The dragonfly fauna of the Aude department (France): contribution of the ECOO 2014 post-congress field trip

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Received 8 October 2015 / Revised and accepted 10 mai 2016

Keywords: ATLAS, AUDE DEPARTMENT, ECOO 2014, EUROPEAN CONGRESS ON ODONATOLOGY, FRANCE, LANGUEDOC-ROUSSILLON, ODONATA, *COENAGRION MERCURIALE, GOMPHUS FLAVIPES, GOMPHUS GRASLINII, GOMPHUS SIMILLIMUS, ONYCHOGOMPHUS UNCATUS*, *CORDULEGASTER BIDENTATA, MACROMIA SPLENDENS, OXYGASTRA CURTISII, TRITHEMIS ANNULATA.*

Mots-clés : ATLAS, AUDE (11), CONGRÈS EUROPÉEN D'ODONATOLOGIE, ECOO 2014, FRANCE, LANGUEDOC-ROUSSILLON, ODONATES, *COENAGRION MERCURIALE, GOMPHUS FLAVIPES, GOMPHUS GRASLINII, GOMPHUS SIMILLIMUS, ONYCHOGOMPHUS UNCATUS, CORDULEGASTER BIDENTATA,MACROMIA SPLENDENS, OXYGASTRA CURTISII, TRITHEMIS ANNULATA.*

Summary – After the third European Congress of Odonatology (ECOO) which took place from 11 to 17 July in Montpellier (France), 21 odonatologists from six countries participated in the week-long field trip that was organised in the Aude department. This area was chosen as it is under-surveyed and offered the participants the possibility to discover the Languedoc-Roussillon region and the dragonfly fauna of southern France. In summary, 43 sites were investigated involving 385 records and 45 dragonfly species. These records could be added to the regional database. No less than five species mentioned in the Habitats Directive (*Coenagrion mercuriale*, *Gomphus flavipes*, *G. graslinii*, *Macromia splendens* and *Oxygastra curtisii*) and three regionally important species (*G. simillimus*, *Onychogomphus uncatus* and *Cordulegaster bidentata*) could be observed and are discussed. Several populations of these species were discovered: *G. graslinii* and *M. splendens*, considered as very rare prior to our investigations, were especially found in the western Corbières and in the middle course of the Aude River. Furthermore many new populations of *Oxygastra curtisii* were detected. A small population of *C. mercuriale* was found in a drainage ditch in a peat land in the Montagne Noire at 850 m a.s.l, in the northern Aude. One of the most remarkable observations was the finding of an exuvia of *G. flavipes* along the Aude River, ca 30 km to the west from the hitherto only record of this species for the department, proving the extension of the range of this species to the southwest. Range extension was also highlighted for *Trithemis annulata*, another increasing species in Europe.

Les Odonates du département de l'Aude : contribution du séjour post-congrès ECOO 2014.

Résumé – Le troisième congrès européen d'odonatologie (ECOO) s'est tenu en France, à Montpellier, du 11 au 17 juillet 2014. Il est de coutume, après chaque congrès ECOO, de proposer un séjour dédié à des prospections odonatologiques dans la région. Ce séjour organisé par la Société française d'Odonatologie (SfO) a permis de réunir 20 odonatologues issus de six pays dans le département de l'Aude.

Outre l'objectif initial de faire découvrir la diversité des libellules du sud de la France, les prospections ont permis d'affiner la connaissance régionale sur la distribution des espèces en ciblant des secteurs sous-prospectés. Les secteurs inventoriés ont été : la basse plaine de l'Aude (Étang de la Matte), la plaine de l'Aude (entre Preixan et Puicheric), la vallée de l'Aude (de Couiza à Alet-les-Bains), les petites Corbières occidentales, le Minervois (la vallée de la Cesse) et la Montagne Noire. Au total, 45 espèces (16 zygoptères et 29 anisoptères) ont été observées, soit 77 % de la faune du département de l'Aude et 62 % de la faune régionale du Languedoc-Roussillon. Les 385 données d'occurrences correspondantes ont été intégrées à la base de données de l'atlas régional des libellules en cours d'élaboration (http://atlas.libellules-et-papillons-lr.org/libellules).

Ces inventaires ont permis de mettre en évidence des nouvelles populations pour cinq espèces en annexes de la directive Habitats (*Coenagrion mercuriale*, *Gomphus flavipes*, *G. graslinii*, *Macromia splendens* et *Oxygastra curtisii*) ainsi que pour trois espèces déterminantes ZNIEFF au niveau régional (*G. simillimus*, *Onychogomphus uncatus* et *Cordulegaster bidentata*). Parmi les observations inédites, la découverte d'une exuvie de *G. flavipes* sur l'Aude à environ 30 km à l'ouest de l'unique localité connue du département témoigne de l'expansion méridionale de l'espèce en limite sud-ouest de son aire de distribution. Deux espèces endémiques du sud-ouest de la France et de la péninsule Ibérique, *G. graslinii* et *M. splendens*, sont connues depuis peu dans le département de l'Aude ; plusieurs localités dans les Corbières occidentales et en aval de la haute vallée de l'Aude repoussent la distribution régionale de ces deux espèces. Les observations d'*O. curtisii* sur les mêmes secteurs permettent de disposer de données plus récentes que celles disponibles dans l'atlas régional. *Coenagrion mercuriale* a été découvert dans le massif de la Montagne Noire, en limite du département du Tarn, au niveau d'un fossé de drainage d'un bas-marais tourbeux situé à 850 m d'altitude (Les Martys; ZNIEFF 910030278). Par ailleurs, l'observation d'une exuvie et de plusieurs imagos de *Trithemis annulata* dans la vallée de l'Aude (Trèbes et Bram) documentent la reproduction de cette espèce d'origine africaine.

Enfin, ce séjour de plusieurs jours dans un contexte informel et convivial a permis de créer ou de renforcer les liens entre les participants et de contribuer ainsi au développement d'un groupe européen d'odonatologues.

Introduction

The French Society of Odonatology (SfO) and the Office for the Insects and their Environment (Opie) hosted the Third European Congress of Odonatology (ECOO) which took place from 11 to 17 July in Montpellier, France. After the congress, a traditional week-long field trip was organised. The organisation and preparation was done by members of the SfO: Xavier Houard, Audrey Poujol and two of us (JI, RKJ). The aims of this field trip were multiple. First, it was to offer the possibility to the participants to discover a region and its dragonfly fauna. The Languedoc-Roussillon region is very interesting due to the presence of several endemic or near-endemic species to south-western Europe: *Boyeria irene*, *Calopteryx haemorrhoidalis*, *Macromia splendens*, *Gomphus graslinii*, *Onychogomphus uncatus*, *Oxygastra curtisii*, *Platycnemis acutipennis* and *P. latipes*. Second, it was to investigate the dragonfly fauna of a less known area, such as the Aude department. All the collected data were transmitted to the coordinators of the regional atlas of Odonata from the Languedoc-Roussillon, namely, the CEN-LR, Opie and the Écologistes de l'Euzière, which is currently in preparation (http://atlas.libellules-et-papillons-lr.org/libellules). And finally, the gathering of 21 odonatologists coming from all over Europe was an opportunity to enhance mutual contacts and to develop a group of European dragonfly enthusiasts.

Investigated areas

In framework of this regional atlas, the Aude department was selected as a focus for our attention as this is one of the least prospected departments within the region (Fig. 1). Indeed, prior to our surveys, several grid squares were still remaining without any dragonfly record. Preixan, to the south of the medieval city of Carcassonne, was chosen as our operating base. This location enabled us (i) to investigate a great variety of habitats

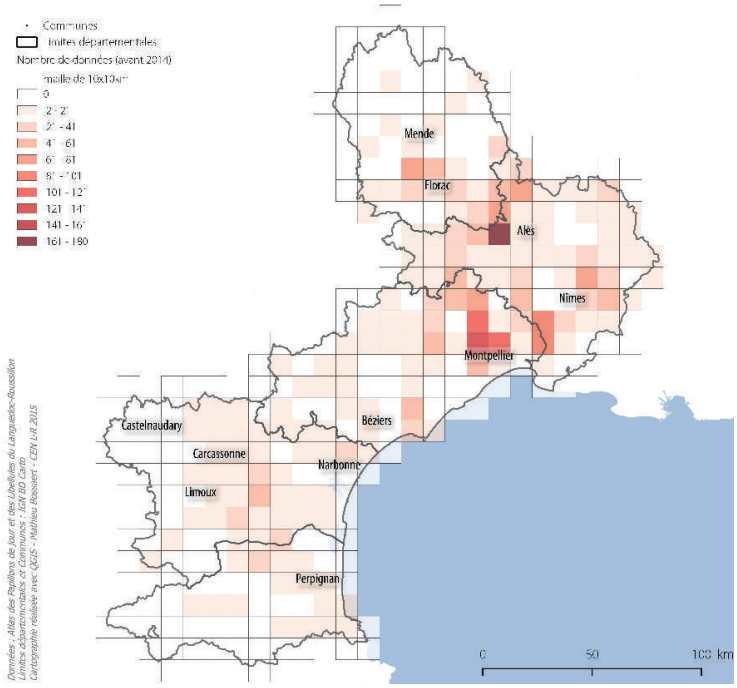

Figure 1. Map of the number of observations by 10 x 10 km grid square in Languedoc-Roussillon region before 2014. ***Carte du nombre d'observations par maille de 10 x 10 km en Languedoc-Roussillon avant 2014 .***

and landscapes within a range of 50 km, which was close to (ii) many of the empty or least prospected grid squares and (iii) near some very promising sites for noteworthy dragonfly species. Sites to investigate were selected by the participants using a pre-selection made by two regional experts (namely Stéphane Jaulin and Laurent Pelozuelo), and by consulting both analogue and digital topographic maps from the French 'Institut géographique national', and by referring to the web portal http://libellules-et-papillons-lr.org/ for the presence or absence of dragonfly species in a certain municipality or grid. A total of 43 different localities were surveyed on their dragonfly fauna (Annex 1); they can be distributed across six areas (Fig. 2):

The lower plain of the River Aude, Étang de la Matte

Located in the municipality of Lespignan between the Hérault (34) and the Aude (11) departments, this site is designated as a Natura 2000 site and is also part of ZNIEFF (Natural Zone of Interest for Ecology, Flora and Fauna). It is composed of a network of ponds and meadows, just above sea-level, representing a typical Mediterranean lagoon landscape. Due to the unfavorable weather conditions during our visit, we assume that only few of the dragonfly species were observed.

The river valley of the Aude between Preixan and Puicheric

The river valley of the Aude is an agricultural landscape dominated by vineyards at an elevation between 60 m a.s.l. in Puichéric and 125 m a.s.l. in Preixan. The main watercourses are the Canal du Midi and the Aude River and its tributaries, but also the Orbieu and the Cesse Rivers. Other suitable dragonfly habitats within this area were also surveyed, such as the pond of the campsite in Preixan, where we were based.

The river valley of the Aude between Couiza and Alet-les-Bains

This 7 km long stretch of the middle course of the River Aude forms the transition zone between the upper course of the river (220 m a.s.l. in Couiza) and the Limouxin downstream area (190 m a.s.l. in Alet-les-Bains). From the east to the west, it represents a natural border between the Quercorb and the high Corbières. This area was surveyed in kayak, facilitating the collection of exuviae along the riparian forest.

The little occidental Corbières

The little western Corbières is a hilly region situated to the north-western margins of the Corbières mountain range. Several prospections were made along the Lauquet and its tributaries, the Lauquette and the Alberte, between 180 and 400 m a.s.l. Riparian forests are well developed (*Fraxinus excelsior*, *Alnus glutinosa*, *Salix* sp.) and adjacent grasslands are favorable to the maturation of dragonflies. This area was known to be one of the major under-investigated regions for dragonflies within the Aude department.

The Minervois and the Cesse river valley

The Cesse River has excavated its way through the typical karst area, resulting in gorges, canyons, caves, resurgences and famous sites of the Minerve's natural bridges. In summertime, the river flows underground for several kilometers. Fieldwork was mainly carried out near the municipalities of Agel and Bize-Minervois at elevations below 100 m a.s.l. The surveyed habitat types were vegetated and rocky shores and riparian forests.

The 'Montagne Noire' range

The 'Montagne Noire' is a mountain range located at the north of the Aude department and forms the southern limit of the Massif Central. Its highest summit (Pic de Nore) reaches 1,210 m a.s.l. This highly forested area is dominated by European Beech (*Fagus sylvatica*), Pedunculate Oak (*Quercus robur)*, Silver Fir (*Abies alba*) and Norway Spruce (*Picea abies*). The surveyed habitat types were artificial lakes, ponds **(**Laprade Basse, Lake Castagnat) and peat bogs located between 700 and 850 m a.s.l. Two sites in the Tarn department (locality of La Calmilhe, in the municipality of Mazamet) were also visited although outside the study area.

Figure 2. Location of the six investigated areas during ECOO 2014 post-congress field trip within Aude department. ***Localisation des six zones inventoriées durant le séjour post-congrès ECOO 2014 dans le département de l'Aude.***

Methods

Altogether, 20 odonatologists from six countries attended this post-congress field trip and took part in the surveys. Participants originated from France ($n = 7$) and Germany ($n = 5$), but also from Belgium and the Netherlands ($n = 3$, each), Denmark ($n = 1$) and Italy ($n = 1$) (Tab. 1).

At each site, all suitable habitats for dragonflies were visually inspected. These included habitats close to the water (breeding sites) as well as farther away from water (e.g. maturation, feeding or copulation habitats). Each investigated site was attributed to one of the following habitat-types: river, stream, peat-bog stream, canal, dam-lake, pond, peat-bog pond and terrestrial (away from water). One location – Les Martys, la Sagne Grande – is a peat-bog characterised by some small ponds and a drainage ditch, closely situated to each other; hence, each recorded species was attributed to one of the two corresponding habitat types regarding where most individuals had been observed.

Dragonflies were identified visually, sometimes using short-focusing binoculars. Species harder to identify, e.g. members of the genus *Gomphus*, were netted for closer inspection. Special attention was paid to the search for exuviae, proof of successful reproduction of a species. In this regard, we had one occasion to use kayaks during the prospection of the River Aude between Couiza and Alet-les-Bains. The abundance of each species is assessed using the relative number (*Rn*) of locations where it was observed: $Rn > 50$ % = 'very common', $50 > Rn > 26$ % = 'common', $25 > Rn > 12$ % = 'rather common', $12 > Rn > 6$ % = 'rare' and $Rn < 6$ % = 'very rare'.

Table 1. List of post-congress field trip participants and their country of origin.
Liste des participants au séjour post-congrès et leur pays d'origine.

Name ***Nom***	**Country** ***Pays***
Emma Avilès	France
Jean-Pierre Boudot (JPB)	France
Klaus Burbach (KB)	Germany *Allemagne*
Klaus-Jürgen Conze (KJC)	Germany *Allemagne*
Geert De Knijf (GDK)	Belgium *Belgique*
Isha De Knijf	Belgium *Belgique*
Cyrille Deliry (CD)	France
Heidi Demolder (HD)	Belgium *Belgique*
Martha Douma	Netherlands *Pays-Bas*
Jean Ichter (JI)	France
Régis Krieg-Jacquier (RKJ)	France
Camille Le Merrer (CLM)	France
Jan-Joost Mekkes	Netherlands *Pays-Bas*
Erland Nielsen	Denmark *Danemark*
Audrey Poujol (AP)	France
Dolf Ramaker	Netherlands *Pays-Bas*
Sabine Senkel	Germany *Allemagne*
Franz-Josef Schiel (FJS)	Germany *Allemagne*
Constanza Uboni	Italy *Italie*
Michael Winterholler	Germany *Allemagne*

Results and discussion

Altogether 43 sites were investigated on their dragonfly fauna (Annex 1) and 45 species of Odonata (16 Zygoptera and 29 Anisoptera) could be observed (Table 2a, b). Our observations represent 77 % of the 66 species occurring in the Aude department and 62 % of the 74 species composing the Languedoc-Roussillon regional fauna (OPIE *et al.*, 2011). A total of 385 records could be added to the regional database and will be used in the atlas of the dragonflies of the Languedoc-Roussillon region.

The overview of the most frequently surveyed habitat type (Tab. 3) show that our surveys were strongly biased towards lentic water systems, especially streams (44.2 %, $n = 19$) and to a lesser extent rivers (23.6 %, $n = 10$). However, this reflects well the availability of the different habitat types in the Aude department, and to a wider extent, in the Languedoc-Roussillon region. The three most common species *P. latipes*, *C. xanthostoma* and *C. haemorrhoidalis* are all typical for running waters (Tab. 2). Even enigmatic species such as *O. curtisii* and *M. splendens* can be considered as respectively 'common' and 'rather common' on a regional scale.

A total of eight species are important species with regard to legislation and conservation (Tab. 4). We limit our annotations to these set of species and to *Trithemis annulata*, which regional faunistic is worth to comment on. The distribution of these nine noteworthy species is presented in figure 3.

Coenagrion mercuriale

We found *C. mercuriale* in the Montagne Noire at 850 m a.s.l., along a drainage ditch in the peat-land of the site Grande Sagne (Les Martys). Although we observed only few males, we assume that they belong to a local population.

The Mercury Bluet is restricted to western Europe and North Africa and prefers well vegetated small streams and drainage ditches in river valleys (SCHORR, 1990). The species is widely distributed and even locally common in France and the Iberian Peninsula (BOUDOT & KALKMAN, 2015). The highest population densities and concentrations are found in southern France (GRAND & BOUDOT, 2006; DUPONT, 2010). *Coenagrion mercuriale* is scarce and often uncommon in the northern and eastern part of its range, where in recent decades the number of populations or occurrence seem to increase like in the Netherlands (GERAEDS & MUUSSE, 2012), Belgium (DE KNIJF & DEMOLDER, 2000) or northern France (VANAPPELGHEM & HUBERT, 2010). In the Languedoc-Roussillon region, *C. mercuriale* is mainly found in lowland river valleys below an altitude of 250 m a.s.l.

This is not only the first record for this site but also for the whole mountain range of the Montagne Noire.

Gomphus flavipes

We found one exuviae at a concrete pillar at the border of the River Aude in Puichéric sur l'Aude (GDK, KB, KJC, FJS).

The River Clubtail has a very large distribution occurring in northern Asia and in most of Europe (BOUDOT & KALKMAN, 2015). After suffering a severe decline in most of western and central Europe it nearly completely disappeared (DE KNIJF *et al.*, 2014). *Gomphus flavipes* has quite rapidly recolonized nearly all major rivers since the mid-nineties and has even settled in several new rivers where it was never found before (MÜLLER, 1997; REDER, 1997; SCHIEL & RADEMACHER, 1999; WINTERHOLLER & LEINSINGER, 1999; KLEUKERS & REEMER, 1998; GRAND *et al*., 2011a, b; DE KNIJF *et al.*, 2014). In France, the species occurs essentially along the great rivers Loire and Rhône and to a lesser extent also the River Rhine (GRAND *et al*., 2011a, b). A stable population has also been found along the River Adour in south-western France (LECONTE *et al*., 2002). The larval habitat of *G. flavipes* has been mostly described as the shallow margins of rivers where the current slows down (MÜLLER, 1995). The substrate of the river is mostly sandy, but can also be partly muddy (MÜLLER, 1995; GRAND *et al*., 2011a).

Until our surveys in the Aude department, *Gomphus flavipes* was only known from the Languedoc-Roussillon region from one observation dated May 2011 from the municipality of Cuxac-d'Aude, along the lower course of the river at ca 15 km from the Mediterranean Sea (CARRÈRE & BLANCHON, 2012). Our finding confirms the presence of the reproduction of the species in the River Aude, and represents also the most southwesterly population known.

Gomphus graslinii

Our surveys in the Aude department resulted in the observation of at least 20 adults of the Pronged Clubtail along the Aude River, south of Alet-les-Bains (GDK, JPB, CLM) and a male along the Lauquet stream in the western Corbières (GDK). At both localities, the substrate of the rivers was sandy and was often partly covered by decaying leaves.

Gomphus graslinii is an endemic species of southern and western France and the Iberian Peninsula where it can be found along streams and slow-flowing rivers. The species is considered Near Threatened (NT) in Europe (KALKMAN *et al*., 2010). In France, *G. graslinii* is legally protected and the most important populations are found along the rivers Garonne, Hérault, Ardèche, Loire and Charente (DUPONT, 2010). The species is rather rare in the Languedoc-Roussillon region and is mostly seen in the departments of the Hérault and Gard (OPIE *et al*., 2011). *Gomphus graslinii* was only recently discovered for the Aude department and was found in Corbières along the Orbieu River and the Aude River in Cuxac-d'Aude (http://atlas.libellules-et-papillons-lr.org).

Our new findings extend the regional distribution of *Gomphus graslinii* considerable to the south-west. DUPONT (2010) considered that the species might also be present in the department of the Eastern Pyrenees.

Table 2a. List of Zygoptera species observed during the ECOO2014 post-congress field trip. For each species, we provide the abundance together with the number of occurrence(s) per investigated habitat type, and in total.
Liste des espèces de Zygoptères inventoriées lors du séjour post-congrès ECOO 2014. Pour chaque espèce sont donnés l'abondance et le nombre d'occurrences par type d'habitat prospecté ainsi qu'au total.

Species name	Abundance	Habitat								Total
		terrestrial	damlake	pond	pond peat	canal	river	stream	stream peat	
Calopteryx haemorrhoidalis (Vander Linden, 1825)	common						4	15		19
Calopteryx virgo meridionalis Selys, 1873	common	1	1				1	9	1	13
Calopteryx xanthostoma (Charpentier, 1825)	very common		1			2	8	9	1	21
Chalcolestes viridis (Vander Linden, 1825)	rather common			3			2	3		8
Lestes barbarus (Fabricius, 1798)	very rare			2						2
Lestes virens virens (Charpentier, 1825)	very rare			1						1
Platycnemis acutipennis Sélys, 1841	common		1				6	7		14
Platycnemis latipes Rambur, 1842	very common			2		1	10	14		27
Platycnemis pennipes (Pallas, 1771)	rather common		1			2		5		8
Ceriagrion tenellum (de Villers, 1789)	rare			1			1	2		4
Coenagrion mercurial (Charpentier, 1840)	very rare								1	1
Coenagrion puella (Linnaeus, 1758)	rare		1	1	1			1		4
Enallagma cyathigerum (Charpentier, 1840)	rare		1	1				1		3
Erythromma lindenii (Sélys, 1840)	common		1	2		2	8	4		17
Erythromma viridulum (Charpentier, 1840)	very rare			1			1			2
Ischnura elegans (Vander Linden, 1820)	common		1	6		1	2			10
Pyrrhosoma nymphula (Sulzer, 1776)	rare		1					1	1	3

Table 2b. List of Anisoptera species observed during the ECOO2014 post-congress field trip. For each species, we provide the abundance together with the number of occurrence(s) per investigated habitat type, and in total.
Liste des espèces d'Anisoptères inventoriées lors du séjour post-congrès ECOO 2014. Pour chaque espèce sont donnés l'abondance et le nombre d'occurrences par type d'habitat prospecté ainsi qu'au total.

Species name	Abundance	Habitat								Total
		terrestrial	damlake	pond	pond peat	canal	river	stream	stream peat	
Aeshna affinis Vander Linden, 1820	very rare			1						1
Aeshna cyanea (Müller, 1764)	very rare							1		1
Aeshna grandis (Linnaeus, 1758)	very rare	1								1
Aeshna mixta Latreille, 1805	rare	1	1					1		3
Anax imperator Leach, 1815	common		1	1	1	1	5	3		12
Anax parthenope (Sélys, 1839)	very rare		1							1
Boyeria irene (Fonscolombe, 1838)	common			2			4	12		18
Gomphus flavipes (Charpentier, 1825)	very rare						1			1
Gomphus graslinii Rambur, 1842	rare						2	1		3
Gomphus pulchellus Sélys, 1840	rather common		1	1	1		1	4		8
Gomphus simillimus Sélys, 1840	rare						2	2		4
Onychogomphus forcipatus (Linnaeus, 1758)	common		1				6	5		12
Onychogomphus f. unguiculatus (Vander Linden, 1823)	rare						1	3		4
Onychogomphus uncatus (Charpentier, 1840)	common						5	7		12
Cordulegaster bidentata Sélys, 1843	very rare							1		1
Cordulegaster boltonii (Donovan, 1807)	rather common		1				2	3	1	7
Cordulia aenea (Linnaeus, 1758)	very rare		1							1
Oxygastra curtisii (Dale, 1834)	common						4	9		13
Macromia splendens (Pictet, 1843)	rather common							6		6
Crocothemis erythraea (Brullé, 1832)	rare			1	1		2			4
Libellula depressa Linnaeus, 1758	very rare		1		1					2
Libellula quadrimaculata Linnaeus, 1758	very rare		1	1						2
Orthetrum brunneum (Fonscolombe, 1837)	very rare						1		1	2
Orthetrum cancellatum (Linnaeus, 1758)	rather common		1	3		2				6
Orthetrum coerulescens (Fabricius, 1798)	rather common		1				1	5	1	8
Sympetrum fonscolombii (Sélys, 1840)	very rare			1						1
Sympetrum meridionale (Sélys, 1841)	very rare			1						1
Sympetrum striolatum (Charpentier, 1840)	very rare			1						1
Trithemis annulata (Palisot de Beauvois, 1805)	very rare			1			1			2

Tab 3. Number of investigated localities per habitat type.
Nombre de sites visités par types d'habitat.

Habitat	*n*	Habitat	*n*
stream / *ruisseau*	19	damlake / *réservoir de barrage*	1
river / *rivière*	10	peat-bog pond / *étang de tourbière*	1
pond / *étang*	5	peat-bog stream / *ruisseau de tourbière*	1
canal / *canal*	2	terrestrial / *milieu terrestre*	1

Table 4. Protection and conservation status according to the Habitats Directive (Ann. II = species of community interest whose conservation requires the designation of special areas of conservation; Ann. IV = species of community interest in need of strict protection), the French decree of the 23 April 2007 stating the list of protected insect species, the European Red List of Odonata (KALKMAN *et al.*, 2010), the National Action Plan for Odonata (DUPONT, 2010) and the list of determinacy species for the designation of ZNIEFF in the Languedoc-Roussillon region (COLL., 2009).
Liste des espèces inventoriées lors du séjour post-congrès ECOO 2014 ayant un statut particulier de protection ou de conservation selon la directive Habitats (Ann. II = espèces d'intérêt communautaire dont la conservation nécessite la désignation de zones spéciales de conservation, Ann. IV = espèces d'intérêt communautaire qui nécessitent une protection stricte), l'Arrêté du 23 avril 2007 fixant les listes des insectes protégés, la Liste Rouge européenne des Odonates (KALKMAN et al., 2010), le Plan National d'Actions en faveur des Odonates (DUPONT, 2010) et la liste des espèces déterminantes pour la désignation des ZNIEFF en Languedoc-Roussillon (COLL., 2009).

Species name	Habitats directive	French protection	European Red List	National Action Plan for Odonata	'Strict' determinacy level (ZNIEFF)
Coenagrion mercuriale	Ann. II	✓	NT	✓	✓
Gomphus flavipes	Ann. IV	✓	LC	✓	
Gomphus graslinii	Ann. II, IV	✓	NT	✓	✓
Gomphus simillimus			NT		✓
Onychogomphus uncatus			LC		✓
Cordulegaster bidentata			NT		✓
Oxygastra curtisii	Ann. II, IV	✓	NT	✓	✓
Macromia splendens	Ann. II, IV	✓	VU	✓	✓

Gomphus simillimus

The Yellow Clubtail was observed at four sites, all running water along the Lauquet River in the western Corbières and in the upper courses of the River Aude.

Gomphus simillimus has a similar but wider distribution range to that of *G. graslinii* and occurs also in North Africa and farther north in France. It is a typical species of slow-flowing watercourses (both streams and rivers) but can also be found in nearby lentic habitats such as gravel-pits and oxbows (BOUDOT & KALKMAN, 2015). Larvae have a clear preference for sandy and loamy bottoms often covered by debris (SUHLING & MÜLLER, 1996).

Unlike *G. graslinii* and *Macromia splendens* that can be found in similar habitats, the Yellow Clubtail was already known from the western Corbières and from the upper courses of the River Aude (http://atlas.libellules-et-papillons-lr.org). However since *G. simillimus* is sensitive to pollution and structural modification of rivers, our new localities can be considered as an indicator of quality of the aquatic ecosystems.

Onychogomphus uncatus

We found the Large Pincertail at all stream and river sites, from which the species was already known, especially in the western Corbières, the upper courses of the Aude River and in the Minervois. This species is typical of well oxygenated streams and small rivers (SUHLING & MÜLLER, 1996; GRAND & BOUDOT, 2006; DUPONT, 2010).

Cordulegaster bidentata

We found the Sombre Goldenring only at the upper course of the Lauquet stream in the western Corbières (GDK, KJC, HD). The stream is here less than 0.5 m wide and completed shaded by forest.

Cordulegaster bidentata is an endemic European species. In France, the species can be encountered in the mountainous regions such as the Pyrenees and the Central Massif and the whole eastern part of the country, from the Belgian-Luxembourg border nearly to the Mediterranean Sea (BOUDOT *et al.,* 1990; GRAND & BOUDOT, 2006). The species has a clear preference for springs (often calcareous springs such as *Cratoneurion*), spring brooks and small forested streams characterised by a sandy bottom. In the Languedoc-Roussillon region, *C. bidentata* is rare in the Lozère and Hérault departments and very rare in the other parts of the region (OPIE *et al*., 2011).

In the Aude department, most observations of *C. bidentata* are from 'La Montagne Noire'. In the Corbières, only few data are available. This new locality from the western Corbières suggests that this species is probably under-sampled and may be more present in small forest streams in the area.

Oxygastra curtisii

The Orange-spotted Emerald was quite commonly found along slow-flowing streams, especially where the stream bottom was covered by decaying leaves and where the waterside was characterized by the presence of overhanging tree roots. It was common along rivers, namely: the Lauquette, the Lauquet, the Cesse (Bize-Minervois) and along the Aude (Couiza).

Oxygastra curtisii is endemic to western Europe and very rare in North Africa (Morocco only) but is a rather common species in the Atlantic and Mediterranean part of France (http://inpn.mnhn.fr/espece/cd_nom/65381).

Although the species is well-known to occur in the Aude department, most records dates from before 1990 (http://atlas.libellules-et-papillons-lr.org). Our field survey confirms not only the widely occurrence of this species in the Aude department but also could add several new localities for this species. Its preference for decaying leaves on the stream bottom as we found in the Aude department is confirmed by a study about the habitat preference of the larvae of *O. curtisii* by LEIPELT & SUHLING (2001).

Macromia splendens

We found the Splendid Cruiser at several localities along the streams of the Lauquet and the Alberte rivers, west of the Corbières between 197 and 345 m a.s.l. *Macromia splendens* was often numerous, with up to more than 10 adults seen at a single site. Exuviae were found both on overhanging rocks and stony walls, sometimes fully sun-exposed rocks, and in dense riparian vegetation, with only limited sunshine penetrating, mostly 20 to 60 cm away from the water.

Macromia splendens is one of the most enigmatic European dragonfly species and is assessed as Vulnerable in the European Red List (Tab. 4). It is restricted to southern France, Spain and Portugal. In France, the species is mainly found in the river basins of the Garonne (Dordogne, Lot, Célé, Tarn), Hérault and Rhône (http://odonates.pnaopie.fr/especes/macromiidae/macromia-splendens/). *Macromia splendens* was discovered in the Aude department in 1988, at Saint-Nazaire-d'Aude (observation by D. Grand, http://atlas.libellules-et-papillons-lr.org). This record was only followed by a second, at Cuxac-d'Aude in 2011 (observation by L. Spanneut, http://atlas.libellules-et-papillons-lr.org). Since then, the species has also been found in the valley of the Orbieu, east of the Corbières (observation by B. Louboutin and T. Rafton, http://atlas.libellules-et-papillons-lr.org).

All our findings are new sites for the species, supporting that our study area was under-sampled in the past.

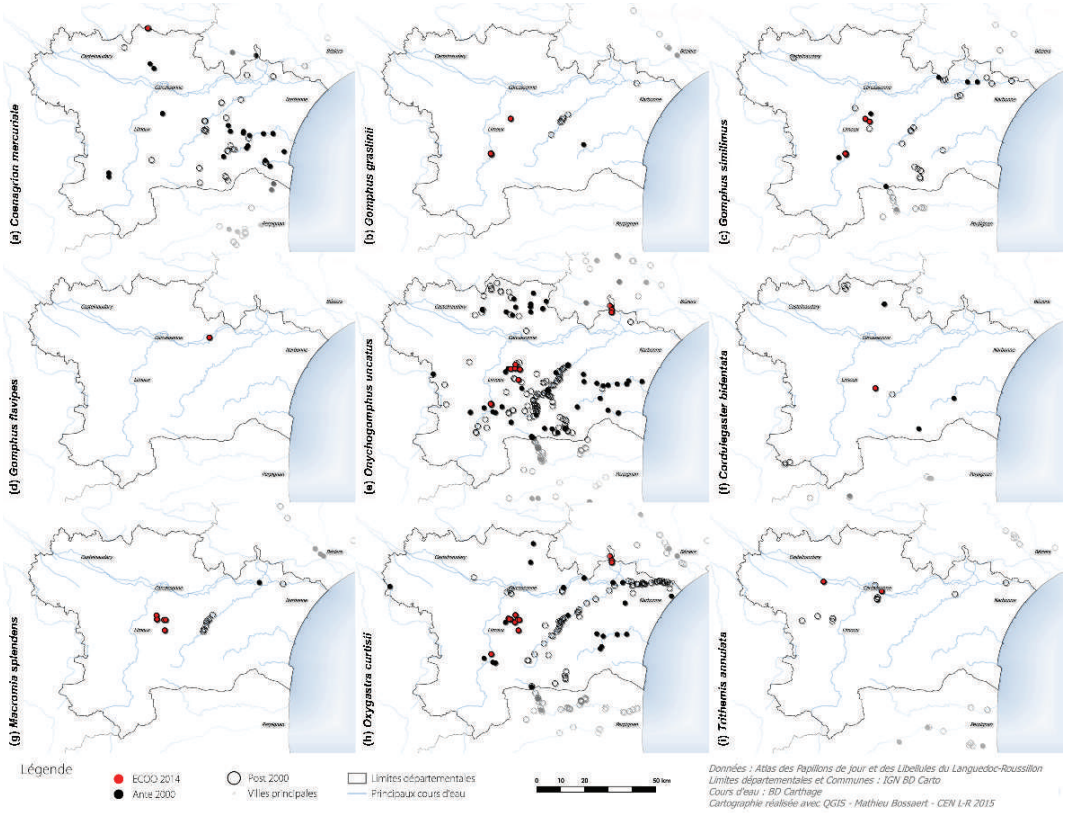

Figure 3. Distribution of nine dragonfly species being noteworthy with regard to their protection, conservation status or biogeographic position in the Aude department: (a) *Coenagrion mercuriale*, (b) *Gomphus graslinii*, (c) *G. simillimus*, (d) *G. flavipes*, (e) *Onychogomphus uncatus*, (f) *Cordulegaster bidentata*, (g) *Macromia splendens*, (h) *Oxygastra curtisii* and (i) *Trithemis annulata*.
***Répartition de neuf espèces d'odonates remarquables du fait de leurs statuts de protection, de conservation ou de leur situation biogéographique dans le département de l'Aude : (a)* Coenagrion mercuriale, *(b)* Gomphus graslinii, *(c)* G. simillimus, *(d)* G. flavipes, *(e)* Onychogomphus uncatus, *(f)* Cordulegaster bidentata, *(g)* Macromia splendens, *(h)* Oxygastra curtisii *et (i)* Trithemis annulata.**

Trithemis annulata

A male of the Violet Dropwing was seen hovering above the Aude River in the municipality of Trèbes (GDK, AP). The species was also found at the so-called lake of Buzerens in the municipality of Bram, ca. 20 km west of Carcassonne. Here, both male and female were observed in flight as well as an exuvia was collected, proving its capacity of local reproduction (RKJ, CD, CLM). This lake is in fact a former gravel pit near the Canal du Midi, now transformed into a fish pond of 4 ha. Its margins are partly bordered by *Juncus* sp. and *Salix* sp. vegetation.

This afrotropical species has colonised most of the Mediterranean part of Europe since the eighties (AGUIAR & AGUIAR, 1983; CARFI *et al.*; 1983; FERRERAS-ROMERO,

1983; BELLE, 1984; OCHARAN, 1985; GRAND, 1990). Its presence in France was first observed in Corsica (ROCHE, 1989), soon followed by mainland France (GRAND, 1994). It is a rare species in the Aude department (GRAND & BOUDOT, 2006).

Our surveys yielded two new localities of *T. annulata* for the Aude department.

Conclusion

Because of its particular biogeographic position between the Massif Central, the Pyrenees and the Mediterranean Sea, and the occurrence of well-preserved habitats, the Aude department has a rich and diverse dragonfly fauna. The gathering of 20 dragonfly experts from across Europe in this promising and hitherto under-investigated area resulted in many new and interesting dragonfly records for the Languedoc-Roussillon region. Besides the common and typical species (e.g. *Calopteryx* spp., *Platcynemis* spp.) for streams and rivers, we were also able to collect data from several species of special conservation interest. Indeed, we could show the presence of several populations in a good conservation status (e.g. *Macromia splendens*, *Oxygastra curtisii, Gomphus graslinii*) from species mentioned in the European Habitats Directive. Beside these European protected species, several populations were found of regionally important species (ZNIEFF) like *G. simillimus*, *O. uncatus* and *C. bidentata*.

Most of the investigated localities during this post-congress field trip had never been surveyed, resulting in a lot of original data for the Aude department and making an important contribution to the regional atlas. This highlights the lack of knowledge for the department, especially for the western Corbières. Most of our observations were made in lentic habitats. This explains why the three most common observed species were *P. latipes*, *C. xanthostoma* and *C. haemorrhoidalis*, as they are all typical of running waters. Even *Oxygastra curtisii* and *Macromia splendens* can be considered as respectively ‘common’ and ‘rather common’ to the regional scale. Our records of exuviae proved the successful reproduction of *G. flavipes* and *T. annulata* in the valley of the River Aude. This testifies of their expansion to the south for the former, and to the north for the latter.

Finally, these seven days we spent in an informal and friendly atmosphere has helped to create or strengthen the links between participants and contributed to the development of a European odonatologist group.

Acknowledgements

We would like to thank all the participants (see Table 1) to this post-congress meeting for their enthusiasm, motivation and friendly intercourse. Special thanks to Audrey Poujol who took care of the daily practicalities. Thanks are due to Stéphane Jaulin, Xavier Houart, Samuel Jolivet (Office pour les insectes et leur environnement) and Laurent Pelozuelo (CNRS-INPT-UPS) for their help during the preparation of the fieldwork, Mathieu Bossaert and Alexis Rondeau (Conservatoire d’espaces naturels du Languedoc-Roussillon) for map production and Cyrille Deliry for helping to put our data in the data-portal. We would like to thank Nick van Wouwen check for linguistic comments on an earlier version.

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Annex 1. Recording sites of Odonata in the Aude and Tarn departments, southern France, during the post-congress ECOO 2014 camp, together with their main habitat-type and total number of recorded species (N). Municipalities and toponyms are given in French, latitude (Lat.) and longitude (Long.) in decimal degrees (WGS84 system), and altitude a.s.l. in meters.
Sites d'observations d'Odonates dans les départements de l'Aude et du Tarn au cours du séjour post-congrès ECOO2014, avec leur type d'habitat principal et le nombre total d'espèces observées (N). Les latitudes (Lat.) et longitudes (Long.) sont données en degrés décimaux (datum WGS84) et l'altitude en mètres.

Municipality / Commune	Toponym / Toponyme	Lat.	Long.	Alt.	Habitat	*N*
Agel	la Cesse	43,34270	2,86830	79	river / rivière	14
Belcastel	bord de route D40	43,03442	2,38178	450	terrestrial / terrestre	3
Bize-Minervois	la Cesse (St Hilaire)	43,32747	2,87818	64	river / rivière	13
	la Cesse	43,31878	2,87832	62	river / rivière	10
Bram	Plan d'eau de Buzerens	43.24809	2.13708	122	former gravel pit / ancienne gravière	10
Caunette-sur-Lauquet	le Lauquet (La Caunette-Basse)	43,03017	2,41547	440	stream / ruisseau	4
Clermont-sur-Lauquet	le Lauquet (les Escoumeilles)	43,03918	2,41990	380	stream / ruisseau	3
	le ruisseau des Illes	43,04618	2,42095	380	stream / ruisseau	3
Couffoulens	camping Air Soleil	43,15742	2,29333	125	pond / étang	5
Couiza - Alet-les-Bains	l'Aude	42,97083	2,25933	220	river / rivière	13
Cuxac-Cabardès	lac de Laprade Basse	43,42530	2,28102	780	damlake / barrage	20
Greffeil	le Lauquet (les Usclades)	43,06145	2,39823	345	stream / ruisseau	4
	le Lauquet (la Coumo de Poulas)	43,09185	2,37953	230	stream / ruisseau	8
	le Lauquet	43,06145	2,39823	345	stream / ruisseau	5
	le Lauquet (au sud du Camp de la Gleizo)	43,06889	2,37472	282	stream / ruisseau	3
Ladern-sur-Lauquet	l'Alberte	43,10050	2,38037	220	stream / ruisseau	4
	l'Alberte (pont de Saint Andrieu)	43,10083	2,39417	250	stream / ruisseau	6
	l'Alberte (abbaye de la Rieusette)	43,10108	2,40216	259	stream / ruisseau	8
	l'Alberte (les ruines Jean Estève)	43,10083	2,40556	270	stream / ruisseau	8
	la Lauquette (chemin de la moulinette)	43,10289	2,35073	192	stream / ruisseau	5
	la Lauquette (cimetière Ladern-sur-Lauquet)	43,10570	2,34633	188	stream / ruisseau	7
	la Lauquette (amont de la station d'épuration)	43,10237	2,35758	210	stream / ruisseau	11
	le Lauquet (les Picharelles)	43,10167	2,37611	215	stream / ruisseau	3
	le Lauquet (Labau)	43,09867	2,37800	225	stream / ruisseau	7
	la Lauquette (Fourmillades)	43,11766	2,35474	253	stream / ruisseau	7
	la Lauquette (amont de la station d'épuration)	43,10237	2,35758	197	stream / ruisseau	23
Les Martys	la Sagne Grande	43,44361	2,30444	807	pond peat-bog / étang de tourbière	5
	la Sagne Grande	43,44361	2,30444	807	stream peat-bog / ruisseau de tourbière	7
Lespignan	marais de la Matte	43,27114	3,15320	1	pond / étang	9
Lespignan	pont de la Muscade Ouest - Le Brasset	43,26135	3,15618	2	pond / étang	3
Luc-sur-Aude	l'Aude (les grottes de Sainte Croix)	42,96694	2,25944	2	river / rivière	7
	l'Aude	42,97083	2,25933	220	river / rivière	4
Marseillette	le canal du Midi	43,20310	2,53873	80	canal / canal	7
	l'Aude (pont de Marseillette)	43,19967	2,53987	70	river / rivière	3
Mazamet	étang de Castagnat	43,45190	2,31842	730	pond / étang	9
	ruisseau de la Gachal	43,45526	2,32059	720	stream / ruisseau	4
Millegrand	le canal du Midi	43,19495	2,49577	70	canal / canal	4
	l'Aude (la Prade)	43,18712	2,49577	70	river / rivière	3
Puichéric	l'Aude (Pont D111)	43,2222	2,62665	55	river / rivière	6
St-Polycarpe	Buc ruisseau	43,03630	2,32698	290	stream / ruisseau	3
Trèbes	mare	43,20910	2,43973	85	pond / étang	3
	l'Aude	43,20910	2,44140	85	river / rivière	8
Villefloure	la Lauquette (Bac de Merou)	43,11903	2,38230	222	stream / ruisseau	8