

IDF



International Dragonfly Fund - Report Journal of the International Dragonfly Fund

1-22

Vladimir E. Skvortsov & Natalya Y. Snegovaya

Two new species of *Cordulegaster* Leach, 1815 from Azerbaijan
(Odonata, Cordulegastridae)

Published 06.08.2015

85

ISSN 1435-3393

The International Dragonfly Fund (IDF) is a scientific society founded in 1996 for the improvement of odonatological knowledge and the protection of species.

Internet: <http://www.dragonflyfund.org/>

This series intends to publish studies promoted by IDF and to facilitate cost-efficient and rapid dissemination of odonatological data.

Editorial Work: Martin Schorr, Milen Marinov

Layout: Bernd Kunz

Indexed by Zoological Record, Thomson Reuters, UK

Home page of IDF: Holger Hunger

Impressum: International Dragonfly Fund - Report - Volume 85

Publisher: International Dragonfly Fund e.V., Schulstr. 7B, 54314 Zerf, Germany.

E-mail: oestlap@online.de

Responsible editor: Martin Schorr

Two new species of *Cordulegaster* Leach, 1815 from Azerbaijan (Odonata, Cordulegastridae)

Vladimir E. Skvortsov¹ & Natalya Y. Snegovaya²

¹Evolution Department, Faculty of Biology, M.V. Lomonosov Moscow State University,
Moscow, 119992, GSP-1, Russia <west-urnus@yandex.ru>

²Zoological Institute NAS of Azerbaijan, proezd 1128, kvartal 504, Baku, AZ 1073,
Azerbaijan <snegovaya@yahoo.com>

Abstract

Two new *Cordulegaster* species are described and illustrated by drawings, photographs and SEM images. The first one, *C. plagionyx* sp. nov., was discovered in NW Azerbaijan in a low-mountain forest landscape; the second, *C. nachitschevanica* sp. nov., occurs in the subalpine zone of Nakhichevan AR, south of the main territory of Azerbaijan. Both new taxa look generally similar to *C. insignis* Schneider, 1845; however, each of them reveals unique features and distinctive combinations of characters that set them apart from other species of the genus. Both new species exhibits new types of sex dimorphism previously unknown in *Cordulegaster*. Some traits related to the structure of male appendages and important details of colouration prevent both *C. plagionyx* sp. nov. and *C. nachitschevanica* sp. nov., from being reliably classified under any of two widely accepted groups of species within the genus *Cordulegaster*: the *boltonii*-group and the *bidentata*-group.

Key words: Odonata, *Cordulegaster*, new species, Azerbaijan, Nakhichevan, Caucasus

Introduction

Azerbaijan presents a relatively new region for odonotological studies. The authors have become the first entomologists to start there a regular, long-term, and country-wide research focused on dragonfly fauna. It has already brought a series of new faunistic data and rich comparative material for some taxonomically difficult groups, e.g. *Coenagrion puella* species complex (Skvortsov & Snegovaya 2015).

Another interesting group in the area is no doubt the genus *Cordulegaster* Leach, 1815. A great number of species and subspecies within the genus are now known in Europe and the Mediterranean, while the Caucasian races and populations are poorly studied. Some authors believe (Dumont 1976; Van Pelt 2006: 220-221; Verschuren et al. 1987) that only one highly polymorphic species is present in the most part of the territory, namely *C. insignis* Schneider, 1845, with a lot of its subspecies ranging from

the large, blue-eyed and very yellow *C. i. nobilis* (Morton, 1916) to the small, green-eyed and extremely dark *C. i. mzymtae* (Bartenev, 1929), which can hardly be considered as belonging to the same species. Unsurprisingly, Lohmann (1993) assigned (or restored) the species level to some of those taxa, and even described another species, *C. helladica* (Lohmann, 1993) closely related to *C. insignis*. When doing this, he especially stressed on the structure of the male anal appendages and considered the differences in body colouration as much less significant. Therefore such species as *C. insignis* s. str., *C. charpentieri* (Kolenati, 1848), *C. montandoni* (St. Quentin, 1971), *C. helladica*, and *C. amasina* (Morton, 1916) can be told from one another much better using some structural features, while their body patterns are often very similar or even identical. Lohmann (1992, 1993) treated *C. nobilis* and *C. coronata* as true species although he did not give their differential diagnoses. This concept provides a sounder base to separate taxa of *Cordulegaster* on both species (structural traits) and sub-species (colouration pattern) levels.

During our field work in Azerbaijan, we discovered two unusually-looking populations of *Cordulegaster* (Figure 1). It was, of course, body colouration (or some of its details) that we noticed first. However interesting these features might look, it could not satisfy us without a close examination of the male appendages. After a careful study involving SEM imaginary we make sure that the structural features of both the morphs are unique, and even taken alone they could constitute a new species for each. Added by other traits including eye colouration, pale and black markings on the head and the abdomen etc., they open a good possibility to describe two well recognizable and easy to identify species now looking endemic for Azerbaijan. The species are also of particular interest for general taxonomy of the genus *Cordulegaster* since some of their traits make them difficult to place into either of the two widely recognized groups of species within the genus *Cordulegaster*: the *boltonii*-group or the *bidentata*-group. All specimens will be deposited in the Institute of Zoology of the Azerbaijan National Academy of Sciences, Baku (IZ ANAS).



Figure 1. Geographical location of Azerbaijan and the type localities (●) of the new species found. – a, *Cordulegaster plagionyx* sp. nov., – b, *C. nachitschevanica* sp. nov.

Cordulegaster plagionyx sp. nov.

Figures 2–6

Derivatio nominis

The name *plagionyx* derived from Old Greek words *plagios* (oblique or obliquely - sideways - directed) and *onyx* (claw), which refers to the way the medioventral teeth in the species' male superior appendages are directed.

Specimens examined

Holotype ♂: Environs of Dzhidzhikhana [Cicixana], Balaken District, Azerbaijan, 41°40'33.9"N 46°29'34.8"E, 316 m a.s.l., 25 vi 2013, VS. Deposited in IZ ANAS.

Paratypes 1♂, same location, 2 vii 2014, VS; 1♀ (allotype), same location, 13 vi 2015, NS. Both deposited in IZ ANAS.

Diagnosis

A medium-sized *Cordulegaster* with the body pattern similar to that in *C. charpentieri* (Kolenati, 1846). Males are blue-eyed; females, in contrast have green eyes.

Description of the holotype, male

Measurements [mm]. Body with head and appendages 73, without appendages 71, Abdomen with appendages 53, without appendages 51. Forewing 45, hind wing 44, pterostigma 4.0 in forewing, 4,5 in hind wing. Superior appendages 2.2, inferior appendages 0.9.

Head (Figure 4b, c) Horizontal surface of frons entirely pale-yellow, almost white. Vertical surface of frons with a well-developed black bowed crossbar forming a typical 'raised eyebrow' figure. Suture between frons and clypeus practically unmarked, only with a small brownish dot in the very middle. Anteclypeus black, postclypeus yellow. Labrum yellow with a thin black rim around it and a very short incomplete brownish streak descending along the median suture. Labium yellow. Antennae and vertex black. Fore side of occipital triangle pale-yellow, almost flat, hind part is bright yellow, strongly inflated. Eyes light blue, turn to yellow-brown post mortem. Postocular area black with wide bright-yellow bands descending along postgenae.

Thorax (Figures 2b, c; 4b, c, d) Hind border of prothorax with a continuous yellow rim and a yellow streak along each side. Yellow antehumeral stripes on synthorax with wavy outer margins; their upper outer corners are almost rounded in frontal view (Figure 4b); however, in dorsal view they appear angular, protruding outwards (Figure 4c). Additional yellow mark between two main yellow bands is long triangular in shape but rather short, as short as $\frac{1}{3}$ the distance between alar sinus and leg bases.

Wing venation as shown on Figure 2d, e. Pterostigma in Hw is longer than that in Fw by 0.5 mm (4 mm and 4.5 mm respectively). Anal triangle 3-celled. Membranula very narrow, smoky-gray.

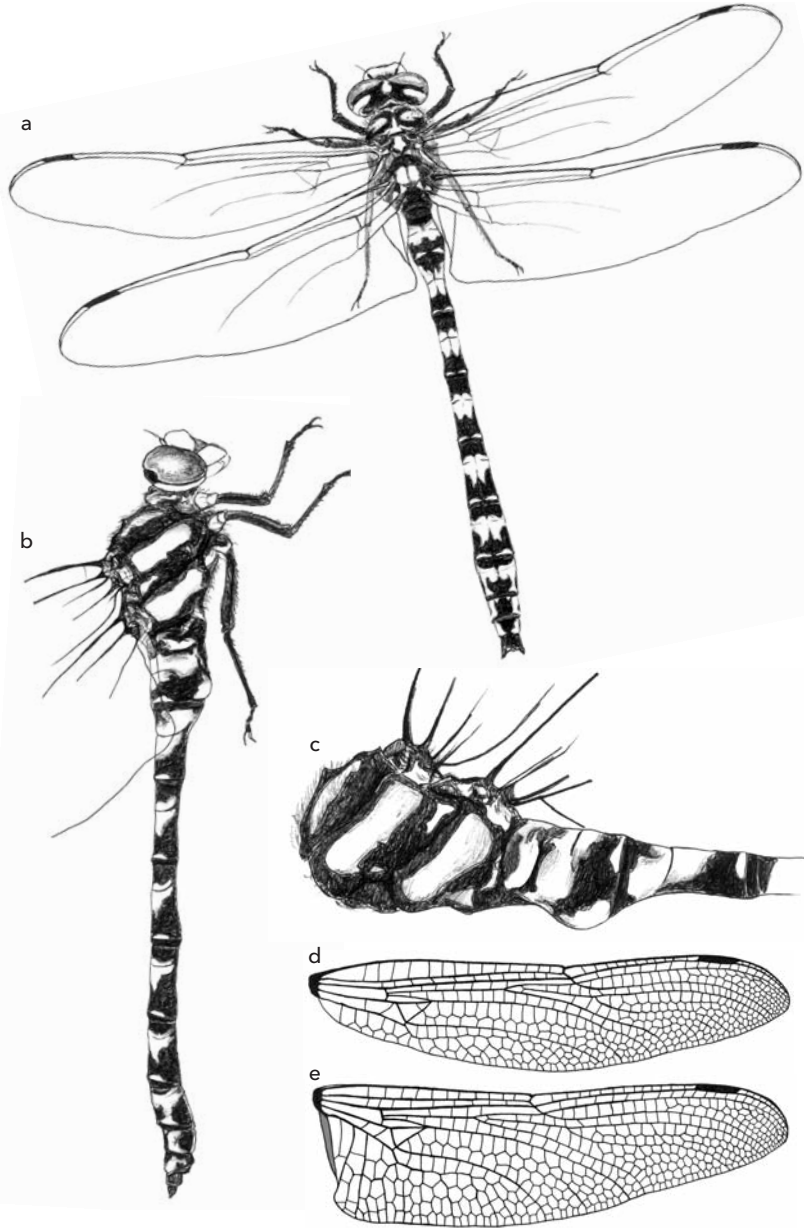


Figure 2. General appearance of the holotype *Cordulegaster plagionyx* sp. nov. – a, dorsal view; – b, lateral view; – c, detail of thorax with abdominal segments 1-3; – d, right forewing; – e, right hind wing. Drawings by Eugeneina V. Semenova

Legs entirely black, except for the bright yellow coxae.

Abdomen Abdominal pattern as shown on Figures 2a, b; 4a, d. Dorsal surface of S1 with indistinct yellow markings, lateral markings not seen from above. Yellow mark on the sides of S1 very large, as long as the entire side of S1 and almost as broad as S1 in its upper portion although the lower portion is rather thin. Dorsal surface of S8 with two 7-shaped yellow figures formed by hind and fore markings connected with each other; however, on S7 they are separated, and the 7-shaped figure is lacking. S10 black in the middle but with two large obliquely diverging yellow lateral spots, each as long as the entire segment. Secondary genitalia as on Figure 5.

Anal appendages (Figure 3) Superior appendages (dorsal view) slender, parallel, with straight outer and inner borders and pointed tips. They do not touch each other themselves; however, their medioventral teeth are horizontally directed, perfectly visible in dorsal view, touching one another. In lateral view, medioventral teeth are hardly visible (at most as smallest blunt knobs). Laterobasal teeth (lateral view) strongly developed, reaching or overlapping inferior appendage, but almost totally covered by distal border of S10. Inferior appendage in ventral view almost quadrate, not tapering to end, with a rather deep notch at top; sides are slightly bent inwards. Its posterior border (caudal view) with irregularly-lobate plates on either side of apex; each plate is roughly serrated with 2-4 obtuse teeth.

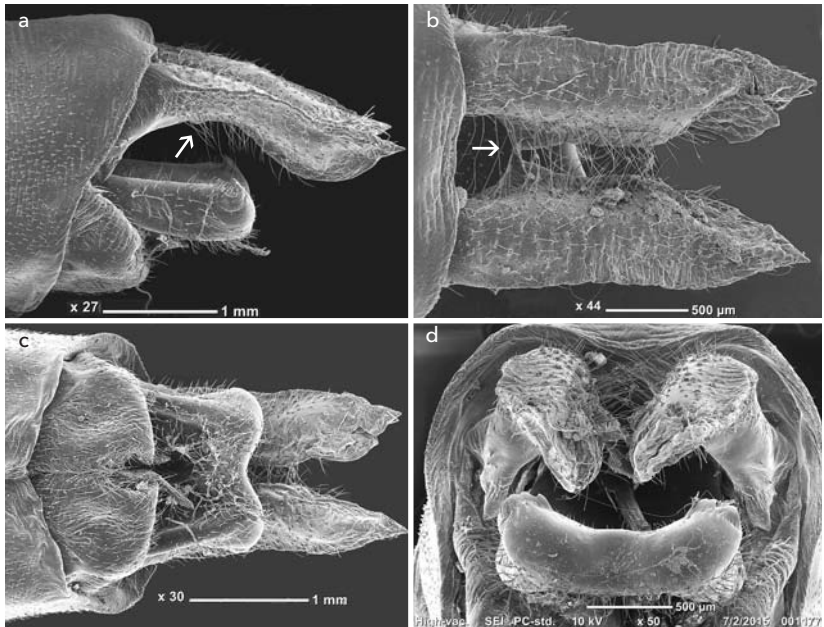


Figure 3. Males anal appendages of the holotype of *Cordulegaster plagionyx* sp. nov. – a, lateral view; – b, dorsal view; – c, ventral view; – d, apical. SEM photographs by NS.

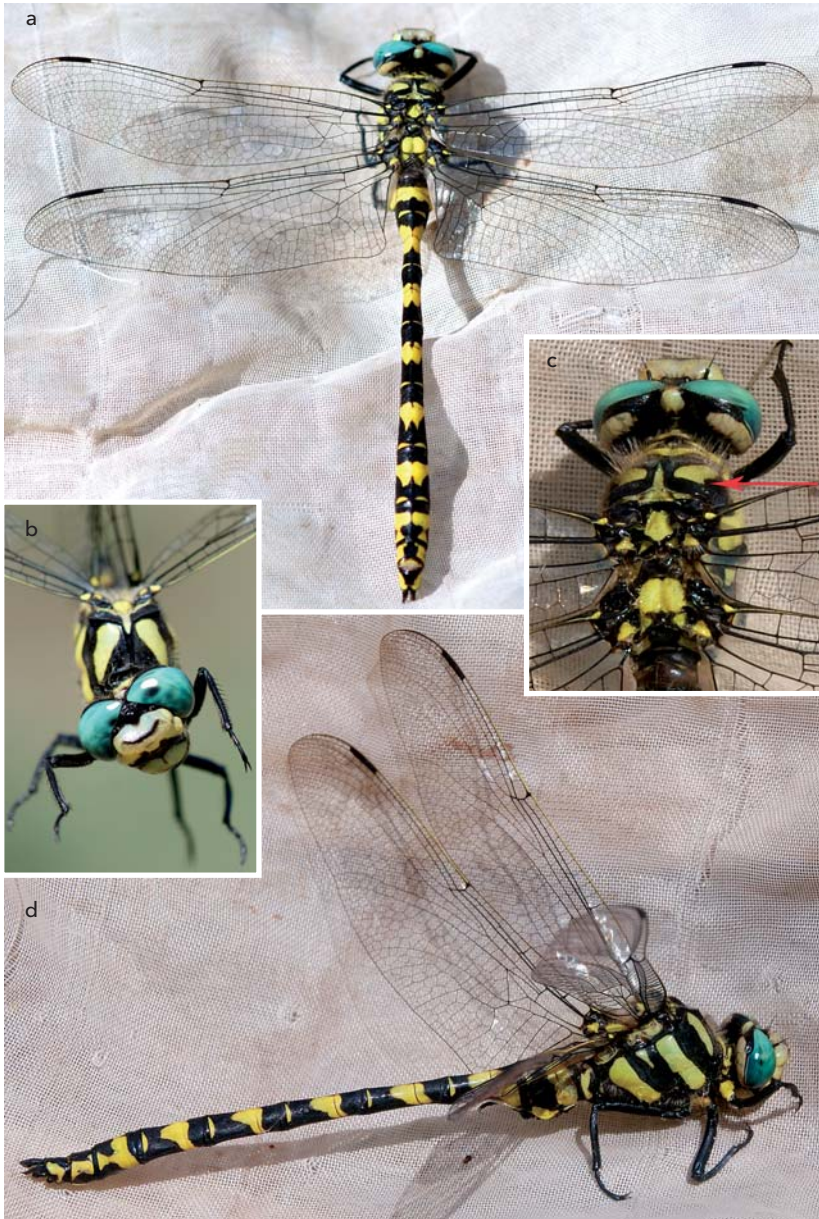


Figure 4. Colour features of the living holotype of *Cordulegaster plagionyx* sp. nov. – a, dorsal view; – b, detail of frons and thorax; – c, detail of thorax and antehumerals, dorsal view; – d, lateral view. Photographs by NS.

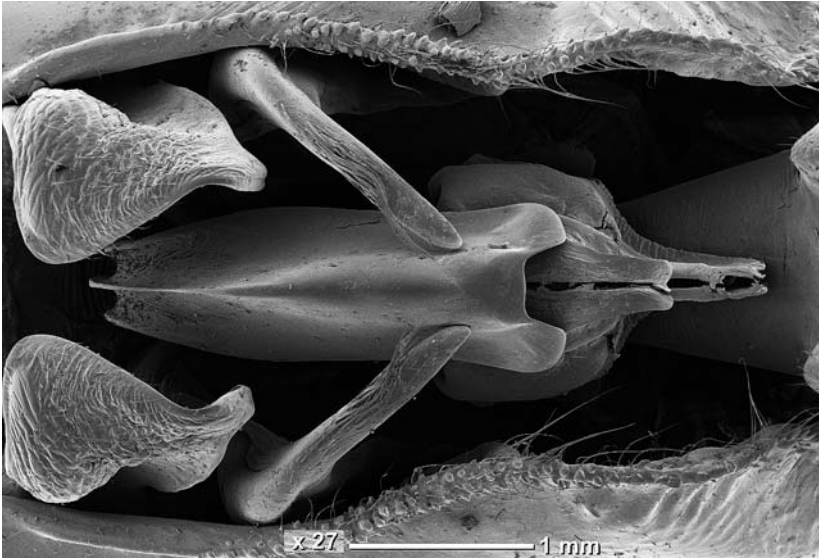


Figure 5. Secondary genitalia of the holotype of *Cordulegaster plagionyx* sp. nov. SEM photograph by NS.

Description of the allotype, female

Female [mm] (Figure 6). Body with ovipositor 80; without ovipositor 78, abdomen with ovipositor 59, without ovipositor 57. Forewing 48, hind wing 47, pterostigma 4.0 in forewing, 5.0 in hind wing. Superior appendages 1.0, ovipositor 8.5, protruding part 2.0.

Head (Figure 6a, b) Eyes light green, not blue. Horizontal surface of frons entirely bright-yellow, much brighter than in males.

Abdomen (Figure 6a, b, c) Dorsal surface of S1 black with two thin yellow streaks converging towards the segment base.

Ovipositor almost entirely black, somewhat brownish at base.

Variation in paratype

This male was a bit larger than the holotype, measurements being mostly the same. **Measurements** [mm]. Body with head and appendages 74, without appendages 72, Abdomen with appendages 53, without appendages 51. Forewing 46, hind wing 45, pterostigma 4.0 in forewing, 4,5 in hind wing. Superior appendages 2.2, inferior appendages 0.9.

Larva unknown.



Figure 6. Colour features of the allotype of *Cordulegaster plagionyx* sp. nov. – a, dorsal view; – b, detail of frons and thorax; – c, lateral view. Photographs by NS.

Distribution

Known only from the *locus typicus* in the low-mountain forest zone of North-Western Azerbaijan between the cities of Zagatala and Balaken (Figure 1a). The population has been observed for three years and appears quite stable, although not very numerous.

Habitat Adult males fly on glades and meadows in the forest and in various open grassy places (used as hayfields or pastures) in Dzhidzikhana village or close to it (Figure 7). Most male individuals are active after 16.00 and fly up to dusk. They normally fly low to the grass and keep close to forest margins or fences surrounding the fields and pastures. The only observed female was captured close to water in the upper reaches of a small shallow fast-flowing river (Figure 7) that crosses the village about 500 m downstream. The river has stony bottom and densely forested banks, so that its watercourse is well-shadowed almost everywhere. No individual was noticed downstream of the village where the river is getting 3–4 m wide and flows in the open. This species co-occurs with a large population of *Caliaeshna microstigma* (Schneider, 1845) that inhabits the upper reaches of the same river.



Figure 7. Small stream above Dzhidzikhana village, Balakan District, Azerbaijan, where *Cordulegaster plagionyx* sp. nov. female was caught. Photograph by VS

Cordulegaster nachitschevanica sp. nov.

Figures 8-12

Derivatio nominis

The name *nachitschevanica* is derived from the name of the Republic of Nakhichevan, an autonomous part of Azerbaijan south of its main territory, where the new species was collected.

Specimens examined

Holotype ♂: Agdere [Ağdərə], Ordubad District, Nakhichevan AR, Azerbaijan, 39°06'37.3"N 45°54'52.3"E, 1,973 m a.s.l., 28 vi 2012, NS. Deposited in IZ ANAS.

Paratype 1 ♀ (allotype), same location and date, NS. Deposited in IZ ANAS.

Diagnosis

A pale, blue-eyed, medium-sized species with an extensively developed yellow pattern on the abdomen, similar to that in *C. nobilis*. Females are easily identified by the sharply angular upper outer corners of their yellow antehumeral stripes on thorax.

Description of the holotype, male

Measurements [mm]. Body with appendages 72, without appendages 70, abdomen with appendages 52, without appendages 50. Forewing 44, hind wing 43, pterostigma 3.7, 3.9 in forewing (left, right wing), 4.4 in hind wing. Superior appendages 2.0, inferior appendages 0.8 in length, 0.9 in width.

Head (Figure 8b) Horizontal surface of frons entirely pale-yellow, almost white. Vertical surface of frons totally yellow. Suture between frons and clypeus unmarked. Anteclypeus black, postclypeus yellow. Labrum yellow with a thin black rim around it (thicker at bottom), but without a black marking along the median suture. Labium yellow. Antennae and vertex black. Both sides of occipital triangle light-yellow, dorsal side moderately inflated; occipital side strongly inflated. Eyes light blue, turn to yellow-brown post mortem. Postocular area black with wide bright-yellow bands descending along postgenae.

Thorax Hind border of prothorax with a continuous yellow rim and a yellow streak along each side. Pale antehumeral stripes on frontal surface of thorax very broad, with almost straight outer margins; and strongly bowed inner ones. Yellow antehumeral stripes on frontal surface of synthorax very broad, with almost straight outer margins; their upper outer corners in both frontal and dorsal view are obtusely-angular, slightly protruding outwards (Figure 8b). Additional yellow mark between two main yellow bands is long-triangular in shape but rather short, as short as $\frac{1}{3}$ the distance between alar sinus and leg bases.



Figure 8. Colour features of the holotype of *Cordulegaster nachitschevanica* sp. nov. – a, dorsal view; – b, detail of frons and synthorax; Photograph by NS

Wing venation as shown on Figure 8a. Pterostigma in Hw is longer than that in Fw by 0.5 mm (4 mm and 4.5 mm respectively). Anal triangle 3-celled. Membranula narrow, whitish.

Legs black except coxae, which are bright yellow.

Abdomen Colour pattern as shown on Figure 8a. Dorsal surface of S1 black with two thin yellow streaks converging towards the segment base. Yellow mark on the sides of S1 very large, as long as the entire side of S1 and almost as broad as S1 in its upper portion although the lower portion is rather thin. Dorsal surface of S8 with two 7-shaped yellow figures formed by hind and fore markings connected with each other; however, on S7 they are separated, and the 7-shaped figure is lacking. Dorsal surface of S8 with two 2-shaped yellow figures connected at its distal margin. Dorsal surface of S10 with an unpaired droplet-like yellow spot in the middle and two large obliquely diverging yellow spots on sides, each as long as the entire segment (Figure 11c). This detail is identical in both sexes. Secondary genitalia as on Figure 9

Anal appendages (Figure 10) Superior appendages (dorsal view) broad and stout, parallel with very shortly pointed tips. Outer margins are straight, whilst inner margins

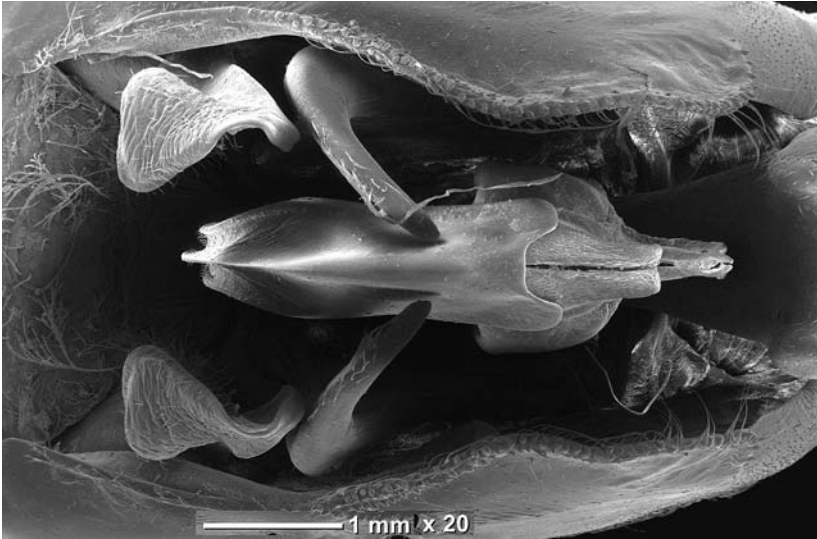


Figure 9: Secondary genitalia of the holotype of *Cordulegaster nachitschevanica* sp. nov. SEM photograph by NS.

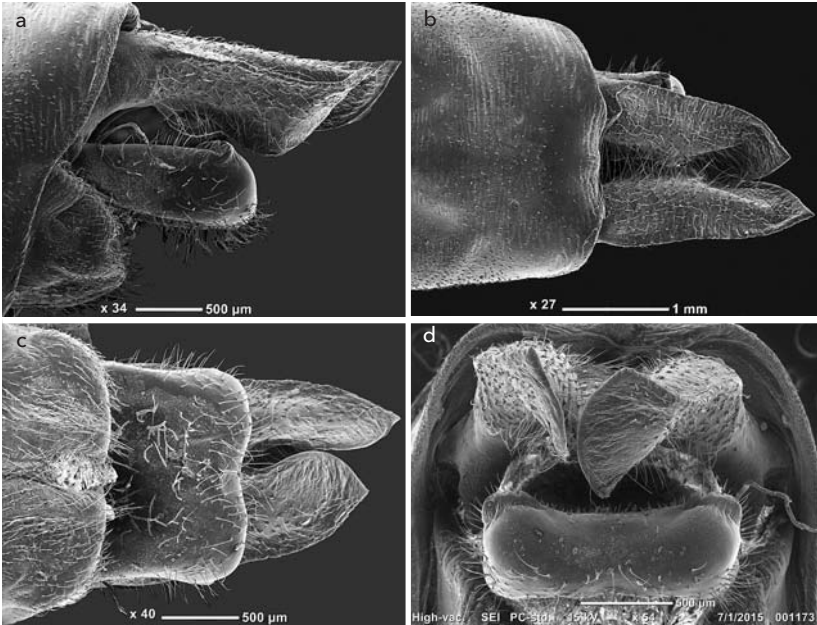


Figure 10. Anal appendages of the holotype of *Cordulegaster nachitschevanica* sp. nov. – a, lateral view; – b, dorsal view; – c, ventral view; – d, apical. SEM photographs by NS.

are wavy and dilated outwards near the middle and close to tips. Their medioventral teeth are well visible from above and directed towards S10, yet they do not touch. On the SEM photographs they seem to nearly do so, but if they are placed normally, so that their outer margins cover those of the inferior appendage, it is clearly seen that the teeth are separated from each other. In lateral view, medioventral teeth also well visible, with their tips pointing back to S10. Laterobasal teeth (lateral view) strong, overlapping inferior appendage, but almost totally covered by distal border of S10, sometimes hardly visible. Inferior appendage (ventral view) more or quadrate, not tapering to end, with length to width ratio <1 ; top is only slightly notched; sides are very gently bent inwards. Its posterior border (caudal view) with one roughly-serrated plate on each side of apex; each plate bears four obtuse teeth.

Description of the allotype, female

Female [mm] (Figures 11, 12) Body with ovipositor 79, without ovipositor 77 mm, abdomen with ovipositor 59, without ovipositor 57. Forewing 48, 49, hind wing 46, 47. pterostigma 3.8, 4.0 of forewing, 4.4, 4.5 of hind wing (left, right wing respectively). Superior appendages 1.0, ovipositor 8.2, protruding part 2.0.

Head Eyes blue as in males. Horizontal surface of frons entirely bright yellow, much brighter than in males (Figures 11b, 12c).



Figure 11: Colour features of the allotype of *Cordulegaster nachitschevanica* sp. nov. – a, dorsal view; – b, detail of frons and synthorax; – c, detail of S9-S10, dorsal view. Photographs by NS.

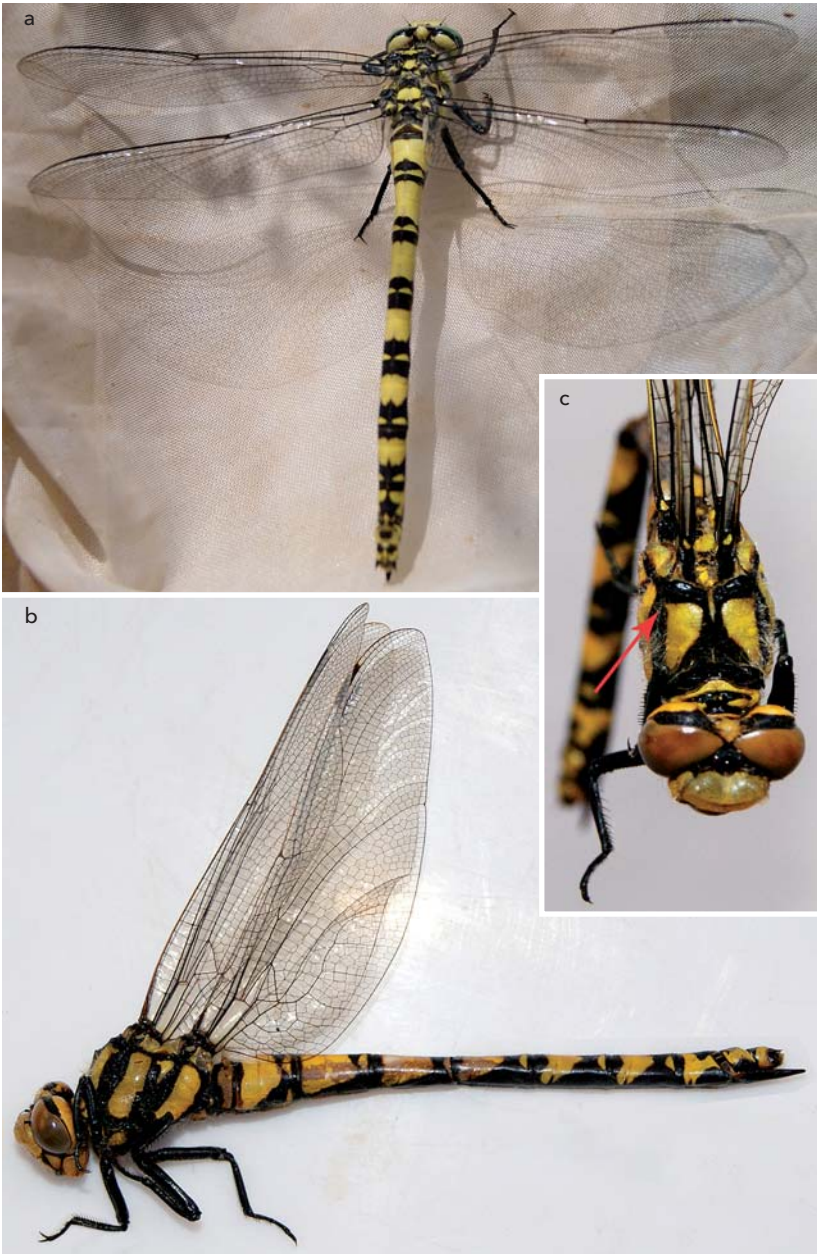


Figure 12: Colour features of the allotype of *Cordulegaster nachtschevanica* sp. nov. – a, dorsal view; – b, lateral view; – c, detail of frons and thorax. Photographs by NS.

Thorax (Figure 12b, c) Yellow antehumeral stripes on frontal surface of synthorax very broad, with almost straight outer margins; their upper outer corners in both frontal and dorsal view are sharply angular and protruding outwards (Figure 12c) with an almost spur-like proximal corner; it reaches $\frac{1}{3}$ the distance between alar sinus and coxa.

Ovipositor almost entirely black, somewhat brownish at base.

Larva unknown.

Distribution

Known only from the *locus typicus* in subalpine zone of Ordubad District, Nakhichevan AR, Azerbaijan (Figure 1b).

Habitat Discovered in a high-mountain semi-open area (ca. 2,000 m a.s.l.) covered with subalpine tall-herb grasslands and shrubby thickets (Figure 13). The small moderately fast-flowing river along which the species flies has rocky banks with sparse vegetation and stony bottom with pools and cascades along the watercourse.



Figure 13: High-mountain, semi-open area at Agdere [Ağdərə], Ordubad District, Nakhichevan AR, Azerbaijan. Photograph by NS.

Differential diagnosis

Cordulegaster insignis (sensu amplissimo) is believed to be the only species with blue eyes in the entire genus (Van Pelt 2006: 220). Since two taxa described above do have blue eyes (males in *C. plagionyx* sp. nov. and both sexes in *C. nakhitschevanica* sp. nov.), it is natural to consider their descriptions in connection with *C. insignis*. To discuss the most important diagnostic features of the new species in a broader context, we compiled a table containing some data on structural traits of male superior appendages for a number of species related (or similar) to *C. insignis* and added our new species to it. Most of the data are taken from Lohmann (1993) because he used these traits to describe *C. helladica* and to support species level of some other taxa. Data on *C. mzymtae* partly are original (VS collected two males in the Western Caucasus close to the locus typicus), partly combine descriptions from Akramovsky & Shengelia (1967) and Dumont & Schneider (1984); all the data concerning the latter species agree well with each other.

From this table alone, without any other data involved, it is clear that each of the new species represents some very rare traits, while their combination is absolutely unique. *C. nakhitschevanica* sp. nov. has reversely directed medioventral teeth, and in having this trait it can be compared only with *C. amasina*. On the other hand, the laterobasal teeth in *C. nakhitschevanica* sp. nov. are very long, overlapping inferior appendage in lateral view, and almost fully covered by the hind margin of S10: both features are otherwise found only in *C. charpentieri*.

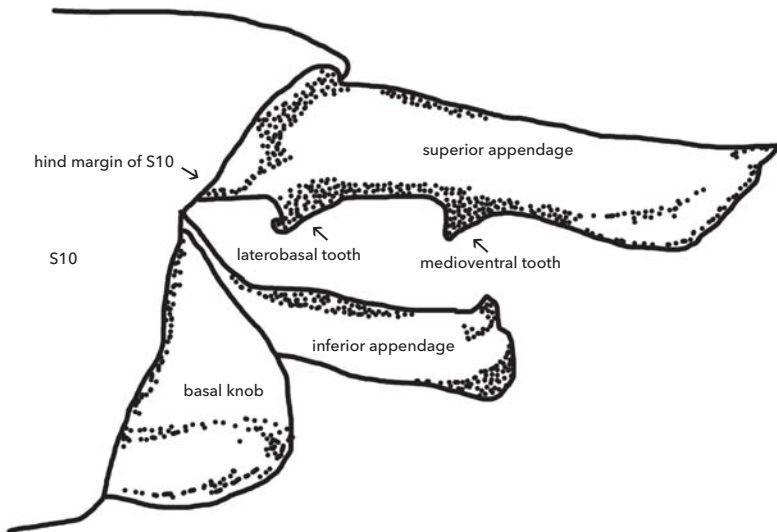


Figure 14: Terminology of *Cordulegaster* male anal appendages as used in Table 1. Re-drawn after Lohmann 1993 (showing the taxon *helladica*).

Table 1. Comparative morphology (see Figure 14 for terminology) of male superior appendages in some *Cordulegaster* species. Unfortunately we were unable to include the taxon *nobilis* by the lack of information about the males anal appendages. Discriminating features are printed in **bold**. – lv, lateral view; dv, dorsal view.

species	laterobasal teeth	medioventral teeth
<i>amasina</i>	lv: close to hind margin of S10 but not covered lv: do not reach inferior appendage	lv: directed towards body lv: clearly visible dv: do not touch each other
<i>charpentieri</i>	lv: almost covered by hind margin of S10 lv: overlap inferior appendage	lv: directed downwards lv: clearly visible dv: do not touch each other
<i>helladica</i>	lv: clearly separated from hind margin of S10 lv: do not reach inferior appendage	lv: directed downwards, somewhat sidewards lv: clearly visible / less clearly visible dv: do not touch each other
<i>insignis</i> s. str.	lv: more or less separated from hind margin of S10 lv: do not reach inferior appendage / almost reach inferior appendage	lv: directed downwards lv: clearly visible dv: do not touch each other
<i>montandoni</i>	lv: clearly separated from hind margin of S10 lv: do not reach inferior appendage	lv: directed sidewards lv: hardly visible dv: do not touch each other
<i>mzymtae</i>	lv: clearly separated from hind margin of S10 lv: almost reach inferior appendage	lv: directed downwards lv: clearly visible dv: do not touch each other
<i>nachitschevanica</i> sp. nov.	lv: almost covered by hind margin of S10 lv: overlap inferior appendage	lv: directed towards body lv: clearly visible dv: do not touch each other
<i>plagionyx</i> sp. nov.	lv: almost covered by hind margin of S10 lv: reach inferior appendage / overlap inferior appendage	lv: directed sidewards lv: hardly visible from side dv: clearly touch each other

In *C. plagionyx* sp. nov. the medioventral teeth are directed exactly sideways, toward each other, therefore hardly visible in lateral view. So far, this condition has been known only in *C. montandoni* (although in some specimens of *C. helladica buchholzi* (Lohmann, 1993) the teeth can be somewhat bent sideways too). However, *C. plagionyx* sp. nov. differs from both *C. montandoni* and *C. helladica* by having the latero-basal teeth covered by the hind margin of S10.

We can equally well express the same idea another way: Both *C. plagionyx* sp. nov. and *C. nachitschevanica* sp. nov. are similar to *C. charpentieri* because in all three species the laterobasal teeth are almost covered by the hind margin of S10. However, in each of them the medioventral teeth are directed differently - downwards in *C. charpentieri*, sideways in *C. plagionyx* sp. nov., and backwards in *C. nachitschevanica* sp. nov. As for *C. helladica*, *C. insignis* s. str., and *C. zmymtae*, they all have more than one important structural feature that differ from each of the new species.

In addition to the unique combinations of traits described above, both *C. plagionyx* sp. nov. and *C. nachitschevanica* sp. nov. possess some distinctive features that set them apart from all similarly looking or related species. In males of *C. nachitschevanica* sp. nov. it is the shape of the male upper appendages in dorsal view: they are broad with straight outer margins and wavy inner margins remarkably dilated outwards in two points, near the middle and close to tips. To our knowledge, no other *Cordulegaster* species have superior male appendages like this. The females possess another unusual character: the yellow antehumeral stripes on frontal surface of their synthorax have sharply angular upper outer corners. Of all other *Cordulegaster* species, this feature is known only in *C. heros* (cf. Theischinger 1979; Van Pelt 2006; Kalkman 2006). Importantly, in the latter, this feature is equally well-expressed in both sexes. Quite the contrary, in *C. nachitschevanica* sp. nov. females exhibit this condition to even greater extend than *C. heros*, whilst in males it is rather hardly noticeable. This kind of sex dimorphism is new for the genus *Cordulegaster*.

The most important structural trait of *C. plagionyx* sp. nov. is that the medioventral teeth in male superior appendages are not simply directed sideways but touching. This condition is not uncommon in species related to *C. boltonii*; however, all of them have diverging upper appendages, while in *C. plagionyx* sp. nov. they are strictly parallel, with straight and not wavy outer and inner margins.

Another extraordinary feature of *C. plagionyx* sp. nov. is, again, a new kind of sex dimorphism, which involves eye colouration. Generally speaking, *Cordulegaster* species can be either green-eyed or blue-eyed (the latter is actually related only to *C. insignis* s.l.). It is possible that males and females have not exactly the same eye colours (e.g. in *C. vanbrinkae* Lohmann, 1993 eyes in males are rather dark green while in females they are very bright green), yet the background colour is the same in both sexes. The rule will hold true even if we combine a number of taxa into one polymorphous species. Within *C. insignis* sensu amplissimo, in some subspecies (such as *C. i. insignis*

or *C. i. charpentieri*) both sexes are blue-eyed whilst in others (*C. i. mzymtae* etc.) they are green-eyed. Thus, as far as we are informed, *C. plagionyx* sp. nov. represent the only case in the whole genus where in males eyes are blue and in females they are green.

Cordulegaster nachitschevanica sp. nov. is not the only *Cordulegaster* species found in Nakhichevan. Akramovsky (1939) identified several specimens collected in this territory as *C. insignis nobilis*; Akramovsky (1948) published more abundant material under the same name from Armenia. In both cited papers he notes that all the local specimens differ from Morton's type by the lack of the yellow 7-shaped figure on S7 and a smooth anterior margin of the yellow dorsal spot on S2. Recently Tailly et al. (2004) reexamined all the Armenian material on *Cordulegaster* and identified it as *C. insignis charpentieri*. Based on this revision, we first published our specimens from Nakhichevan under the same name (Skvortsov & Snegovaya 2014). Actually, in terms of body pattern, our material is not similar to both type specimen *C. insignis nobilis* (cf. Morton, 1916: plate XXXVI) and *C. insignis charpentieri* as it is depicted in Van Pelt (2006: 220) and in Lohmann (1993). Nor has it much to do with *C. insignis lagodechicus* Bartenev, 1929, which both Dumont (1976) and Lohmann (1993) believe to be a synonym of *C. insignis charpentieri*. Moreover, we do not think that minor details of body colouration could help in reliable separation of species within the genus. Our decision to describe the discussed specimens as new species is founded on structural features, which are more promising where colour polymorphism is too strong.

Discussion

Discoveries related to *Cordulegaster* species often lead to new ideas concerning the taxonomy of this highly variable genus. We have no intention to suggest any serious additions or changes to this subject; however, the newly described species open a good possibility to briefly discuss some issues in sub-generic classification of *Cordulegaster*. Two large groups of species are traditionally recognized in the genus, namely *boltonii*-group and *bidentata*-group. Morphological differences between them have been widely discussed, and the most recent summary on them (Van Pelt 2006; Kalkman 2006) involves two main features:

1. In *boltonii*-group, yellow lateral marking on S1 takes the shape of a reverse 'C' and is located along lower hind corner of S2. The same marking in *bidentata*-group appears as a small oblique spot near the middle of S2 (sometimes more or less stretched downwards).
2. Male superior appendages in *boltonii*-group are diverging and said to touch at base. These in *bidentata*-group are described as parallel and not touching at base. The above statements are illustrated in many sources, of which Van Pelt (2006) is the best to compare the different species.

Comparison of the above features with respective morphological characters of both here described species clearly shows that neither *C. plagionyx* sp. nov. nor *C. nachitschevanica* sp. nov. fit well into any the two groups.

1. The yellow lateral marking on S1 in both *C. plagionyx* sp. nov. and *C. nachitschevanica* sp. nov. is extremely large, covering ca. 50% of the segment's lateral surface. In its upper portion it occupies almost the entire width of S1, then stretches down along its hind margin as far as its posteroventral corner. This condition does not match anything supposed to be typical for both *boltonii*-group and *bidentata*-group. It is interesting that although *C. plagionyx* sp. nov. is generally much darker than *C. nachitschevanica* sp. nov., the spot is equally well developed in both species. Therefore, it is not the general yellowness of body colouration that determines the large size of this characteristic element of abdominal pattern in *Cordulegaster*.

2. In addition to the above, *C. plagionyx* sp. nov. reveals a very peculiar combination of traits typical for *bidentata*-group with those known only in *boltonii*-group. As indicated above, the male upper appendages in the species are parallel, with both outer and inner margins being also straight and parallel; on the other hand, their medioventral teeth clearly touch each other. It is necessary to point out here that in *C. boltonii*-group the appendages themselves do not really touch at base despite the usual way to describe their arrangement. In fact, the appendages are well-separated at base in both *bidentata*- and *boltonii*-group and it is only medioventral teeth that touch in the latter (see figures in Van Pelt 2006: 213–221). Hence, the condition found in *C. plagionyx* sp. nov. presents a typical feature of *boltonii*-group 'inserted' into a *bidentata*-like structural environment.

The validness of *boltonii*- and *bidentata*-groups has been revised several times, as well as the placement of certain species into each of them. Dumont & Schneider (1984) considered *bidentata*-group as non-existing; Verschuren et al. (1987) restored the traditional separation into the two groups on the base of larval features. Most recently, Froufe et al. (2014) supported the monophyly of the two groups using molecular markers of a very large sample of Western Palearctic species. However, this research does not involve eastern species, among which there are some poorly studied taxa. *C. mzymtae* was placed by Bartenev first into *boltonii*-group (1929) then into *bidentata*-group (1930). Dumont & Schneider (1984) assign the same species to *boltonii*-group, whilst Verschuren et al. (1987) treat it as a member of *bidentata*-group, and Van Pelt (2006) considers *C. mzymtae* as a subspecies of *C. insignis*.

The discovery of *C. plagionyx* sp. nov. and *C. nachitschevanica* sp. nov. raises again the question of how accurately the two groups can be separated using both colouration and structural features. The eye-colouration sex dimorphism in *C. plagionyx* sp. nov. seems to combine in a single species two patterns, one of which (blue eyes) has been known only in *bidentata*-group. The shape of antehumeral stripes provides a good example of a unique character (the angular outer corner) developed independently in two not closely related species one of which (*C. heros*) is believed to belong

to *boltonii*-group, and the other (*C. nachitschevanica* sp. nov.) looks in general appearance as if it was a member of *bidentata*-group. However, sex dimorphism in this feature found in *C. nachitschevanica* sp. nov. suggests that such trends are rather hard to predict. The genus *Cordulegaster* seems to exhibit a reticular pattern in its morphological evolution, so there may not be any hierarchical approach to satisfactory render its variability.

Acknowledgements

We thank our colleague artist Eugeina V. Semenova for her most valuable artworks made for this article.

References

- Akramovsky [Akramovskij] N.N. 1939. Dragonflies of Nakhichevan Republic (chiefly based on the collection of D.N. Znojko). Nauchnye trudy Yerevanskogo gosudarstvennogo universiteta 9: 47-53. [Russian, English title]
- Akramovsky [Akramovskij] N.N. 1948. Dragonfly fauna of Soviet Armenia. Zoologicheskii sbornik Akademii nauk Armyanskoy SSR. 5: 117-188. [Russian]
- Akramovsky [Akramovskij] N.N. & E.S. Shengelia [Schengelia] 1967. Neue Angaben über *Cordulegaster mzymtae* Barteneff, 1930 (Odonata, Cordulegasteridae). Deutsche entomologische Zeitschrift (N.F.) 14 (3-4): 313-321.
- Bartenev [Barteneff] A.N. 1929. Neue Arten und Varietäten der Odonaten des West-Kaukasus. Zoologischer Anzeiger 85: 54-68.
- Bartenev [Barteneff] A.N. 1930. Die paläarktischen Arten der Gattung *Cordulegaster*. Raboty Severo-Kavkazskoi gidrologicheskoi stantsii pri Gorskomp selskokhozyaystvennom institute 3: 1-32. [Russian, German title and summary]
- Dumont H.J. 1976. *Aeschna charpentieri* Kolenati, 1846, a synonym of *Cordulegaster insignis* Schneider, 1845, and on the correct status of *Cordulegaster charpentieri* auctorum (Anisoptera: Cordulegasteridae). Odonatologica 5: 313-321.
- Dumont H.J. & W. Schneider 1984. On the presence of *Cordulegaster mzymtae*, Barteneff, 1929 in Turkey, with a discussion of its geographic distribution and taxonomic position (Anisoptera, Cordulegasteridae). Odonatologica 13 (3): 467-476.
- Kalkman V.J. 2006. Key to the dragonflies of Turkey, including species known from Greece, Bulgaria, Lebanon, Syria, the Trans-Caucasus and Iran. Brachytron 10: 3-82.
- Kolenati F.A. 1846. Insecta Caucasi. Coleoptera, Dermaptera, Lepidoptera, Neuroptera, Mutillidae, Aphaniptera, Anoplura. Meletemata Entomologica 5: 4-140.
- Lohmann H. 1992. Revision der Cordulegastridae. 1. Entwurf einer neuen Klassifizierung der Familie (Odonata: Anisoptera). Opuscula zoologica fluminensia 96: 1-18.
- Lohmann H. 1993. Revision der Cordulegastridae. 2. Beschreibung neuer Arten in den Gattungen *Cordulegaster*, *Anotogaster*, *Neallogaster* und *Sonjagaster* (Anisoptera). Odonatologica 22: 273-294.

- Morton K.J, 1916. Some Palaearctic species of *Cordulegaster*. Transactions of the Royal Entomological Society London (3-4): 273-290.
- Skvortsov V.E. & N.Y. Snegovaya 2014. Additions to the knowledge of the Odonata fauna of Azerbaijan, with six new records. Notulae Odonatologicae 8 (3): 37-76.
- Skvortsov V.E. & N.Y. Snegovaya 2015. A second addition to the Odonata fauna of Azerbaijan. IDF-Report (in prep.).
- Tailly M., Ananian V. & H.J. Dumont 2004. Recent dragonfly observations in Armenia, with an updated checklist. Zoology in the Middle East 31: 93-102.
- Theischinger G. 1979. *Cordulegaster heros* sp. nov. und *Cordulegaster heros pelionensis* ssp. nov., zwei neue Taxa des *Cordulegaster boltonii* (Donovan)-Komplexes aus Europa (Anisoptera, Cordulegastridae). Odonatologica 8 (1): 23-38.
- Van Pelt G.J. 2006. Cordulegastridae. *Cordulegaster* Leach, 1815 – Goldenrings. In: Dijkstra K.-D.B. & R. Lewington (Eds). Field Guide to the Dragonflies of Britain and Europe. British Wildlife Publishing, Milton on Stour: 210-221.
- Verschuren D., Demirsoy A. & H.J. Dumont 1987. Description of the larva of *Cordulegaster mzymtae*, Bartenev, 1929, with a discussion of its taxonomic position (Anisoptera, Cordulegastridae). Odonatologica 16 (4): 401-406.

INSTRUCTION TO AUTHORS

International Dragonfly Fund - Report is a journal of the **International Dragonfly Fund (IDF)**. It is referred to as the journal in the remainder of these instructions. Transfer of copyright to IDF is considered to have taken place implicitly once a paper has been published in the journal.

The journal publishes original papers only. By original is meant papers that: a) have not been published elsewhere before, and b) the scientific results of the paper have not been published in their entirety under a different title and/or with different wording elsewhere. The republishing of any part of a paper published in the journal must be negotiated with the Editorial Board and can only proceed after mutual agreement.

Papers reporting studies financially supported by the IDF will be reviewed with priority, however, authors working in general with Odonata are encouraged to submit their manuscripts even if they have not received any funds from IDF.

Manuscripts submitted to the journal should preferably be in English; alternatively German or French will also be accepted. Every manuscript should be checked by a native speaker of the language in which it is written; if it is not possible for the authors to arrange this, they must inform the Editorial Board on submission of the paper. Authors are encouraged, if possible, to include a version of the abstract in the primary language of the country in which their study was made.

Authors can choose the best way for them to submit their manuscripts between these options: a) via e-mail to the publisher, or b) on a CD, DVD or any other IBM-compatible device. Manuscripts should be prepared in Microsoft Word for Windows.

While preparing the manuscript authors should consider that, although the journal gives some freedom in the style and arrangements of the sections, the editors would like to see the following clearly defined sections: Title (with authors names, physical and e-mail addresses), Abstract, Introduction, Material & Methods, Results, Discussion, Acknowledgments and References. This is a widely used scheme by scientists that everyone should be familiar with. No further instructions are given here, but every author should check the style of the journal.

Authors are advised to avoid any formatting of the text. The manuscripts will be stylised according to the font type and size adopted by the journal. However, check for: a) all species names must be given in italic, b) the authority and year of publication are required on the first appearance of a species name in the text, but not thereafter, and c) citations and reference list must be arranged following the format below.

Reference cited in the text should read as follows: Tillyard (1924), (Tillyard 1924), Swezey & Williams (1942). The reference list should be prepared according to the following standard:

Swezey, O. & F. Williams, 1942. Dragonflies of Guam. Bernice P. Bishop Museum Bulletin 172: 3-6.

Rebora, M., Piersanti, S. & E. Gaino. 2004. Visual and mechanical cues used for prey detection by the larva of *Libellula depressa* (Odonata Libellulidae). *Ethology, Ecology & Evolution* 16 (2): 133-144.

Citations of internet sources should include the date of access.

The manuscript should end with a list of captions to the figures and tables. The latter should be submitted separately from the text preferably as graphics made using one of the Microsoft Office products or as a high resolution picture saved as a .jpg .tif or .ps file. Pictures should be at least 11 cm wide and with a minimum 300 dpi resolution, better 360 dpi. Line drawings and graphics could have 1200 dpi for better details. If you compose many pictures to one figure, please submit the original files as well. Please leave some space in the upper left corner of each picture, to insert a letter (a, b, c...) later. Hand-made drawings should be scanned and submitted electronically. Printed figures sent by the post could be damaged, in which case authors will be asked to resubmit them.

Manuscripts not arranged according to these instructions may also be accepted, but in that case their publication will be delayed until the journal's standards are achieved.

No	Year	sponsored person or entity	object of funding
100	2014	Xu, X., Nankai University, Tianjin, China	Odonata of Mt Dabieshan in the center of eastern China
101	2014	Rychla, A., Poland	Untersuchung der Libellen in westpolnischen Mooren.
102	2014	Dow, R., UK/The Netherlands	Naming an <i>Onychogomphus</i> from Malaysia
103	2014	Orr, A.G. & V. Kalkman Australia/The Netherlands	Field guide New Guinea Anisoptera
104	2014	Marinov, M., Christchurch, New Zealand	Odonata of Samoa, revisiting the localities from Fraser 1925, 1926, 1927, 1953 and 1956
105	2014	Zia, A., Pakistan	Species Complex of Zygoptera in Himalayan Foothills of Pakistan
106	2014	Garrison, R., USA	Odonata of Guangdong and Hainan Provinces in China
107	2014	Saeed, M. & F. Gujjar, Haripur, Pakistan	Progress study: Distribution and diversity of Odonata with emphasis on Gomphidae and Cordulegastridae in the border region of Pakistan and Afghanistan and China
108	2014 -2015	Kulijer, D., Bosia & Herzegovina	Dragonfly fauna of the Posavina region of Bosnia with special emphasis on the species of European conservation concern
109	2014	Kosterin, O.E., Russia	Odonata of Sen Monorom, Mondulkiri, Cambodia
110	2014	Schröter, A., Germany	Documentation and reorganisation of the Odonata collections of Georgian museums
111	2014	Tennessee, K., USA	Parasitization of Macromiidae nymphs by Mermi- thidae (Nematoda) in northern Wisconsin lakes
112	2014	Dow, R., UK/The Netherlands	Odonata of upper Baram, Sarawak, Malaysia
113	2015	Dow, R., UK/The Netherlands	Odonata of Gunung Melatai, Sarawak, Malaysia
114	2015	Rychla, A., Poland	Status und Habitatwahl von <i>Aeshna subarctica</i> Walker, 1908 in der Niederschlesischen Heide (Bory Dolnośląskie) im Südwesten Polens
115	2015 -2018	Rychla, A., Poland	Neubesiedlung von neuen künstlichen Gewässern durch gefährdete Libellenarten: Eine Beispielstudie aus der Niederschlesischen Heide (Bory Dolnośląskie) im Südwesten Polens
116	2015	Lohmann, H., Germany	Bestimmungsschlüssel der "Cordulegastridae" des Himalayarumes
117	2015	Skvortsov, V.E., Russia	Ecology of <i>Aeshna vercanica</i> and <i>Cordulegaster</i> <i>vanbrinkae</i> rivulets in Azerbaijan
118	2015	Lohmann, H., Germany	Studying <i>Cordulegaster</i> taxa from Icaria and Somos, Greece
119	2015	Kunz, B., Germany	Research on larval morphology in the contact zone of two <i>Onychogomphus</i> ssp. in France