorrência de *Orthetrum trinacria* no Algarve, sul de Portugal (Odonata: Libellulidae) – A ocorrência de *O. trinacria* está assinalada para o Algarve desde 2002 e, desde então, a espécie foi classificada como incomum e com distribuição limitada na região. Entre Março e Outubro de 2011 conduzimos um estudo sistemático e compilamos observações não publicadas de diferentes fontes, datadas de 2007 a 2011, e concluímos que a espécie tem hoje uma ampla distribuição no Algarve, ocorrendo em muitos sistemas lênticos permanentes. A construção recente de numerosos charcos dispersos na região, associada à elevada capacidade de dispersão da espécie e, eventualmente, ao aquecimento global constituem potenciais causas para explicar esta aparente colonização, mas a repercussão do aumento do esforço de monitorização não poderá ser menosprezado.

Introduction

Orthetrum trinacria (Selys, 1841) is an Afrotropical species, nowadays widespread in Africa, southern Europe and the Middle East (CLAUSNITZER 2006). In the Mediterranean Basin, the species was recorded in all North African countries, from Morocco to Egypt as well as in Israel, Syria, Turkey and Greece, in the Italian islands of Pantelleria, Sardinia and Sicily, in Spain and in Portugal (JACQUEMIN 1987; JACQUEMIN & BOUDOT 1999; CLAUSNITZER 2006; BOUDOT et al. 2009; KALKMAN et al. 2012).

The European Red List of Dragonflies (KALKMAN et al. 2010) regarded it as a «Least concern» species. FERREIRA et al. (2006) included *O. trinacria* in the Portuguese checklist of Odonata and attributed the first national record, from the Alentejo region in June 1991, to JAHN (1996). FIGUEIREDO & GOUVEIA (2001) added two other localities in Alentejo. On a 10x10 km grid map, MALKMUS (2002) revealed the first record for the Algarve region. DE KNIJF & DEMOLDER (2010) reported two new observations dated from July 2008, provided new data for Alentejo, and included *O. trinacria* in their list of 'rare' species. In the first week of June 2002, GESCHKE (2002) observed four individuals emerging at a small pond near Santa Clara-a-Velha, Alentejo, not far from the northern border of the Algarve. However, overall there are no more than a dozen sightings in almost two decades.

With respect to southern Spain the first known record was from HARTUNG (1985), who reported an observation in Huelva province, September 1980. Later, several sightings in other provinces began to be published, such as in Badajoz, July 1981 (P. Jahn in HARTUNG 1985), in Huelva, June 1983 (BELLE 1984), in Almería, June to October 1984 (CONESA-GARCÍA 1985), and in Cáceres, July to August 1986 and June to September 1987 (BENITEZ-DONOSO & GARCÍA-PARRÓN 1989). GARCÍA-PARRÓN & BENITEZ-DONOSO (1988) observed oviposition and teneral, and found more than thirty exuviae, which confirmed the *O. trinacria* life-cycle completion in Cáceres, Spain. BELLE (1984) had already reported a teneral.

SANCHÉZ et al. (2009) compiled Odonata data concerning Extremadura. As for *O. trinacria* they indicate a widespread distribution arising from a recent colonization. CANO-VILLEGAS (2011), in a review on the Odonata fauna of Córdoba province (Andalucía), highlighted that *O. trinacria* was the last Afrotropical species arriving and colonizing the southern half of the Iberian Peninsula, before the new but still scattered occurrence of *Trithemis kirbyi*.

DUMONT (1982) and JACQUEMIN (1987) emphasized that *O. trinacria*, as well as *Diplacodes lefebvrii*, are typical Afrotropical species, which reached the north of Africa during a former pluvial spell and settled in southern Europe. OTT (2010) included *Trithemis annulata* in the list of species that have been conquering new domains in the European continent. FERREIRA et al. (2006) emphasized that libellulids are excellent fliers which are able to migrate from northern Africa to southern Europe and may have a strong dispersion capacity. Migrations have been reported for *O. trinacria* itself (FRASER 1956). HEISER & SCHMITT (2010) concluded that the Strait of Gibraltar is not a major dispersal barrier for Anisoptera, and several species are distributed on both northern and southern sides of the Mediterranean Basin.

In this article I consolidate the available records regarding the occurrence of *O. trinacria* in the Algarve, in order to update its status in the southernmost area of mainland Portugal.

Materials and methods

The Algarve region (Fig. 1), ranging from 37°00'N to 37°30'N, with near 5,000 km², has a dry-summer subtropical or Mediterranean climate (Csa type, Köppen-Geiger classification, and Csb type in the western border, where the Atlantic Ocean influence is higher; AEMET & IM 2011). Besides the large Guadiana river, perennial lotic systems are not numerous, and seasonal or ephemeral rivers that have running water in winter and in spring then become lentic or fully dry from summer to autumn dominate the Algarve's hydrological network. Artificial, small and medium sized ponds, created to supply water for agriculture, livestock and fighting forest fires, have been becoming countless since the 1990s.

Before beginning the field work, carried out in the Algarve between March and October 2011, I established four major categories for Odonata reproduction habitats: Habitat Type I – Permanent lotic systems; Type II – Seasonal and ephemeral lotic systems. Type III – Lentic systems. Type IV – Brackish waters. Lentic systems were subdivided in small (< 8 ha) permanent systems (Type III.i), small temporary systems (Type III.ii) and large permanent (≥ 8 ha) systems (Type III.iii). Hunting and maturation territories were considered as Habitat Type V – Sites away from any water body.

A database dedicated to the occurrence of *O. trinacria* in the Algarve was built from the aggregation of different sources. Firstly, data from literature was analysed. Besides DE KNIJF & DEMOLDER (2010), one record from JAHN (1996) from

the Serpa region in Alentejo was added, mainly for historical reasons. Information provided by MALKMUS (2002) was not included because no accurate position of the record was available. GESCHKE (2002) was included because that record was taken close to the northern border of the Algarve. Secondly, data from our personal surveys, and thirdly, records provided by data contributors and wildlife photographers that posted and tagged *O. trinacria* pictures taken in the Algarve at the Flickr.com web platform were considered. Four of the five photographers contacted provided accurate location information for their shots.

Results

Distribution and habitat preferences

Literature data gave observations in two localities of the Algarve, two localities in Alentejo near the northern border of the Algarve and another one more to the center of Alentejo. The new records collected during this study gave a total of 30 observations from 17 different localities in the Algarve. All the currently known records for *O. trinacria* are shown in Figure 1, showing the new records in com-



Figure 1: Distribution of *Orthetrum trinacria* in the Algarve, southern Portugal. – Abbildung 1: Verbreitung von *Orthetrum trinacria* in der Algarve, südliches Portugal. ▲ data by DE KNIJF & DEMOLDER (2010) and GESCHKE (2002); △ data by JAHN (1996); ● new records, neue Nachweise.

parison to the previously published ones. At one locality, the Lago de S. Lourenço, a large artificial pond near Qt^a do Lago, sightings began in 2007 and have been continuously reported until 2011. In other localities, such as Silves Golf and southeastern ponds, observations also occurred repeatedly in 2010 and 2011, and from 2009 until 2011, respectively. A detailed description of localities and observations is available in Appendix 1.

Nearly all the records occurred in small or large permanent lentic systems with sparse aquatic vegetation and with *Typha* spp., *Juncus* spp., *Carex* spp. and/or *Tamarix* spp. bordering the water. One male was reported in a small temporary lentic system, and a few observations, mostly of females, were originated at sites away from any water body.

Flight period and reproductive behaviour

The earliest seasonal records of imaginal *O. trinacria* in the Algarve occurred in the last week of May – one observation on 27-v-2011 and two on 30-v-2011, and the latest records in the second half of September – one observation in 2010; two observations on 19-ix-2011 and one on 20-ix-2011. In October 2011 I was unable to find the species in the localities where I had found it earlier in the season.

Available records regarding reproductive behaviour are scarce. An oviposition event was observed in June 2007 by a data contributor, and a copula was observed on 03-vi-2011.

Discussion

Distribution and habitat preferences

New data accumulated during our work changed the picture of the distribution of *Orthetrum trinacria* in the Algarve. Now, the species appears to be well scattered in the region. It is not easy to explain this apparent change. On one hand, surveying efforts of the different teams that investigated Odonata in the Algarve are not measurable with any kind of accuracy and cannot be compared. Even so, I believe that the new picture of the distribution results largely from the increased field work carried out in recent years. On the other hand, it is hard to rule out the hypothesis that *O. trinacria* is colonizing the Algarve, and there is ample evidence of similar processes in the neighbouring southern Spain, as it was recorded in Andalucía and Extremadura provinces. To discuss this in greater depth, two main variables are useful: the habitat preferences of the species and the climate environment.

Along the Algarve a significant number of small sized ponds have been built in the last two decades, and the interior of the region, where water was historically scarce, has changed considerably. New freshwater habitats have become available for wildlife. The explosion of the Algarve's golf sport industry and golf courses provided an additional number of water bodies. It can be assumed that these new lentic systems, mostly permanent, are suitable for *O. trinacria*, because nearly all the localities included in Appendix 1 are examples of these man-made water bodies. As a general rule, it is expected that there will be a positive correlation

between the number of artificial ponds dispersed throughout the Algarve and the distribution of several Odonata species. The issue is not new in the Algarve, as well as in other areas. JONES (1996), for example, associated the limited distribution of *Lestes virens* in the Algarve with the lack of freshwater pools, and SAMWAYS (2002) pointed out the enormous benefits of the construction of large dams to some South African endemic damselflies.

The habitat preferences of *O. trinacria* in the Algarve showed a high level of consistency. During my field work I conducted numerous surveys in permanent, seasonal and ephemeral lotic systems, as well as in brackish waters, and I never observed the presence of the species. Similarly, DE KNIJF & DEMOLDER (2010) listed the preferred habitats as small ponds with well developed vegetation at their margins and some aquatic plants. Spanish localities described by BELLE (1984), CONESA-GARCÍA (1985), HARTUNG (1985), BENITEZ-DONOSO & GARCÍA-PARRÓN (1989) and CANO-VILLEGAS (2011) exhibited similar features, and in SÁNCHEZ et al. (2009) the description of the habitat preferences is similar.

These habitat preferences also agree with the general species characterization. JACQUEMIN & BOUDOT (1999) mentioned the species occurring in large lakes and reservoirs, CORBET et al. (2006) stated the need for permanent water and KALKMAN (2006) related the species to lentic systems with aquatic vegetation. Nevertheless, *O. trinacria* is flexible enough to complete its life cycle even in saline habitats. In Morocco JACQUEMIN (1987) and JACQUEMIN & BOUDOT (1999) reported reproduction in brackish waters, and in Namibia SUHLING et al. (2003) observed numerous individuals in waters with a very high conductivity level, and found exuviae in waters with medium conductivity (F. Suhling pers. comm.).

The numerous recently built artificial ponds throughout the Algarve and the suitability of these permanent lentic systems for *O. trinacria* are the most probable driving forces of the observed colonization. Despite that, global warming must be considered as a variable facilitating the progression of the species to new territories. In mainland Portugal the average annual air temperature increased at a rate of 0.47°C per decade in the period 1976-2002 (MIRANDA et al. 2006), and it is recognized that Odonata respond to environmental change, both with adaptations to life-history traits (DINGEMANSE & KALKMAN 2008; HASSALL & THOMPSON 2008) and to geographic distribution (OTT 2010). TERMAAT et al. (2010) considered the increasing summer temperatures to be one of the main driving forces for shifts in the northern border of some species. Therefore, Odonates are regarded as bio-indicators for changes in climate, such as air temperature and precipitation regimes, and it is highly likely that the Portuguese Odonata fauna is already displaying northern expansion due to global warming. *Orthetrum trinacria* may be an example of this progression.

Flight period and reproductive behaviour

Last week of May to third week of September is the recorded flight period for *O. trinacria* in the Algarve. This is nearly two months less than the interval pointed by JACQUEMIN & BOUDOT (1999) in Morocco (first week of April to third week of

October), where JACQUEMIN (1987) indicated the possibility of individuals flying as late as November. KALKMAN (2006) presented a similar monthly interval for southern Europe and North Africa (April to October). In Spain, CONESA-GARCÍA (1985) reported sightings from 15-vi- to 12-x-1984, with September being the month with highest abundance, but GARCÍA-PARRÓN & BENITEZ-DONOSO (1988) considered June and July the two months of greatest abundance both of imago and exuviae.

Reproductive behaviour and emergence seem to be spread over the whole season. In southern Portugal only data in June is available (emergence, copula, and oviposition), but in southern Spain exuviae have been found from the first week of May (GARCÍA-PARRÓN & BENITEZ-DONOSO 1988) and a tandem sighting in September (CONESA-GARCÍA 1985). In Morocco JACQUEMIN (1987) reported reproductive behaviour between April and September, found numerous exuviae from April to June, and observed emergences until October (22-x-1984).

Therefore, new surveys in the Algarve remain to be done, to refine the observed flight period, the habitats and localities where *O. trinacria* complete their life-cycle, and to observe eventual autumnal emergences. To find exuviae throughout the region is a key challenge (RAEBEL et al. 2010) for the coming years.

Conclusion

The apparent widespread distribution of *O. trinacria* in the Algarve is the most relevant finding evidenced during this work. New records showed that the distribution of the species increased substantially when compared to previous knowledge. Although the rate of distribution change remains unknown, there is ample evidence that the construction of small ponds and reservoirs fitting the ecological requirements of the species was a prerequisite and allowed for its expansion. Whether climate change plays a role by initiating or enhancing this progression is unknown, but it should obviously favour such expansion of Afrotropical species whenever suitable habitats exist.

In the Algarve, as well as in other regions of the southern Iberian Peninsula, future studies dealing with other Afrotropical species, such as *Diplacodes lefebvrii*, can provide new knowledge about these fascinating issues.

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Appendix 1. Compilation of all hitherto known records of *Orthetrum trinacria* from the Algarve, southern Portugal. Additional information to each record in the following sequence: Record No.; source; latitude; longitude; locality name; habitat type; month and year; life stage; population size. Latitude and longitude in decimal degrees (WGS84); population size: a. 1 to 10 individuals, b. 11 to 50 individuals; x. no information available; NSL hitherto unpublished observation by author. – **Anhang 1.** Zusammenstellung aller bisher bekannten Funde von *Orthetrum trinacria* aus der Algarve, südliches Portugal. Zusätzliche Informationen zu jedem Nachweis in der Reihenfolge: Nachweis Nr.; Quelle; geografische Breite; geografische Länge; Ortsname; Habitattyp; Monat und Jahr; Entwicklungsstadium; Populationsgröße. Geografische Breite und Länge in Dezimalgrad (WGS84); Populationsgröße: a. 1-10 Tiere, b. 11-50 Tiere; x. keine Information vorhanden; NSL bisher unpublizierte Beobachtung des Autors.

- R00. JAHN (1996); 37.8334; -7.6298; pond in the Rib^a de Limas basin (Alentejo); III.i.; vi-1991; imago; x
- R01. GESCHKE (2002); 37.4717; -8.4001; 'Gerkens' pond, Portelinhas, St^a Clara-a-Velha (Alentejo); III.i.; vi-2002; teneral; a
- R02. DE KNIJF & DEMOLDER (2010); 37.5356; -7.5894; Sedas, pond 2.5 km away from Rio Guadiana (Alentejo); III.i.; vi-2008; imago; a
- R03. DE KNIJF & DEMOLDER (2010); 37.2448; -8.3591; Vale Fuzeiros, Sesmarias; III.i.; vii-2008; imago; a
- R04. DE KNIJF & DEMOLDER (2010); 37.2887; -8.2931; São Bartolomeu de Messines, near N 265; III.i.; vii-2008; imago; a
- R05. N. Fonseca (pers. comm.); 37.1659; -8.4257; pond in Silves Golf; III.i.; vii-2010; imago; a
- R06. N. Fonseca (pers. comm.); 37.1659; -8.4257; pond in Silves Golf; III.i.; viii-2010; imago; a
- R07. N. Fonseca (pers. comm.); 37.1659; -8.4257; pond in Silves Golf; III.i.; ix-2010; imago; a
- R08. J.T. Tavares (pers. comm.); 37.0505; -7.9794; pond in Pontal, near Faro; III.ii.; v-2011; imago; a
- R09. J.T. Tavares (pers. comm.); 37.0246; -8.0118; Lago de S. Lourenço, Qt^a do Lago; III.iii.; v-2011; imago; a
- R10. J.T. Tavares (pers. comm.); 37.1622; -8.8009; shrubland near Barão de São João; V.; ix-2011; imago; a
- R11. V. Jacinto (photo on Flickr); 37.0195; -7.9862; shrubland near Faro Airport; V.; vii-2009; imago; x
- R12. N. Fonseca (photo on Flickr); 37.0244; -8.0089; scattered pines land near Lago de S. Lourenço, Qt^a do Lago; V.; viii-2011; imago; a
- R13. N. Fonseca (photo on Flickr); 37.1659; -8.4257; pond in Silves Golf; III.i.; vii-2011; imago; a
- R14. V. Jacinto (photo on eol.org); 37.2996; -7.5321; Corte do Gago, near Beliche reservoir; III.iii.; ix-2011; imago; x
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