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Sixty new  
dragonfly and  
damselfly species  
from Africa

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*Ceriagrion banditum* Kipping & Dijkstra sp. nov., detail of holotype male in life. Photograph by Jens Kipping; see page 509 of this issue.

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## Sixty new dragonfly and damselfly species from Africa (Odonata)

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**Taxonomic abstract.** The following new species of Odonata are described from Africa: *Umma gumma*, *Africocypha varicolor*, *Chlorocypha aurora*, *Chlorocypha flammea*, *Chlorocypha granata*, *Chlorocypha maxima*, *Pentaplebia mangana*, *Allocnemis vicki*, *Elattonaura aurifex*, *Elattonaura lapidaria*, *Elattonaura tarbotonorum*, *Aciagrion bapepe*, *Africallagma quingentum*, *Agriocnemis canuango*, *Agriocnemis toto*, *Ceriagrion banditum*, *Ceriagrion junceum*, *Ceriagrion obfuscans*, *Pseudagrion aureolum*, *Pseudagrion dactylidium*, *Pseudagrion munte*, *Pseudagrion pacale*, *Pseudagrion sarepi*, *Pseudagrion tanganyicum*, *Anax gladiator*, *Gynacantha congolica*, *Gynacantha pupillata*, *Lestinogomphus calcaratus*, *Lestinogomphus nefrens*, *Lestinogomphus obtusus*, *Lestinogomphus venustus*, *Notogomphus bosumbuli*, *Notogomphus cobyae*, *Notogomphus gorilla*, *Notogomphus intermedius*, *Notogomphus kimpavita*, *Onychogomphus undecim*, *Paragomphus cammaertsi*, *Paragomphus clausnitzerorum*, *Paragomphus darwalli*, *Paragomphus dispar*, *Paragomphus lemperti*, *Phyllogomphus bongorum*, *Tragogomphus grogonfla*, *Eleuthemis eogaster*, *Eleuthemis libera*, *Eleuthemis umbrina*, *Malgassophebia andzaba*, *Neodythemis infra*, *Neodythemis katanga*, *Orthetrum agaricum*, *Orthetrum kafwi*, *Orthetrum lusinga*, *Orthetrum umbratum*, *Porpax mezierei*, *Trithemis hinnula*, *Trithemis legrandi*, *Urothemis venata*, *Zygonyx annika*, *Zygonyx denticulatus* and *Zygonyx dionyx*. The taxonomy of these genera and species-groups and complexes are also discussed: *Chlorocypha*, including the diagnosis of *C. dahli*, *C. ghesquierei* and *C. victoriae*; the *pauli*-group of *Allocnemis*; the *glauca*-group and *vrijdaghi*-complex of *Elattonaura*; the *suave*-complex of *Ceriagrion*, including the diagnosis of *C. mourae*, *C. sakejii* and *C. suave*; the *varians*-group of *Ceriagrion*, including the diagnosis and rejected synonymy of *C. platystigma* with *C. varians*; the *speratus*-group of *Anax*, including the diagnosis and rejected synonymy of *A. rutherfordi* with *A. speratus*; the *bullata*-group of *Gynacantha*, including the diagnosis and rejected synonymy of *G. victoriae* with *G. bullata*; *Lestinogomphus*, including the diagnosis of *L. matilei* and new synonymy of *L.* (formerly *Microgomphus*) *bivittatus* with *Mastigogomphus* (formerly *Neurogomphus*) *chapini*; *Notogomphus*, including the new synonymies of *N. butoensis* with *N. leroyi*, of *N. anaci* and *N. verschuereni* with *N. spinosus*, and of *N. meruensis*

with *N. kilimandjaricus*; the *supinus*-group of *Onychogomphus*; *Paragomphus*, especially the *cognatus*-group, including the diagnoses and new synonymies of *P. bredoi* and *P. xanthus* with *P. serrulatus*, and of *P. interruptus* with *P. machadoi*, and the diagnosis of *P. maynei*; *Eleuthemis*, including the diagnosis and rejected synonymy of *E. quadrigutta* with *E. buettikoferi*; the *saegeri*-group of *Orthetrum*; the *basinicta*- and *longistyla*-groups of *Trithemis*, including the new synonymies of the genera *Anectothemis*, *Congothemis*, *Lokithemis* and *Porpacithemis* with *Trithemis*, and of *T. trithemoides* with *T. apicalis*; and the *flavicosta*-complex of *Zygonyx*.

**Man knows just one fifth of the nine million species of animal, plant, fungus and protist thought to inhabit our planet. Dragonflies and damselflies are regarded as well-known, however. Nevertheless we describe 60 new species, the most to be named at once in 130 years, adding one to every twelve species known in Africa. Each species is colourful and can often be recognised even from a photograph, showing that not all unknown life is indistinct and concealed. The species' beauty and sensitivity can raise awareness for the densest and most threatened biodiversity: freshwater covers less than one percent of Earth's surface, but harbours ten percent of animal species, of which a third may be at risk of extinction. Most of them, like dragonflies, are insects. They are popular indicators of habitat value and quality, but without a name cannot be added to the IUCN Red List. As habitats are rapidly disappearing, more exploratory and descriptive research is needed, support for which has waned. Nature, natural historians and the archives of life they build together are all under threat: our 60 new species are therefore as much an act of desperation as urgency.**

### Introduction

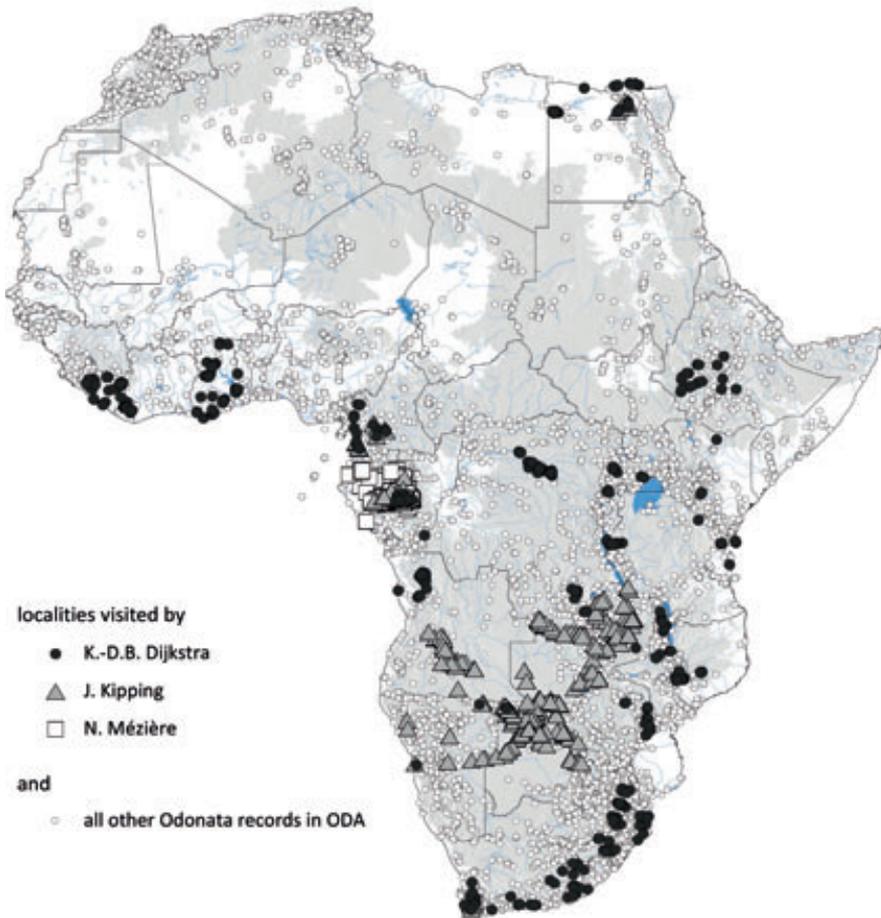
**Unnamed species are anonymous to conservation.** Freshwater is Earth's most intensively exploited environment, covering at most 1% of surface (VÖRÖSMARTY et al. 2010). It harbours 10% of known animal species, of which 32% may be at risk of extinction compared with 24% on land (COLLEN et al. 2014), and up to 80% are insects (DIJKSTRA et al. 2014b). Aquatic insects, possibly the densest of all biodiversity, are much-used indicators of their habitats' demise. Dragonflies and damselflies are especially applicable as 80% of an estimated 7 500 species are known (CLAUSNITZER et al. 2009). While most animal species can fly, few groups applied in conservation represent both the aquatic and aerial realm well, thus neglecting the most reactive biodiversity: climate affects freshwaters directly and flight allows an

active response. The IUCN Red List of Threatened Species is the first step to application (RODRIGUES et al. 2006), but its guidelines exclude unnamed species. Research for the African red list of dragonflies and damselflies revealed almost 10% unnamed species (CLAUSNITZER et al. 2012). A rapid taxonomic solution is needed to remain comprehensive within the five-year reassessment cycle that IUCN recommends.

**Species expertise is essential but poorly supported.** Taxonomy has shifted from lone taxon-focused authors describing many species monographically to teams of tool-oriented (e.g., morphometrics, genetics) authors describing fewer in more papers (COSTELLO et al. 2013). Species discovery may thus seem to be slowing, but as most remain unknown, taxonomic effort itself must be impeded. Tools can improve productivity (e.g., MADDISON et al. 2011), but as each species represents a hypothesis taken on trust until further evidence arises, taxonomic progress ultimately still hinges on the expert's credibility. For example, one of us has seen 78% of African species in the wild, having spent over 1 000 days in the field (Map 1), experience that enables us to condense our species hypotheses to their essence. Similarly, 50% of plant species were discovered by only 2% of collectors (BEBBER et al. 2012). Nonetheless, while even small collections have a Nobel laureate's impact, their build-up and research has been marginalised in science (WINKER & WITHROW 2013). We found 60 new species in the field since 2000, of which 50 just from 2008 to 2012, but only nine during academic employment: as we worked as environmental consultant, 55% were found, and as a school teacher 30%.

**Not all undiscovered species are inconspicuous.** Earth may be inhabited by 8.7 million eukaryote species, but 7 million are not named (MORA et al. 2011). Challenges to this deficit often focus on diversity hidden from human perception (MUTANEN et al. 2013; SMITH et al. 2006). For example, 'new' crocodiles and a wolf from Africa (SHIRLEY et al. 2014; KOEPFLI et al. 2015) and dolphins from Brazil and Australia (HRBEK et al. 2014; MENDEZ et al. 2013) were based on molecular analysis of populations known for hundreds of years. While 4 260 DNA-barcodes of 585 tropical African species (80% of those known) provided an effective molecular control of our taxonomic judgement, and are estimated to conceal another 30 cryptic species, all 60 new species presented

here were identified first in the field or museum. Other studies emphasise the wealth of new species concealed in cryptic groups or remote places (CATERINO & TISHECHKIN 2013; FERNANDEZ-TRIANA et al. 2014; RIEDEL et al. 2013), but ours were found throughout a vast continent and are all colourful, often large, and mostly recognisable even from a photograph, e.g., the massive and bright orange Swordbearer Emperor *Anax gladiator*.



**Map 1.** Localities visited by the authors Klaas-Douwe B. Dijkstra, Jens Kipping and Nicolas Mézière and all other localities with records in the Odonata Database of Africa (ODA).

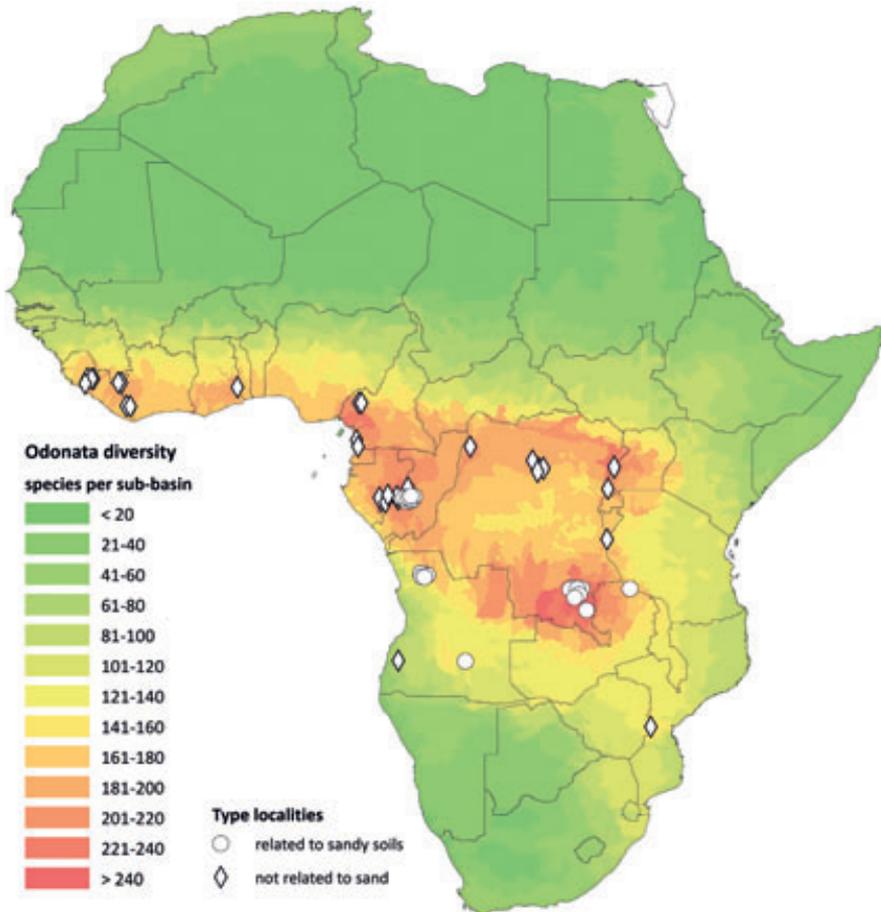
**We name the greatest number of dragonflies and damselflies at once in 130 years.** The final monograph of the founding father of dragonfly systematics contained 100 new nominal taxa (SELYS 1886). Only KIRBY (1890) and LIEFTINCK (1932) neared 50 in a single publication since (M. Wasscher pers. comm.). When Selys published his first African species in 1849, the chance it was unnamed was almost nine in ten. Still less than half had been named when F.C. Fraser began his contribution of 58 valid species in 1926. Elliot Pinhey first encountered more known than unknown species: describing 94 valid species in 32 years, 44 % were nameless when he started in 1950, but 16 % when he retired as the most prolific author in 1981. Those odds may have halved today, we add 8.5 % to the species known, but naming new species is also no longer seen as a primary goal in science (PEARSON et al. 2011). Moreover, processing our taxonomic backlog in the traditional way might have taken over 30 years (see FONTAINE et al. 2012).

**Every species presents a remarkable story of discovery...** Most are colourful, some truly spectacular. Zambia's massive orange Swordbearer Emperor *Anax gladiator* carries a blade at its tail tip. The longleg *Notogomphus gorilla* is as large and dark as the famous ape that shares its Ugandan mountains. Flying over sunny crystal-clear streams in Gabon, the sleek Goldsmith Threadtail *Elattonneura aurifex* and slight Nugget Sprite *Pseudagrion aureolum* glimmer like gold. Scarlet wings render the Red-veined Basker *Urothemis venata* so unmistakable that it was first recognised as new from a photo taken 32 years ago in eastern Congo-Kinshasa. It only resurfaced in 2009, first 1 500 km away in Gabon and then 4 500 km west in Sierra Leone. Such a flashy and widespread species was probably missed because it flies in the rainy season when access to forest swamps is difficult. Both new wisps, each barely a centimetre long, were discovered just 400 m but a season apart: *Agriocnemis canuago* in a downpour, *A. toto* after months of drought. Although all 60 new species have been seen this century, museum specimens over 30 years old were studied for one in three; the oldest from Belgian Congo in 1899: one hundred eleven years on, 50 years after independence, an expedition on the Congo River found definitive proof for the Congo Duskhawker *Gynacantha congolica*.

**Of their environment...** About two out of three new species were found in streams or rivers, and a similar proportion in forest and lowlands respectively: two in five prefer the combination of all three. These habitats have the most stable and amenable conditions and are exactly where most species are expected (Map 2). More notably, almost half occur on the poor sandy soils that stretch from Gabon through Angola and Katanga to Zambia, which absorb high but very seasonal rainfall to provide a permanent abundance of pools, bogs and streams. The latter are very clear and in forest have much leaf litter and dark-stained water due to slow decomposition and leaching tannins. Carnivorous plants, peat moss, grasslands and stunted gallery forests indicate an acidic environment deprived of nutrients. The name of the Redwater Leaf-tipper *Malgassophlebia andzaba* means 'red water' to Gabon's Batéké people, after the water they and the Lovely Fairytail *Lestinogomphus venustus* rely on. The Bongo Leaf-tail *Phyllogomphus bongorum* is named for the Bongo pygmies that also survive in these harsh conditions. Paradoxically, this largely neglected biodiversity hotspot owes its distinct aquatic fauna partly to past aridity. Africa experienced vast climatic changes over millions of years. Sands deposited by deserts expanding deep into central Africa in dry periods, became freshwater havens when wetter times brought rain. Huge parts of Angola and the Congos are unexplored: we predict that most new species still await discovery there (Map 2).

**Of their evolution...** Linking ecology to sexual behaviour may explain why so many species exist. Like birds, males impress mates and rivals with colour, none more so than the jewels with their frantic aerial dances: the Dawn, Flame, Great and Garnet Jewels *Chlorocypha aurora*, *C. flammea*, *C. maxima* and *C. granata* are each a different shade of red. Firebelly males guard small rapids, flashing their bright backs to scare off intruders and waving their coloured bellies to lure mates. The hues of Angola's Sunrise Firebelly *Eleuthemis eogaster*, like clouds in the dawn sky, are unique among dragonflies. The Shadow Firebelly *E. umbrina* from Liberia attracts females with its black-and-yellow underside, but solely in shade. A neighbouring species waves a purely orange belly, but only in full sun. How might such diversity evolve? Africa's great lakes are famous for the rapid evolution of fish species, but as most insects must emerge to reproduce, few profit similarly from

the ecological opportunities deep in these freshwater seas. The Tanganyika Sprite *Pseudagrion tanganyicum* is thus our oddest novelty, only inhabiting the eponymous lake's wave-battered shores. While almost identical to a related species in weedy ponds nearby, males are green rather than red. Which colour stands out in each environment may differ and, if females recognise



**Map 2.** Type localities of all new species, with those related to sandy soils and associated habitats shown separately, projected on the regional diversity of African Odonata species based on inferred ranges, updated and modified from CLAUSNITZER et al. (2012).

males by colour, might be all that prevents interbreeding. What then do the primary colours of the Polychrome Jewel *Africocypha varicolor* from Gabon signal, as its tail can be red, yellow or blue? Why does the glowing red Darkening Citril *Ceriagrion obfuscans* fade into the deep shade of Congo's flooded forests with age? To absorb more heat with its black body, the Rock Threadtail *Elattoneura lapidaria* rests only on reflective rocks in the mist-shrouded heights of Zimbabwe's Chimanimani Mountains, while its relatives perch on shaded plants. Lurking motionless in the gloom by rainforest falls, its larvae clinging to the rocks in the gushing water, the Black Relic *Pentaplebia mangana* is as dark as the manganese ore that is mined within its Gabonese range.

**And of humanity...** The Peace Sprite *Pseudagrion pacale* was discovered on the Moa River near Sierra Leone's diamond capital Kenema. Twenty years earlier villagers trapped between rebel and government forces on opposite banks drowned in these tranquil waters. Two years later Kenema became the national epicentre of the Ebola outbreak. The longleg *Notogomphus kimpavita* was named for the patron saint of the Angolan university where it was found and *N. bosumbuli* after a Congolese word for dragonfly. The horntail *Tragomphus grogonfla* evokes a Liberian pronunciation of 'dragonfly', the sparklewing *Umma gumma* a classic Pink Floyd album (said to be Cambridge slang for making love), and the claspertail *Onychogomphus undecim* simply its date of discovery, 11/11/11. The hooktails *Paragomphus cammaertsi*, *P. clausnitzerorum*, *P. darwalli* and *P. lemperti* and a slew of other species honour those who deserve it most: the taxonomists and facilitators that ensure (often as volunteers) that the world can at least be aware of these species and their fates. We take particular pleasure in honouring our co-author Nico with the Blue-spotted Pricklyleg *Porpax mezierei*. This species is among the eighteen described here found during the seven years that he worked as a teacher in Gabon and the handful of over a thousand libellulids with blue pigment. Most new species are still known too poorly to red-list, but those confined to mountains may be most at risk: mere fragments of suitable forest remain in Cameroon for the Blue-shouldered Yellowwing *Allocnemis vicki*, while goldminers encroach on the Rock Threadtail *E. lapidaria* in Zimbabwe.

### Material and methods

The new species are introduced with the least effort required to comply with the International Code of Zoological Nomenclature, but the most effect for their practical application. All are provided with a (1) scientific and vernacular name; (2) type designation; and (3) brief but conclusive morphological diagnosis. Additionally, (4) one or more sequences of the mitochondrial COI gene are uploaded to BOLD for 93 % of the species; and photographs provided of (5) the holotype for 98 %; (6) the male in life for 51 %; (7) the habitat for 85 %; and (8) drawings of structural details for 93 %.

### Name and authority

While Klaas-Douwe B. Dijkstra, Jens Kipping and Nicolas Mézière are the authors of the full publication, the authority of each species by one or more of these authors and/or Ulf Bjelke, Viola Clausnitzer, Gerhard Diedericks, André Günther, Philippe Lambret, Jochen Lempert, Michel Papazian or Kai Schütte is provided separately.

### Taxonomy

The morphological and genetic evidence for each species is weighted against the taxonomic, geographic and ecological knowledge of its nearest relatives. This often includes taxonomic notes and diagnoses of related species.

### Material

Genetic data is available for specimens with RMNH collection codes (see below). Coordinates of localities are given in decimal degrees in WGS84 format. Acronyms used for collections are: BMNH – Natural History Museum, formerly British Museum (Natural History), London, UK; CAGF – Collection André Günther, Freiberg, Germany; CGVL – Collection Graham Vick, Little London, UK; CJKL – Collection Jens Kipping, Taucha/Leipzig, Germany; CUMZ – University Museum of Zoology, Cambridge, UK; ISNB – Institut royal des Sciences naturelles de Belgique, Brussels, Belgium; MNHN – Muséum national d'Histoire naturelle, Paris, France; MRAC – Musée royal de l'Afrique Centrale, Tervuren, Belgium; NHRS – Naturhistoriska Riksmuseet, Stockholm, Sweden; NMBZ – Natural History Museum of Zimbabwe, Bulawayo, Zimbabwe; RMNH – Naturalis Biodiversity Center, formerly Na-

tionaal Natuurhistorisch Museum Naturalis and Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands; UMMZ – University of Michigan Museum of Zoology, Ann Arbor, U.S.A.; ZMHB – Museum für Naturkunde der Humboldt-Universität, Berlin, Germany; ZMMU – Zoological Museum of Makerere University, Kampala, Uganda; ZMUC – University of Copenhagen, Zoological Museum, Copenhagen, Denmark.

### Genetic sampling

The Naturalis Biodiversity Center may currently house the world's best collection of Odonata, including 88 % of about 730 species known to occur in Africa south of the Sahara. The All Odonata Barcode Initiative generated 9 365 COI sequences of about 1 700 species worldwide, of which 4 260 sequences of 585 sub-Saharan species. 91 % of the African species identified morphologically have unique haplotypes, i.e., only 9 % in pairs or three-somes of closely relatives cannot be separated using this gene. Thus with 93 % of the new ( $n=57$ ) and 80 % of the sub-Saharan species sequenced, and a mean of 7.3 sequences per species, COI data offer strong backing for the morphological, geographic and ecological arguments for species status. Only listed specimens with six-digit RMNH.INS and seven-digit RMNH collection codes were analysed (these prefixes are omitted in the trees): see DIJKSTRA et al. (2014) and HÄMÄLÄINEN et al. (2015) for details on DNA extraction, amplification (including primer combinations) and sequencing. A list of collection codes and corresponding BOLD numbers can be downloaded from the journal website (<http://www.odonatologica.com>).

### Genetic analysis

COI sequences were aligned with MAFFT version 7 (KATOH et al. 2009) under default parameters. After exploring the entire 9 635 sequence dataset using Neighbour Joining analysis, ten partitions with two outgroups each were aligned separately for further analysis. The best-fit models of nucleotide substitution were selected based on the BIC scores obtained from model tests in MEGA (TAMURA et al. 2013): T92 + G for *Elatoneura* and *Orthetrum*; T93 + G for *Anax* and *Eleuthemis*; T93 + G + I for *Ceriagrion*; GTR + G for *Lestigomphus*, *Trithemis* and *Zygonyx*; and GTR + G + I for *Gynacantha* and *Paragomphus*. The same model was assumed for the Maximum Likelihood (ML)

analyses in MEGA and Bayesian inference (BI) analyses in BEAST (DRUMMOND et al. 2012). Support for the ML trees was calculated from 1 000 non-parametric bootstrap replications. For all BI analyses a lognormal relaxed clock was estimated and starting from a random tree (Yule process prior) 50 million MCMC simulations were run, with statistics sampled after every 5 000 iterations. The burn-in was determined by the diagnostics in Tracer (RAMBAUT et al. 2014) for the point of stationarity on the log-likelihood curves and split-frequencies. Statistics of the remaining trees were summarized after exclusion of the burn-in from the posterior sample, and annotated to the tree with the highest clade credibility. The trees were visualized in FigTree 1.4.2 (RAMBAUT et al. 2014) and formatted for publication in Adobe Illustrator.

### Male morphological diagnosis

All new species are diagnosed by adult male characters only. These descriptions cover the variation encountered in all male material studied and thus incorporate the character states encountered in the (always male) holotypes. Features shared with the most similar (group of) species are listed with a letter (a; b; c etc.) and those separating it from that group or species with a number (1; 2; 3 etc.). Morphological nomenclature follows DIJKSTRA & CLAUSNITZER (2014), with the following abbreviations: Ax (antenodal cross-veins); Ax1–2 (first to second antenodal cross-veins); Cux (cubital cross-vein); Fw (fore wing); Hw (hind wing); Pt (pterostigma); S1–10 (first to tenth abdominal segments).

## Calopterygidae

### *Umma gumma* Dijkstra, Mézière & Kipping sp. nov. –

#### Robust Sparklewing

(Type Photo 1, Photos 1–2, Fig. 1)

### Taxonomy

PINHEY (1969) remarked that the variability of *U. longistigma* (Selys, 1869) might conceal unnamed taxa. VICK (1999) noted that two forms with different paraprocts occur together in Cameroon, the typical one having more slender paraprocts, as confirmed by the holotype of *U. longistigma* from that nation in ISNB (Fig. 1). Both forms overlap widely across central Africa, are

easily separated by other characters as well, and differ genetically where they co-occur in Gabon, thus representing good species.

### Material studied

**Holotype** ♂. RMNH.INS.554425, Gabon, Haut-Ogooué Province, Alanga-Aboumi road, Moyol, gravelly and sandy forest river (2–3 m wide, 10–50 cm deep), 424 m a.s.l. (0.8403°S 13.9385°E), 28-ix-2012, leg. N. Mézière, RMNH.

**Further material.** CAMEROON (South Province): 1♂, 26 km E of Campo, Campo-Ma'an National Park (buffer zone), Bitandé River 1 km E of Nkoélon, rocky rainforest river and adjacent roadsides, 70–100 m a.s.l. (2.3940°N 10.0540°E), 16-vi-2008, leg. K.-D.B. Dijkstra, J. Kipping & K. Schütte, RMNH. CONGO-BRAZZAVILLE (Region de Kouilou): 1♂, Conkouati National Park, forest, 50 m a.s.l. (3.7951°S 11.3859°E), 25–26-xi-2010, leg. P.H. Lambret, RMNH. CONGO-KINSHASA (Province Orientale): 1♂, Lilanda and Baombo streams at and upstream of Lilanda and Yafake villages, sandy clear and blackwater streams and river, 390–450 m a.s.l. (0.83°N 24.34°E), 04-v-2010, leg. K.-D.B. Dijkstra, RMNH. 1♂, 20 km NW of Lokutu, between Lukomete and Lunua River, forest streams and clearings, 375–400 m a.s.l. (1.275°N 23.425°E), 01–06-xi-2004, leg. K.-D.B. Dijkstra, RMNH. 1♂, 20 km NW of Lokutu, large shallow, sandy, clear stream (3–5 m wide) in disturbed forest, 410 m a.s.l. (1.0866°N 23.5368°E), 01-xi-2004, leg. K.-D.B. Dijkstra, RMNH. 3♂, Ubundu Road, Yoko Forest, Mokonoka Stream, rock-bottomed (and some sand, gravel, leaf litter) stream and small tributaries in rainforest, 413 m a.s.l. (0.2940°N 25.2888°E), 08-vi-2010, leg. K.-D.B. Dijkstra, RMNH. GABON (Estuaire Province): 1♂ (RMNH.INS.508732), Kougouleu-Medouneu road, Monts de Cristal, Asségone-Essala, mountain stream with rapids and small falls (2–4 m wide, 50 cm deep), 316 m a.s.l. (0.5596°S 10.2362°E), 28-xii-2012, leg. N. Mézière, RMNH. GABON (Haut-Ogooué Province): 1♂, Ndjima, 618 m a.s.l. (1.6643°S 13.0958°E), 21-ii-2009, leg. N. Mézière, RMNH. 1♂, Plateau d'Okouma, road to Vuku, Mounana, gravel-bottomed stream (1–2 m wide) in grassland, 507 m a.s.l. (1.3998°S 13.1920°E), 18-ii-2009, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.506164), righthand road before "Africa No1" radio station in the direction of Franceville, Moyabi, sandy forest river (4 m wide, >50 cm deep) bordered by ponds, 483 m a.s.l. (0.6476°S 13.6800°E),

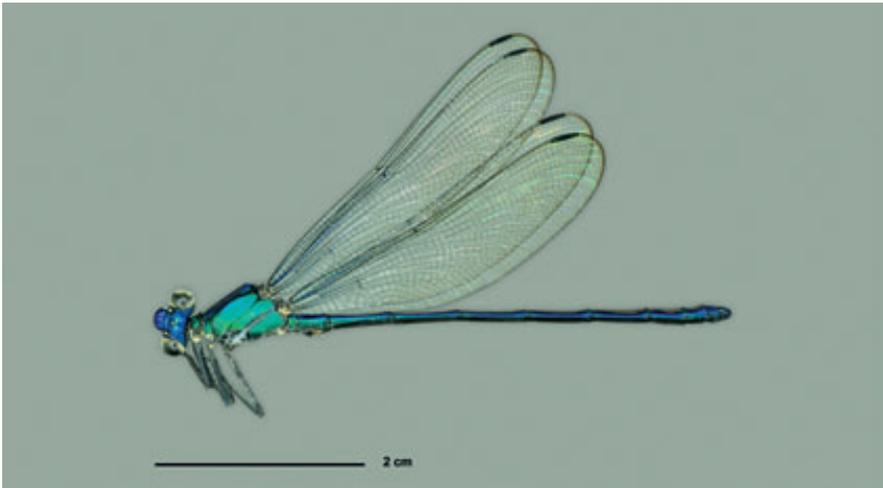
27-iii-2012, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.554468), same locality, small gravelly and sandy forest stream bordered by swamp and springs, 474 m a.s.l. (1.6877°S 13.3113°E), 04-xi-2012, leg. N. Mézière, RMNH. 8♂, Moyabi, concession Rougier, 17 km SSE of Moanda, large sandy stream in dense forest (Photo 2), 398 m a.s.l. (1.7065°S 13.2558°E), 24-ix-2013, leg. J. Kipping, CJKL. 1♂, same locality, same date, leg. A. Günther, CAGF. 1♂, same locality, 17-ix-2013, 1♂ same locality, 01-x-2013, leg. J. Kipping, CJKL.

### Genetics

Four unique haplotypes (n=4) nearest to but distinct from eleven of true *U. longistigma* (n=14).

### Male morphological diagnosis

Similar to sympatric sister-species *U. longistigma* by the combination of (a) a uniformly green to blue metallic head, thorax and abdomen, but dark brown to black legs and poststernum; (b) the largely pale rather than dark mandibular bases; (c) the sparse whitish hairs on the poststernum, rather than a dense patch of long dark hairs; (d) 6–10 cross-veins in the Fw quadrilateral cell; (e) the large Pt with an acute proximal corner, 2.7–3.2 mm; (f) the absence



**Type Photo 1.** Holotype of *Umma gumma* sp. nov., RMNH.

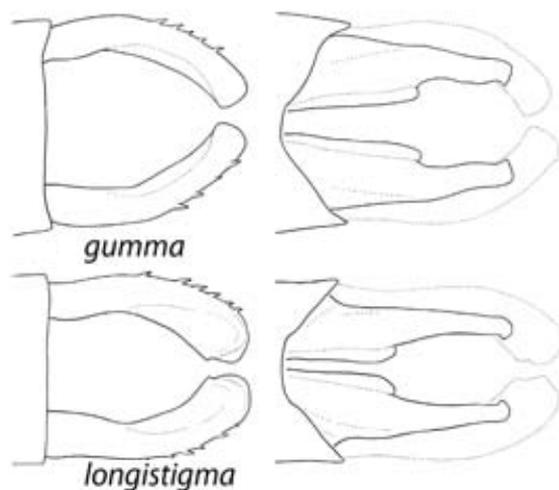
of a clump of thick bristles near the tips of the cerci; and (g) paraprocts that are almost as long as the cerci (Fig. 1). However, is (1) larger with Hw 31.5–35.0 mm (mean 33.6;  $n=15$ ) rather than 30.0–33.0 mm (31.9;  $n=20$ ), with notably more robust build; (2) has a largely pale anterior face to each basal antennal segment, which is entirely dark in most *U. longistigma* specimens, although about a third have indistinct or partial markings; (3) no expansion on the bend of the penis's lateral lobes, but their tips are more widened instead; (4) wide-based cerci that do not expand notably distally and end in unmodified rounded or squarish tips, while in *U. longistigma* the internal flanges widen notably towards the tips, which bear a transverse ridge and hollow, with often a subapical notch or tooth where the flange and ridge meet; and (5) paraprocts that are broad throughout with square-cut tips bearing an inward-directed tooth, rather than slender and tapering to rounded hooked tips (Fig. 1).

### Etymology

Name refers to the classic 1969 Pink Floyd album »Ummagumma« (noun in apposition).

### Range and ecology

Three *Umma* Kirby, 1890 species overlap widely in central Africa's rainforests: *U. mesostigma* (Selys, 1879) – including the probably synonymous



**Figure 1.** Male cerci in dorsal view (left) and paraprocts in ventral view with dotted outline of cerci (right) of *Umma gumma* sp. nov. and *U. longistigma*.

*U. saphirina* Förster, 1916 – is found closest to the source on often gravelly sections, while *U. longistigma* and *U. gumma* appear to co-occur on larger and often sandy streams (Photo 2). The new species has been recorded up to 620 m a.s.l. and favours less shady sections, occurs at lower densities, and comes down to the water only with brighter sunshine.



**Photo 1.** *Umma gumma*, male; Moyabi, Gabon. Photo: JK (24-ix-2013)

**Photo 2.** Sandy forest stream near Moyabi, Gabon. Habitat of *Umma gumma*, *Paragomphus dispar* and *Trithemis legrandi*. Photo: JK (24-ix-2013)



## Chlorocyphidae

### *Africocypha varicolor* Dijkstra, Mézière & Günther sp. nov. – Polychrome Jewel

(Type Photo 2, Photos 3–6, 52, Fig. 2)

#### Taxonomy

Genetically and morphologically notably distinct from other African chlorocyphids, but by its character combination best considered as a third species of the eccentric genus *Africocypha* Pinhey, 1961 (see DIJKSTRA et al. 2014). Remarkable among African Odonata for the discrete male colour forms.

#### Material studied

**Holotype** ♂. Gabon, Haut-Ogooué Province, 14 km SE of Moanda, “Africa No1” radio station, Moyabi, Bapoupou Stream near Madzay, rocky and sandy stream in forest crossing Franceville-Moanda road, 468 m a.s.l., (1.6629°S 13.2916°E), 05-i-2010, leg. K.-D.B. Dijkstra & C. Vanappelghem, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 3♂, as holotype. 6♂ (RMNH.INS.502581), 16 km SE of Moanda, “Africa No1” radio station, Moyabi, Mabégué Stream at Moyabi, swampy stream in rainforest, 484 m a.s.l. (1.6891°S 13.3230°E), 04-i-2010, leg. K.-D.B. Dijkstra, N. Mézière & C. Vanappelghem, RMNH. 2♂ (RMNH.INS.502444, RMNH.INS.502446), “Africa No1” radio station, Moyabi, forest pool, 478 m a.s.l. (1.6890°S 13.3228°E), 18-x-2009, leg. N. Mézière, RMNH. 2♂ (RMNH.INS.502434, RMNH.INS.502453), “Africa No1” radio station, Madjaye, stream (2–4 m wide) with rock and gravel bottom, 462 m a.s.l. (1.6632°S 13.2915°E), 04-ix-2009, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.554540), Bongoville-Léconi road, Boubou River, Ekala, sandy forest stream (1–2 m wide, 5–10 cm deep), muddy edges (Photo 52), 427 m a.s.l. (1.6133°S 13.9124°E), 09-xii-2012, leg. N. Mézière & J. Lekogo, RMNH. 1♂ (RMNH.INS.508765), Franceville-Akieni road, Viticulture road, Assiami, sandy forest stream with numerous adjacent springs, 462 m a.s.l. (1.4410°S 13.7975°E), 16-ii-2013, leg. N. Mézière, RMNH. 9♂, Moyabi, small sandy rainforest stream (Photo 6), 474 m a.s.l. (1.6857°S 13.3094°E), 24-i-2012, leg. A. Günther, CAGF. All same locality: 1♀ (seen in copula), 03-ii-2012, 2♂, 16-ix-2013, all leg.

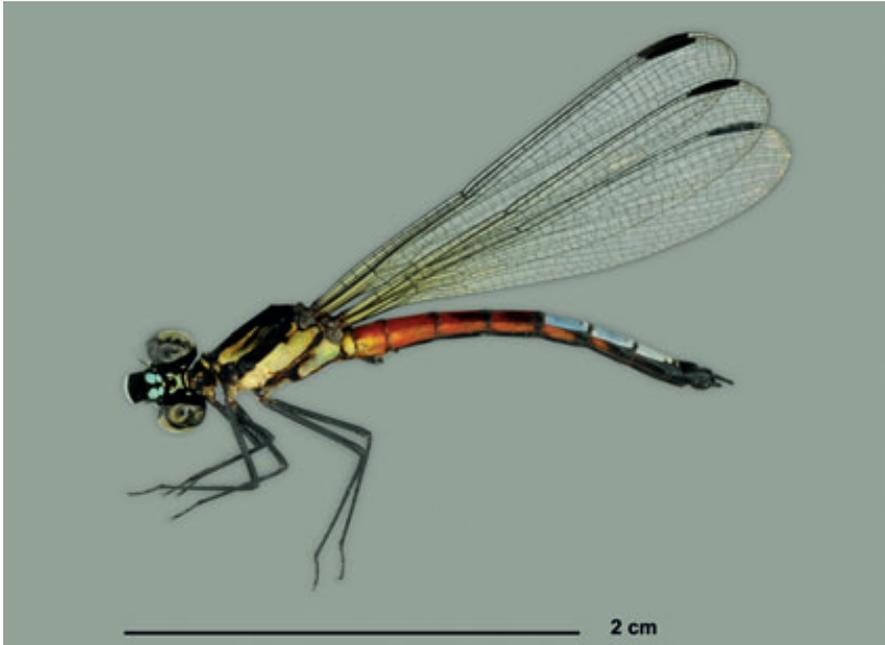
A. Günther, CAGF. 11♂, 24-i-2014, 1♂, 16-ix-2013, 1♂, 24-ix-2013, 7♂, 26-ix-2013, 4♂, 01-x-2013, all leg. J. Kipping, CJKL. 1♂, Bongoville-Léconi road, Ekala, stream Boubou, 393 m a.s.l. (1.6109°S 13.9105°E), 27-i-2012, leg. A. Günther, CAGF.

### Genetics

Four unique haplotypes (n = 7) highly distinct from other family members.

### Male morphological diagnosis

Similar to *A. centripunctata* (Gambles, 1975) and *A. lacuselephantum* (Karsch, 1899) by the combination of (a) the largely blue labrum, anteclypeus and genae; (b) the all black tibiae; (c) the broad abdomen with the dorsa of S9–10 largely black (Fig. 2); and (d) the paraprocts that are half as long as the cerci. However, is (1) smaller, Hw 21–23 mm rather than 24–29 mm; and with maturity (2) the frons and occiput are largely pale blue,



**Type Photo 2.** Holotype of *Africocypha varicolor* sp. nov., RMNH.

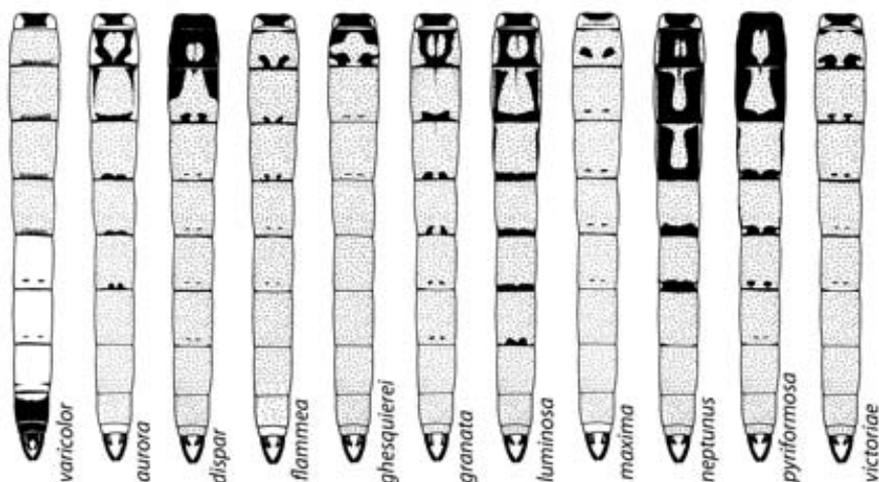
rather than with some greenish spots; (3) the dorsum of S2–5 is red with weakly developed dark apical bars, S6–8 either entirely violet-blue (Photo 3), orange-yellow (Photo 4) or pink-red (Photo 5), S9 black except for the preceding colour at its extreme base, and S10 entirely black (Fig. 2), rather than the dorsum of S2 and sometimes S3 largely black and S3–9 all at least with thick black apical bars; and (4) the ventral portion of the tergites is red marked increasingly with black terminally, from all-red S2–5 to all-black S8–10, rather than all segments appearing rather similar.

### Etymology

Latin “of various colours” refers to the three male colour forms (adjective in nominative singular).

### Range and ecology

Recorded between 425 and 485 m a.s.l. on the border of the sandy Batéké Plateau in south-eastern Gabon, which forms a transition from elevated grassland to lowland rainforest. The species inhabits small clear streams with a sandy bottom and much detritus in gallery forest or at forest edges. The blue male form is most common, the red and yellow forms being known



**Figure 2.** Male abdomens in dorsal view of selection of *Africocypha* (most left) and *Chlorocypha* (others) species.

only from the particularly large population at the type locality. Males with yellow, red and blue abdomen tips all behave territorially: they occupy similar small sunny patches along the stream, mostly perching on vegetation at a height of 0.5–2 m or engaging in threatening flights. A total of five matings were observed, all with red males and without courtship. It is not known if



**Photo 3.** *Africocypha varicolor*, male of the blue colour form; Moyabi, Gabon. Photo: A. Günther (03-ii-2012)



**Photo 4.** *Africocypha varicolor*, male of the yellow colour form; Moyabi, Gabon. Photo: A. Günther (24-i-2012)

the generally discrete colour forms are developmental or genetic, nor what their behavioural function would be. An age-related colour change cannot be excluded, as *A. lacuselephantum* males appear to progress from blue through whitish and orange to red (PINHEY 1971). That species also exhibits



**Photo 5.** *Africocypha varicolor*, male of the red colour form; Moyabi, Gabon. Photo: NM (03-i-2014)



**Photo 6.** Sandy forest stream near “Africa No1” radio station, Moyabi. Type locality of *Africocypha varicolor* and *Paragomphus dispar*. Photo: JK (24-i-2012)

dramatic colour change in females: the almost wholly orange body blackens to leave only blue dorsal spots on the abdomen. Females of the new species are seen rarely, but can also be largely orange as well as blue. It seems they only come to the stream to mate and lay eggs, submerged up to 20 cm deep.

***Chlorocypha aurora* Dijkstra, Kipping & Schütte sp. nov. – Dawn Jewel**  
(Type Photo 3, Photo 7, Fig. 2)

**Taxonomy**

Genetically falls within a poorly resolved group of *Chlorocypha* Fraser, 1928 species that predominates on more open waters, such as large rivers and woodland streams, and includes widespread species like *C. curta* (Hagen in Selys, 1853), *C. fabamacula* Pinhey, 1961, *C. pyriformosa* Fraser, 1947 and *C. victoriae* (Förster, 1914). The present taxon is distinctly marked and



**Type Photo 3.** Holotype of *Chlorocypha aurora* sp. nov., RMNH (horizontally mirrored from original).

therefore, within a genus where structural differences are almost non-existent, worthy of specific recognition.

### Material studied

**Holotype** ♂. Cameroon, South Province, Kienké River at Kribi, large river in degraded rainforest, 10–15 m a.s.l. (2.9347°N 9.9134°E), 10-vi-2008, leg. K.-D.B. Dijkstra, J. Kipping & K. Schütte, RMNH.

**Further material.** CAMEROON (South Province): 3♂ (RMNH.INS.229137, RMNH.INS.500154), 2♀, as holotype, RMNH. 3♂, as holotype, CJKL.

### Genetics

One unique haplotype (n = 2) that is close to those of the complex of species mentioned above.

### Male morphological diagnosis

Near the Upper Guinean *C. luminosa* (Karsch, 1893) and potentially sympatric *C. neptunus* (Sjöstedt, 1900) and *C. pyriformosa* Fraser, 1947 by (a) small



**Photo 7.** *Chlorocypha aurora*, male; Kienké River at Kribi, Cameroon. Photo: JK (10-vi-2008)

size, Hw 18.5–19.5 mm (n=7); and (b) fairly extensive black abdominal markings (Fig. 2). However, is the only *Chlorocypha* species to combine this with (1) a contrastingly yellow-marked head and thorax; (2) yellow-stained wings, especially at their bases; (3) entirely black tibiae with some light pruinosity, rather than with yellow or white anterior streaks; and (4) a reddish orange abdomen with the less extensive black markings on S2 (almost) continuous between the basal and apical border, S3–5 and sometimes S6 each with an apical black bar, and yellow lateral carinae of S4–8 (Fig. 2). The colour of *C. luminosa* has a deeper yellow tone and is more uniform across the body and wings, *C. neptunus* has an especially extensively black abdomen, and *C. pyriformosa* becomes almost red on the abdomen and black on the thorax.

### Etymology

Latin “dawn” refers to the orange coloration (noun in apposition) and the first author’s colleagues of DAWN; the Damselfly Workers at Naturalis (see DIJKSTRA et al. 2014).

### Range and ecology

Near sea level on the Kienké, a large forested river at Kribi in southern Cameroon.

## ***Chlorocypha flammea* Dijkstra & Clausnitzer sp. nov. – Flame-tipped Jewel**

(Type Photo 4, Photo 8, Fig. 2)

### Taxonomy

Confused with the poorly understood *C. victoriae*, which was also described from Uganda (Entebbe) and may be locally sympatric. FÖRSTER’S (1914) two males were not found in UMMZ and thus seem lost (GARRISON et al. 2003). He described the abdomen as red, which is true for two *Chlorocypha* species in the region. FRASER (1950) mentioned a »frons with a large blue or bluish green spot« for *C. victoriae*, which better fits *C. trifaria* (Karsch, 1899), while PINHEY (1967) mentioned both blue frontal spots and white-streaked tibiae, a combination of characters not known in the genus. To end the confusion, we select a male labelled »*C. rubida*, Kyagwe Coast. R. Uganda. H. Carpen-

ter« and »E.C. Fraser Bequest. Brit. Mus. 1963–234.« in BMNH as neotype, which agrees with FRASER'S (1949) redescription of *C. victoriae* based on material »from a coast stream on the Karagwe side of Lake Victoria, south of Entebbe, collected by G. Hale Carpenter«. Karagwe is on the Tanzanian side of the lake and is taken to be a misinterpretation of Kyagwe on the Sezibwa River. The specimen (Hw 23.0 mm) has only limited and poorly contrasting brown markings on the head and thorax, the mid and hind tibiae all white anteriorly and an all-red abdomen marked as in Figure 2. The species described here is sufficiently distinct in morphology to be treated as such by DIJKSTRA & CLAUSNITZER (2014). Moreover, it is genetically nearer the blue *C. aphrodite* (Le Roi, 1915) than to specimens assigned to *C. victoriae* and similar red species.

### Material studied

**Holotype** ♂. Uganda, Bundibugyo District, 20 km NW of Fort Portal, Semliki National Park, Ntandi, Nkisi River, shallow, sandy river (and small-



**Type Photo 4.** Holotype of *Chlorocypha flammea* sp. nov., ZMMU.

er streams) flanked by bushes in open rainforest, 700 m a.s.l. (0.815°N 30.1433°E), 29-v-07-vi-2003, leg. K.-D.B. Dijkstra, ZMMU.

**Further material.** UGANDA: 2♂, as holotype, RMNH. 2♂ (RMNH. 5009370, RMNH.5009528), Kibale National Park, Dura River at Chimps Nest, 1 141 m. a.s.l. (0.4093°N 30.4063°E), 15-vii-2014, leg. V. Clausnitzer, RMNH.

### Genetics

Two unique haplotypes (n=2) nearest to five of *C. aphrodite* (n=6).

### Male morphological diagnosis

Similar to the potentially sympatric *C. victoriae* by (a) the largely black labrum with two poorly defined dark brown spots; (b) the white streaks on the anterior surface of the mid and hind tibiae; (c) the largely red abdominal dorsum; and (d) the black markings on the dorsum of S2 lying near the apical border, curved laterally and not extending to base (Fig. 2). However, has (1) greater size, Hw 23.0–25.0 mm (n=3) rather than 20.0–22.5 mm; (2) the markings on the head, thorax and abdomen underside are pale greenish rather than dark brown and thus more contrasting; (3) the basal third to half of the fore tibiae also with a white streak, rather than wholly black; and



**Photo 8.** *Chlorocypha flammea*, male; Semliki National Park, Uganda. Photo: H.-J. Clausnitzer (27-x-2005)

(4) the red on the abdominal dorsum is not uniform but on S8–9 grades to a yellow S10.

### Etymology

Latin “fiery” refers to the flame-like transition of the abdomen from red to yellow (feminine adjective).

### Range and ecology

Forested streams and small rivers between 700 and 1 230 m a.s.l. in western Uganda, now known from Mitano Gorge and several sites in Kibale, Queen Elizabeth and Semliki National Parks.

## *Chlorocypha granata* Dijkstra sp. nov. – Garnet Jewel

(Fig. 2)

### Taxonomy

No recent material and thus genetic data for this species is available, but its coloration is distinctive. Confusion is possible with the poorly known *C. ghesquierei* Fraser, 1959 described also from north-western Congo-Kinshasa. Based on the holotype and topotypical material from Eala in MRAC, the male differs subtly from similar species with (a) an all-red abdominal dorsum; and (b) all black legs; by being (1) fairly small, Hw 21.0–22.0 mm rather than 22.0–25.0 mm; having (2) a dark face with prominent double pale (probably yellow or blue in life) spots on the labrum and pale genae extending as narrow wedges along the eyes; (3) a dark thorax with the pale ante-humeral stripes obscured with age, leaving only two yellowish bands on the sides; and (4) a quite extensively black dorsum of S2 contrasting with the almost unmarked remaining abdomen (Fig. 2).

### Material studied

**Holotype** ♂. Labels »COLL. MUS. CONGO, Ubangi: Ebuku, IX-1935, A. Bal«, »*Chlorocypha luminosa* (Karsch) 1959 det. F.C. Fraser«, MRAC. No specimen photograph available.

**Further material.** 1♂, as holotype, MRAC. 2♂ with labels »COLL. MUS. CONGO, Bomboma (Terr. Giri) -IV-1935, A. Bal«, »*Chlorocypha selysi* (Karsch) 1959 det. F.C. Fraser«, MRAC.

### Genetics

No data available.

### Male morphological diagnosis

Recalls the western African *C. dispar* (Palisot de Beauvois, 1807) and potentially sympatric *C. pyriformosa* by (a) the small size, Hw 19.5–21.0 mm ( $n = 4$ ); (b) the extensively black head, including the all black labrum, and thorax, both with quite limited and inconspicuous brown markings; (c) the anteriorly white-streaked mid and hind tibiae, but black fore tibiae; (d) the red abdominal dorsum; and (e) the black markings on S2 enclosing a central red marking (Fig. 2). However, (1) the middorsal carina of the thorax is dark as in *C. dispar*, not contrastingly pale as in *C. pyriformosa*; (2) the anterior faces of the mid and hind tibiae are entirely white as in *C. pyriformosa*, while the mid is only half white in *C. dispar*; and (3) S2–3 are red rather than extensively black laterally, S2 is marked with an oval spot dissected by a black line over the dorsal carina recalling a coffee bean, S3–5 have paired thick black spots fused to apices, and S6–7 paired subapical dark hyphens (Fig. 2).

### Etymology

Latin “having a grain” refers to the kernel-shaped marking on S2, but indirectly also to the species’ red colour as in the words pomegranate and garnet (feminine adjective).

### Range and ecology

Only known from the type material collected 80 years ago in the Kungu area at around 385 m a.s.l. in north-western Congo-Kinshasa. Possibly inhabits swamp forest.

### *Chlorocypha maxima* Dijkstra, Kipping & Mézière sp. nov. – Great Jewel

(Type Photo 5, Photos 9–10, Fig. 2)

### Taxonomy

This species was initially identified as *C. dahli* Fraser, 1956 that is known with certainty only from the holotype in ZMUC from eastern Cameroon,

but its character combination is unique compared with photographs of that specimen provided by N.P. Kristensen. It is also genetically notably distinct from other chlorocyphids.

### Material studied

**Holotype** ♂. RMNH.INS.508083, Gabon, Ngounie Province, Montagne de Chaillu, 21 km NE of Moukabou, small sandy stream in dense forest, 641 m a.s.l. (1.4816°S 11.8009°E), 18-ix-2013, leg. J. Kipping, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 4♂, 33 km S of Franceville, Mopia, Bai on Djoumou River, large sandy river, 414 m a.s.l. (1.9219°S 13.6759°E), 11-i-2010, leg. K.-D.B. Dijkstra, N. Mézière & C. Vanappelghem, RMNH. 3♂, Bakoumba River between Bakoumba-Ville and -Village, sandy river in rainforest, 544 m a.s.l. (1.8576°S 13.0148°E), 02-i-2010, leg. K.-D.B. Dijkstra & N. Mézière, RMNH. 2♂, La Lékédi, Bakoumba, large sandy river in forest, 591 m a.s.l., (1.7594°S 12.9501°E), 30-iv-2009, leg. C. Vanappelghem & N. Mézière, RMNH. 1♂, Moanda, sandy forest stream (2–3 m wide), 423 m a.s.l. (1.5555°S 13.1195°E), 07-iii-2010, leg. N. Mézière, RMNH. 1♂, same locality, 28-ii-2010, leg. N. Mézière, RMNH. 1♂, forest road on right at exit of Moanda, Kounda, sandy stream (4 m wide, 50 cm deep), 423 m a.s.l. (1.5555°S 13.1195°E), 13-xi-2010, leg. N. Mézière, RMNH. 1♂, Etéké road, Yeno, sandy and gravelly forest stream, 527 m a.s.l. (1.5845°S 11.5093°E), 23-iv-2011, leg. N. Mézière, RMNH. 1♂, les eaux claires, Bakoumba, small sandy/gravel river in forest (<2 m), 680 m a.s.l. (1.6812°S 12.9018°E), 30-iv-2009, leg. C. Vanappelghem & N. Mézière, RMNH. 1♂, Bakoumba road, Landébengué, sandy forest river (4 m wide, 40–80 cm deep), 404 m a.s.l. (1.6234°S 13.1330°E), 17-x-2010, leg. N. Mézière, RMNH. 1♂, Moanda-Bakoumba road, Lemagna, sandy forest stream (2–3 m wide), 493 m a.s.l. (1.6132°S 13.0945°E), 26-ii-2011, leg. N. Mézière, RMNH. 1♂, Bakoumba road, village 3 km before Kounda, Mikouangna (Mouyeugue), sandy river (>2 m wide), 520 m a.s.l. (1.5911°S 13.1552°E), 26-v-2009, leg. N. Mézière, RMNH. 1♂, Bakoumba road, Kounda, Mbéressé, sandy forest river, partly open and sunny (3 m wide, 50–100 cm deep), 484 m a.s.l. (1.5859°S 13.1563°E), 06-x-2012, leg. N. Mézière, RMNH. 1♂, Konda, 11 km W of Moanda, sandy stream in dense forest, 423 m a.s.l. (1.5555°S 13.1195°E), 30-i-2012, leg. J. Kipping, CJKL.

1♂, Mopia, 428 m a.s.l. (1.9132°S, 13.6347°E), 01-ii-2012, leg. A. Günther, CAGF. 1♂, Makokou, broad river with swamps, 494 m a.s.l. (0.5577°N 12.6141°E), 30-xii-2011, leg. N. Mézière, CAGF. GABON (Ngounie Province): 1♂ (RMNH.INS.508836), Parc National des Monts Birougou, sandy forest stream (4 m wide, 50 cm deep) (Photo 10), 747 m a.s.l. (1.9655°S 12.2188°E), 05-ix-2013, leg. N. Mézière, RMNH.

### Genetics

Two unique haplotypes (n=2) nearest to *C. helenae* Legrand, 1984 and highly distinct from other *Chlorocypha* species, although *C. dahli* was not available for analysis.

### Male morphological diagnosis

Similar to *C. dahli* by its (a) largely bright occiput, postclypeus, genae and mandibular bases that contrast with the wholly black anteclypeus and labrum and largely black frons; (b) bright ante-humeral stripes that cover



**Type Photo 5.** Holotype of *Chlorocypha maxima* sp. nov., RMNH.

most of the mesepisterna; (c) red abdominal dorsum with black markings reduced to a pair of large subapical dots on S2 and smaller pairs on S3–4 and sometimes S5–6 (Fig. 2); and (d) boldly black and yellow abdomen underside. However, unlike it and most *Chlorocypha* has (1) large size, Hw 25.5–28.0 mm (n = 10) rather than 23.0 mm (n = 1); (2) olive-green rather than orange markings on the head and thorax; (3) blue-white apical 75–80 % of the anterior face of the hind tibiae and apical 0–30 % of the mid tibiae, rather than yellow-white apical 80 % of the front and mid tibiae; and (4) yellow dorsum of S10 contrasting with red on S2–9. *Chlorocypha* species often have



**Photo 9.** *Chlorocypha maxima*, male; Mbéressé Stream, Kounda, Gabon. Photo: NM (25-i-2013)



**Photo 10.** Mandjougou stream in Parc National des Monts Birougou, Gabon. Habitat of *Chlorocypha maxima*. Photo: NM (05-ix-2013)

white and sometimes yellow streaks on both the mid and hind tibiae, and sometimes on the fore tibiae as well, but both their presence and absence on only the hind pair is unusual, as is their apical rather than basal position.

### Etymology

Latin “greatest” refers to the species’ exceptional size (feminine adjective).

### Range and ecology

Calm sandy but often somewhat turbid (i.e., silty) streams in rainforest between 400 and 750 m a.s.l., especially in and around the Chaillu Mountains of southern Gabon.

## Pentaplebiidae

### *Pentaplebia mangana* Dijkstra, Lambret & Mézière sp. nov. – Black Relic

(Type Photo 6, Photos 11–12, Fig. 3)

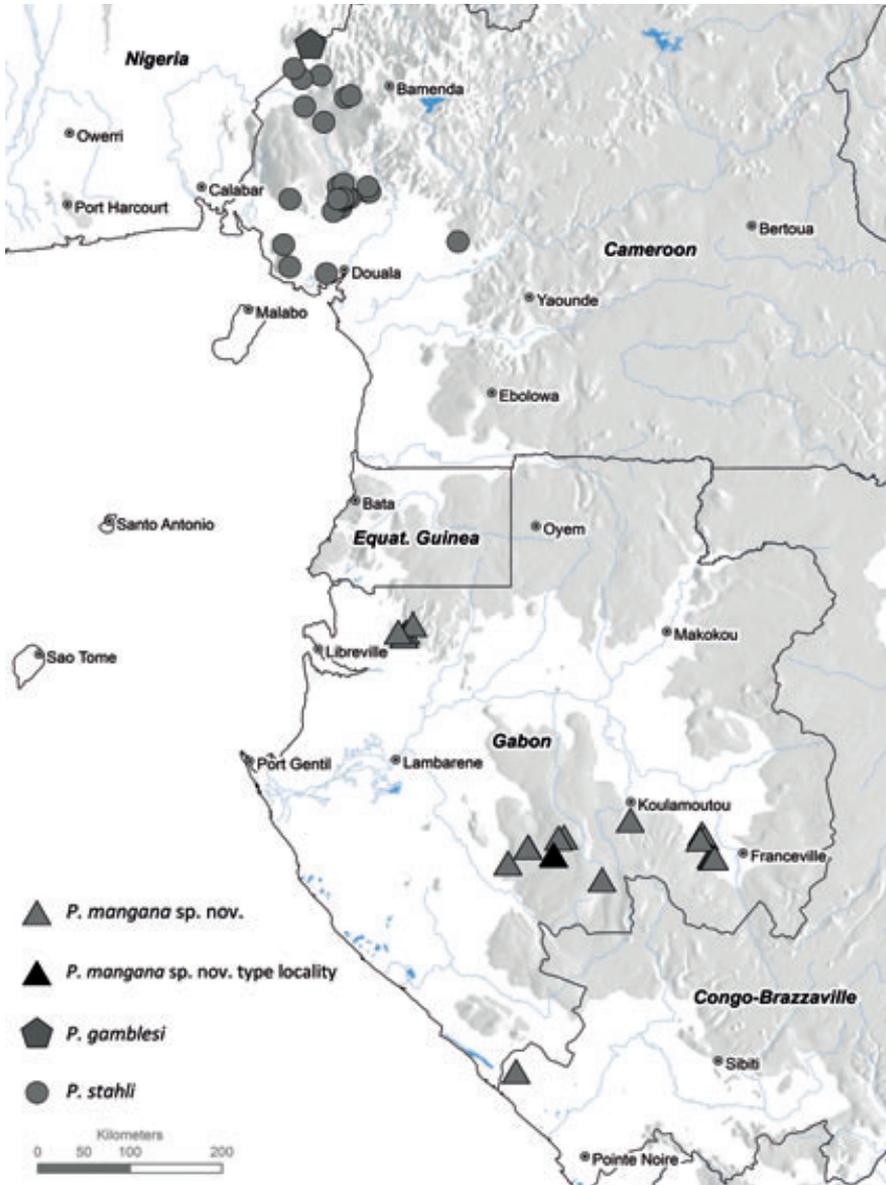
### Taxonomy

DIJKSTRA et al. (2014) separated *Pentaplebia* Förster, 1909 as a monogeneric family, which is currently the only endemic odonate family known from the African continent. The new species is the first of the genus to be found south of Cameroon and to have largely black rather than red coloration (Map 3).

### Material studied

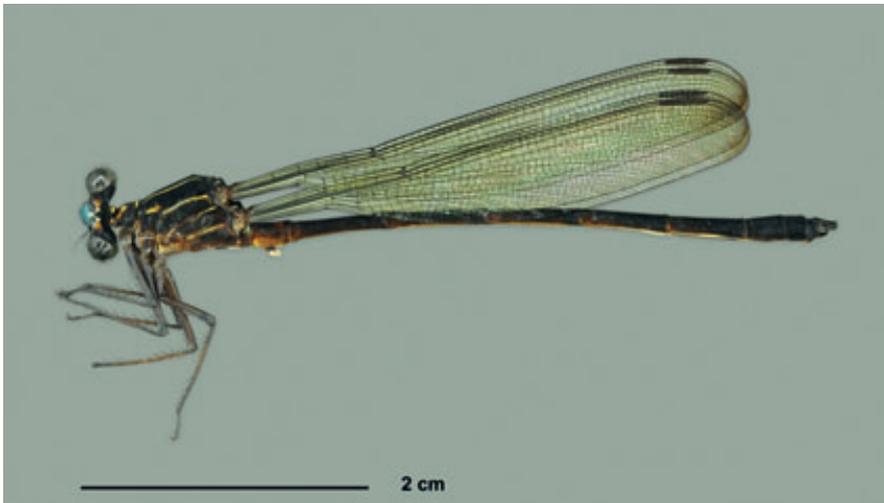
**Holotype** ♂. Gabon, Ngounie Province, Mouyanama, Pougui, mountain stream (1–1.5 m wide) with falls, 624 m a.s.l. (1.6443°S 11.7502°E), 22-iv-2011, leg. N. Mézière, RMNH.

**Further material.** CONGO-BRAZZAVILLE (Region de Kouilou): 1♂ 2♀, Conkouati National Park, forest, 90 m a.s.l. (3.7951°S 11.3858°E), 25-ii-2010, leg. P.H. Lambret, RMNH. GABON (Estuaire Province): 1♂ (RMNH.INS.508736), Monts de Cristal, Kougouleu-Medouneu Road, Asségone-Essala, mountain stream with rapids and small falls (2–4 m wide, 50 cm deep), 469 m a.s.l. (0.5596°N 10.2362°E), 28-xii-2012, leg. N. Mézière & J. Lekogo, RMNH. GABON (Haut-Ogooué Province): 3♂ (RMNH.INS.502559), 14 km SE of Moanda, “Africa No1” radio station, Moyabi,



**Map 3.** Distribution of the three *Pentaplebia* species: *P. gamblesi*, *P. mangana* sp. nov. and *P. stahli*.

Bapoupou Stream near Madzay, rocky and sandy stream in forest crossing Franceville-Moanda road, 468 m a.s.l. (1.6628°S 13.2915°E), 05-i-2010, leg. K.-D.B. Dijkstra & C. Vanappelghem, RMNH. 7♂ 2♂♀, road to the station, Moanda, gravel-bottomed stream and rocky stream (manganese ore) in forest with rapids and waterfalls, 521 m a.s.l. (1.4815°S 13.2275°E), 28-ii-2009, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.502654), same locality, 21-viii-2009, leg. N. Mézière, RMNH. 1♂, Franceville road, “Africa No1” radio station, Moyabi, river with rocks and rapids in gallery forest, 460 m a.s.l. (1.6777°S 13.3176°E), 31-iii-2010, leg. N. Mézière, RMNH. 1♀, “Africa No1” radio station, Madjaye, stream (2–4m) with rock and gravel bottom, 462 m a.s.l. (1.6632°S 13.2916°E), 04-ix-2009, leg. N. Mézière, RMNH. 1♂, “Africa No1” radio station, Madzai, sandy and rocky stream (<2 m) with waterfall, 303 m a.s.l. (1.6614°S 13.3026°E), 30-iv-2011, N. Mézière, RMNH. 1♂, Moanda-Mounana road, Mbéréssé bridge, Nguiaassono, sandy stream (2 m wide, 30 cm deep) with rapids and rocks, 420 m a.s.l. (1.4918°S 13.1826°E), 08-i-2011, leg. N. Mézière, RMNH. 1♂ 1♀, Moyabi, 17 km SE of Moanda, rocky and sandy stream with small waterfall in dense forest, 456 m a.s.l. (1.6777°S 13.3118°E), 24-i-2012, leg. J. Kipping, CJKL. GABON (Ngounie



**Type Photo 6.** Holotype of *Pentaphlebia mangana* sp. nov., RMNH (horizontally mirrored from original).

Province): 5♂, as holotype, RMNH. 2♂, Mimongo-Mouila road, mountain stream with falls, rapids and large rocks, 478 m a.s.l. (1.7289°S 11.3072°E), 29-iii-2011, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.506198), 2♀ (RMNH.INS.506170), same locality, 07-iv-2012, leg. N. Mézière, RMNH. 4♂, Etéké road, Yeno, sandy and gravelly mountain stream with rapids and little waterfalls, 650 m a.s.l. (1.5712°S 11.5049°E), 23-iv-2011, leg. N. Mézière, RMNH. 2♂ (RMNH.INS.506202, RMNH.INS.506214), 1♀, same locality, 09-iv-2012, leg. N. Mézière, RMNH. 2♂ 1♀, Mouila-Mimongo road, Mboutoubi, shallow stream (3 m wide) with falls, 625 m a.s.l. (1.4820°S 11.8011°E), 01-iv-2011, leg. N. Mézière, RMNH. 1♀, Mouila-Mimongo road, Moukandi, >10 m wide river with waterfall, 573 m a.s.l. (1.4716°S 11.8541°E), 01-iv-2011, leg. N. Mézière, RMNH. 1♂, Montagne de Chaillu, Dibandi, small stream with small waterfall in dense forest (Photo 12), 650 m a.s.l. (1.4820°S 11.8011°E), 18-ix-2013, leg. J. Kipping, CJKL. GABON (Ogooué-Lolo Province): 1♂, Koulamoutou-Pana road, mountain stream (1–2 m wide) with rocks and falls, 432 m a.s.l. (1.3045°S 12.5012°E), 02-iv-2011, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.506143), same locality, 09-ii-2012, leg. N. Mézière, RMNH.

### Genetics

Five unique haplotypes (n=11) are very distinct but nearest to *P. stahli* Förster, 1909.



**Figure 3.** Male appendages in dorsal (left) and lateral view (middle) and detail of cerci tips (right) of two *Pentaplebia* species.

### Male morphological diagnosis

Typical of genus, that is unique among African damselflies, by its (a) great size, Hw 31.5–36.5 mm ( $n=7$ ); (b) rather dark and uniform coloration; (c) long and narrow wings with darkened falcate tips; (d) 2–4 supplementary Ax distal to the 2 primary Ax in all wings, which are restricted to the costal space; (e) dense venation with 38–47 postnodal cross-veins in Fw but no cross-veins in quadrilateral cells; and (f) IR3 originating at level of the quadrilateral cell, much closer to the arculus than to the node. Most simi-



**Photo 11.** *Pentaphlebia mangana*, male; Mbé, Monts de Cristal, Gabon. Photo: NM (25-xii-2013)

**Photo 12.** Nicolas Mézière and Jens Kipping exploring the habitat of *Pentaphlebia mangana* in Montagne de Chaillu, Gabon. Photo: H. Krahnstöver (ix-2013)



lar to *P. stahli* by (g) the long and narrow Pt of 3.0–3.3 mm; (h) the robust cerci with denticulate tips and a well-defined internal subapical blade that is short but wide; and (i) the gradually up-curved paraprocts (Fig. 3). However, (1) the body is entirely dark brown to coal black, even at emergence, save the densely pruinose coxae and femoral bases and a few pale yellow-green lines on the thorax with maturity, while *P. stahli* is largely brick red with yellow thoracic lines; and (2) the subapical blade on the cerci is more rounded (Fig. 3).

### Etymology

Name is derived from the word manganese (noun in apposition). The ore is similarly black as the species and mined within its range.

### Range and ecology

Rocky forest streams between 90 and 700 m a.s.l. in Gabon and adjacent north-western Congo-Brazzaville. Males perch in shade near rapids and waterfalls; larvae are assumed to live under rocks like *P. stahli* (VICK 1998).

## Platycnemididae

### *Allocnemis vicki* Dijkstra & Schütte sp. nov. – Blue-shouldered Yellowwing

(Type Photo 7, Photo 13, Fig. 4)

### Taxonomy

Reported as *Chlorocnemis pauli* (Longfield, 1936) by GAMBLES (1975), but DIJKSTRA et al. (2014) sunk that genus in *Allocnemis* Selys, 1863. Indeed belongs to the *pauli*-group of *Allocnemis* (see below), which also includes *A. interrupta* (Legrand, 1984) and *A. wittei* (Fraser, 1955), and possibly *A. eisentrauti* (Pinhey, 1974), although it is morphologically and genetically distinctive.

### Material studied

**Holotype** ♂. Cameroon, Northwest Province, 12 km SW of Bamenda, Baba II, small stream in montane forest, 1 800–1 900 m a.s.l. (5.85°N 10.10°E), 29-v-2008, leg. K.-D.B. Dijkstra & K. Schütte, RMNH.

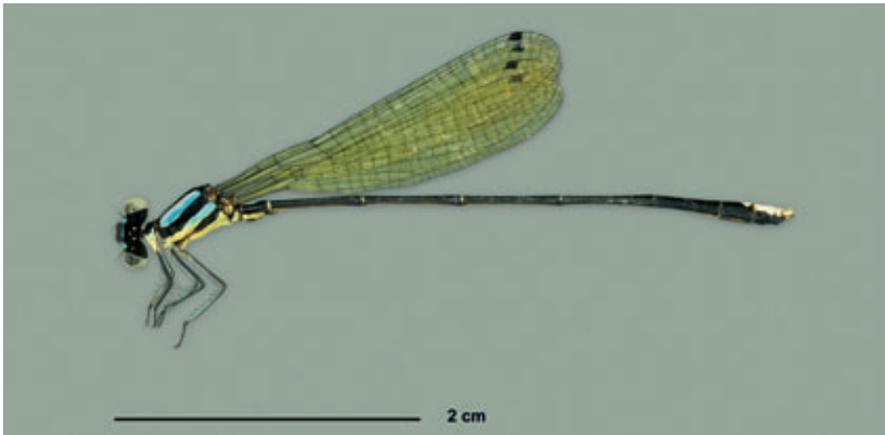
**Further material.** CAMEROON (Northwest Province): 7♂ (RMNH. INS.229129, RMNH.INS.500115), 2♀ (one in copula with holotype), as holotype, RMNH. CAMEROON (Southwest Province): 1♂, Kodmin, Serungwe River (4.9989°N 9.7011°E), 06-iv-2003, leg. & coll. G.S. Vick.

### Genetics

Two unique haplotypes (n=2) fall within the variation of five (n=8) of *A. pauli* from Angola, Gabon and Uganda; the two together nearest to *A. interrupta* and *A. wittei*.

### Male morphological diagnosis

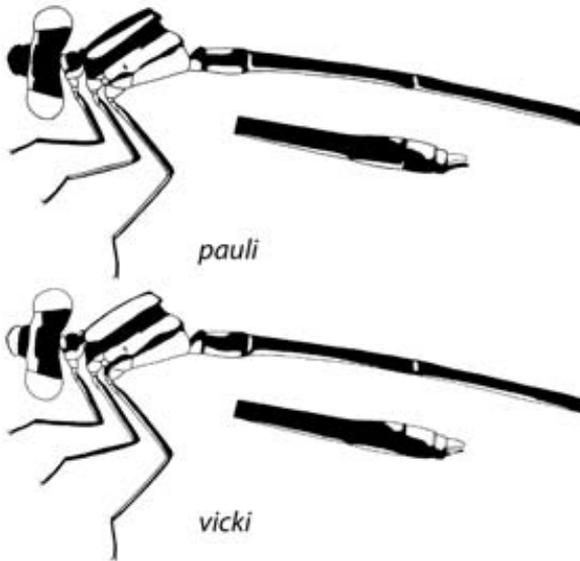
Fairly large damselfly (Hw 22.0–23.0 mm; n=5) that belongs to the *pauli*-group by the combination of (a) the blue-marked head and thorax; (b) the anteriorly blue femora and tibiae; and (c) the orange abdomen tip, which as in its sister-species *A. pauli* covers the entire dorsum of the cerci and S9–10, with a dorso-apical spot on S8, although the latter can be absent in *A. pauli* (Fig. 4). Differs by (1) the narrowly black-bordered blue rather than wholly black labrum, although *A. pauli* rarely has a blue central spot; (2) the almost completely blue mesepisterna, rather than with ante-humeral stripes that are about half as wide as mesepisternum; and (3) the paraprocts that extend as far as the tips of the cerci, rather than somewhat beyond (Fig. 4).



**Type Photo 7.** Holotype of *Allocnemis vicki* sp. nov., RMNH.

### Etymology

Named in honour of Graham S. Vick who made significant contributions to the knowledge of central African Odonata with his Cameroon Dragonfly Project (masculine singular genitive noun).



**Figure 4.** Male head in dorsal and thorax, legs, S1–4 and S7–10 in lateral view of two *Allo-cnemis* species.



**Photo 13.** View on Baba II Forest near Bamenda, Cameroon. Type locality of *Allo-cnemis vicki*. Photo: KDBD (29-v-2008)

### Range and ecology

Found to be common at a tiny stream overgrown by herbs in the forest remnant of Baba II near Bamenda (Photo 13). Also collected at Kodmin in the Bakossi Mountains and from the Obudu Plateau in Nigeria (GAMBLES 1975). Thus appears to be endemic to forest streamlets in the highlands of south-western Cameroon and bordering Nigeria between 1 500 and 1 900 m a.s.l., a range and habitat almost identical to that of *Africocypha centripunctata*.

### *Elattonaura aurifex* Dijkstra & Mézière sp. nov. – Goldsmith Threadtail

(Type Photo 8, Photos 14–15, 26, 52, 62, Fig. 5)

### Taxonomy

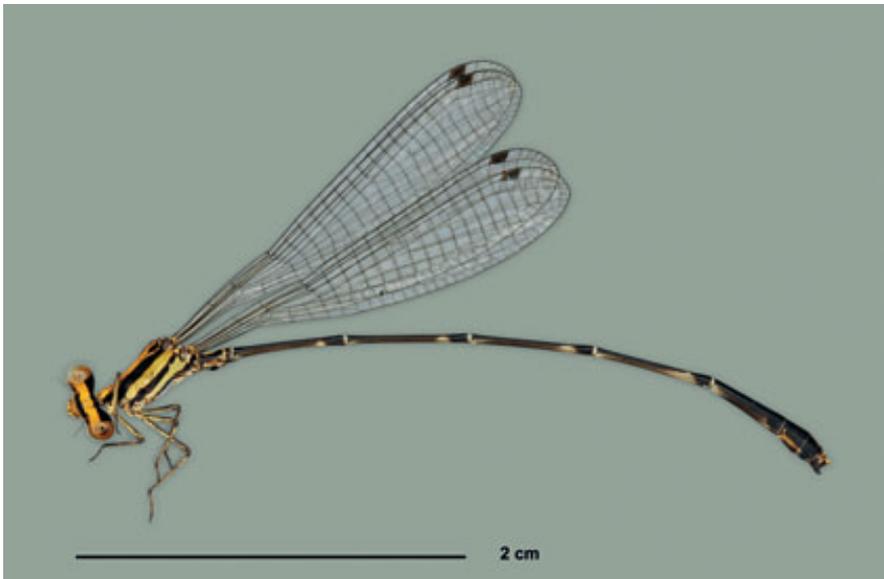
Morphologically and genetically nearest to the unresolved *vrijdaghi*-complex of *Elattonaura* Cowley, 1935, but clearly distinct on both accounts. LEGRAND (1980) synonymised *E. tsiamae* Aguesse, 1966 with *E. vrijdaghi* Fraser, 1954 but DIJKSTRA & CLAUSNITZER (2014) treated them separately on account of specimens attributable to two species found in sympatry in central Congo-Kinshasa and south-eastern Gabon. However, these regional forms also differ from each other while the holotype of *E. vrijdaghi* in MRAC has paraprocts and ante-humerals more like as illustrated for *E. tsiamae* by DIJKSTRA & CLAUSNITZER (2014) and thus further study of the complex is needed (Fig. 5).

### Material studied

**Holotype** ♂. RMNH.INS.502487, Gabon, Haut-Ogooué Province, 34 km E of Franceville, Franceville-Léconi Road, NE of Bongoville, small streams and swamp at forest edge, 417 m a.s.l. (1.6131°S 13.9056°E), 31-xii-2009, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♀, 5 km after Bongoville towards Léconi, Andzaba River, Ekala, sandy and swampy stream, 389 m a.s.l. (1.6319°S 13.8888°E), 28-iii-2010, leg. N. Mézière & J. Renoult, RMNH. 1♂, 31-viii-2010, 1♂, 26-xi-2011, 1♂ (RMNH.INS.508775), 09-iii-2013, all same locality, all leg. N. Mézière, RMNH. 2♂♀, 34 km E of Franceville, Franceville-Léconi Road, NE of Bongoville, small streams and swamp at forest edge, 417 m a.s.l. (1.6131°S 13.9056°E), 31-xii-2009, leg. K.-D.B. Dijkstra, RMNH. 1♂, Bongoville-Léconi road, Boubou River, Ekala,

swamp close to the river, 421 m a.s.l. (1.6116°S 13.9116°E), 19-xi-2011, leg. N. Mézière, RMNH. 2♂ (RMNH.INS.502422, RMNH.INS.502425), Bon-goville-Léconi road after Ekala, old village of Boubou, stream (2 m wide) with gravel bottom, 393 m a.s.l. (1.6114°S 13.9105°E), 20-ix-2009, leg. N. Mézière, RMNH. 3♂, 30-xii-2010, 1♂, 05-ii-2010, 1♂, 28-xii-2010, all same locality, all leg. N. Mézière, RMNH. 2♂ 1♂♀, Léconi road, Souba, little sandy stream in gallery forest (2 m wide, 30 cm deep) and another bigger stream (3 m, 1 m), 413 m a.s.l. (1.5689°S 14.0382°E), 28-i-2012, leg. N. Mézière, A. Günther, J. Kipping & H. Krahnstöver, RMNH. 1♂, 50 km N of Franceville, Franceville-Okondja Road, Léconi River at bridge N of Onvouri-Olounga, large sandy river, 307 m a.s.l. (1.1776°S 13.5389°E), 10-i-2010, leg. K.-D.B. Dijkstra, N. Mézière & C. Vanappelghem, RMNH. 1♂ (RMNH.INS.508088), Batéké Plateau, small sandy stream near Souba Lake, 413 m a.s.l. (1.5688°S 14.0388°E), 27-i-2011, leg. N. Mézière, CJKL. 2♂ 1♀, same locality, same dates, CJKL. 1♂♀, Batéké Plateau, 18 km NW of Léconi, sandy stream in dense gallery forest, tributary to Léconi River, 425 m a.s.l. (1.4472°S 14.1661°E), 30-ix-2013, leg. J. Kipping, CJKL.

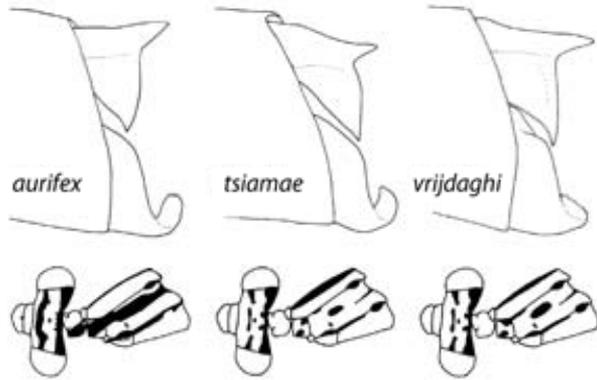


**Type Photo 8.** Holotype of *Elattoneura aurifex* sp. nov., RMNH.

### Genetics

Five unique haplotypes ( $n = 5$ ) are very distinct but nearest to the *vrijdaghi*-complex.

**Figure 5.** Male appendages in lateral view (above) and head in dorsal and thorax in lateral view (below) of *vrijdaghi*-complex of *Elattoneura*. Note that *E. tsiamae* and *E. vrijdaghi* are illustrated as interpreted by DIJKSTRA & CLAUSNITZER (2014) but appear not to agree with type material.



**Photo 14.** *Elattonaura aurifex*, male; Batéké Plateau, Gabon. Photo: NM (26-xi--2011)

### Male morphological diagnosis

Fairly small damselfly (Hw 20.0–21.5 mm; n = 8) that is nearest to *E. tsiamae/vrijdaghi* by (a) the entirely brightly coloured labrum, clypeus and antefrons, as well as a broad band across the black dorsum of the head between the antennae and lateral ocelli; (b) the mesepisterna with little black; (c) the dull pale legs with blotchy dark markings, rather than uniformly red or black legs; (d) the double pair of finger-like lobes placed closely to each other at the penis apex; and (e) the triangular ventral process of the cerci, with its anterior border at an acute angle to the posterior border (Fig. 5). However, (1) the colour on the head and mesepisterna is warm yellow, rather than dark ochre yellow to reddish; (2) the eyes in life are brown rather than red; (3) the pronotal dorsum and mesepisterna are almost wholly yellow, contrasting with the largely black sides of the pronotum, mesokatepisterna and mesepimera; (4) the metapleural suture typically has a broad black stripe along its entire length; (5) only the dorsa of the cerci and S9–10 are yellowish, contrasting with the largely black abdomen, rather than most of these segments and the appendages rufous; (6) the ventral process of the cerci is less drawn out; and (7) the apical process of the paraprocts is more slender and rounded (Fig. 5).

### Etymology

Latin “goldsmith” refers to the yellow coloration (noun in apposition).



**Photo 15.** Sandy and clear stream on the Batéké Plateau in Gabon. Habitat of *Elattonaura aurifex*. Photo: A. Günther (27-i-2012)

### Range and ecology

Shady spots along clear sandy streams in gallery forests between 300 and 425 m a.s.l. on the Batéké Plateau in south-eastern Gabon (Photos 15, 26, 52, 62). CUMZ has specimens from Djoumouna, a river at 375 m a.s.l. 20 km southwest of Brazzaville in Congo-Brazzaville, and the species is likely to occur widely across the sandy soils of this region.

### *Elattoneura lapidaria* Dijkstra & Bjelke sp. nov. – Rock Threadtail

(Type Photo 9, Photos 16–17, Fig. 6)

### Taxonomy

DIJKSTRA & CLAUSNITZER (2014) discussed this species and provided a photograph but no characters for identification. It belongs to the genetically and ecologically distinct *glauca*-group of pruinose-faced *Elattoneura* species, which includes *E. cellularis* (Grünberg, 1902), *E. frenulata* (Hagen in Selys, 1860), *E. glauca* (Selys, 1860), *E. nigra* Kimmins, 1938, *E. tarbotonorum* sp. nov. and presumably *E. pasquinii* Consiglio, 1978 (Tree 1). Occurs with its nearest relative *E. glauca*, differing in behaviour, coloration, structure and genetically. Note however, that COI data suggest that *E. cellularis* and *E. glauca* conceal additional species (Tree 1).

### Material studied

**Holotype** ♂. RMNH.5007711, Zimbabwe, Manicaland, 16 km E of Chimanimani village, Chimanimani National Park, Bundi Plain and Valley, rocky sections of Bundi in grassy and boggy plain and sheltered gorge, 1 510–1 577 m a.s.l. (19.784°S 33.029°E), 01-xii-2013, leg. K.-D.B. Dijkstra & U. Bjelke, RMNH.

**Further material.** 3♂ (RMNH.5007732, RMNH.5007751), 5♀ (RMNH.5007715, RMNH.5007753, RMNH.5007764, RMNH.5007785), as holotype, RMNH.

### Genetics

Three unique haplotypes (n = 7) nearest to but well-separated from *E. glauca* from the Eastern Cape (South Africa) and even more distant from specimens of that species from northern South Africa, Tanzania, Zambia and Zimbabwe, including syntopic ones (Tree 1).

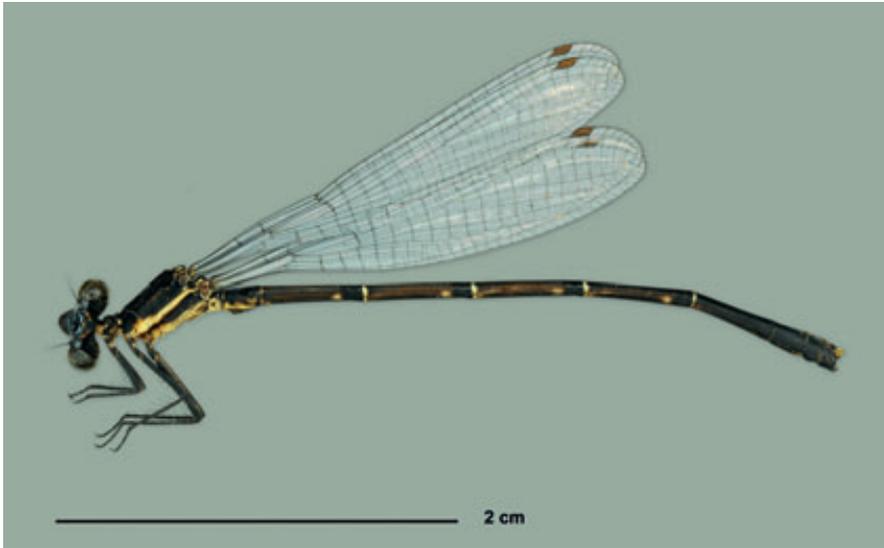
### Male morphological diagnosis

Nearest to *E. glauca* by (a) the pruinose face with maturity; (b) the penis with pointed apical lobes as well as slender filament-like lateral branches; and (c) the ventral process of the cerci that is wide at base, with a conspicuous

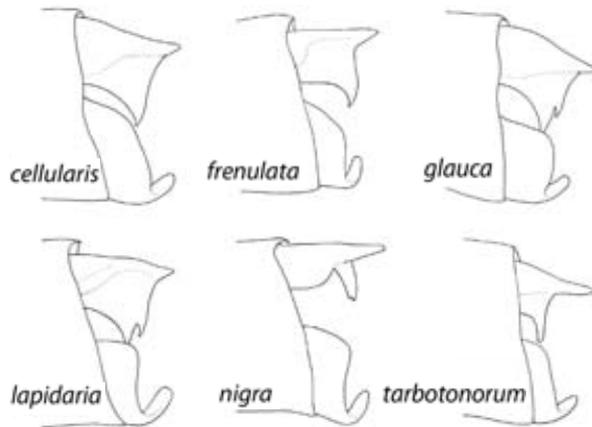


**Tree 1.** 50 % majority rule consensus of 1 000 trees from Maximum Likelihood analysis for the *glauca*-group of *Elattoneura* and two outgroup taxa. For relevant branches posterior probabilities from Bayesian inference analysis are shown first, as is bootstrap support (both as percentages).

subapical tooth next to the single apical tooth (Fig. 6). However, is (1) larger, Hw 21.5–22.2 mm (n = 4) rather than 17.5–19.5 mm (n = 6); (2) darker with pruinosity on face, S8–10 and especially thorax less dense, with only narrow ante-humeral stripes of pruinosity rather than largely pruinose mesepisterna; (3) has the penis with broader apical lobes that are laterally more round-



**Type Photo 9.** Holotype of *Elattonaura lapidaria* sp. nov., RMNH.



**Figure 6.** Male appendages in lateral view of the *glauca*-group of *Elattonaura*, except *E. pasquinii* that is similar to *E. cellularis*.

ed and less abruptly narrowed to their fine tips; (4) the cerci with relatively shorter apex but broader ventral process; and (5) the basal part of the paraprocts longer dorsally than ventrally in lateral view; however, the appendage shape may fall within the variation of *E. glauca* (Fig. 6).

### Etymology

Latin “belonging to stones” refers to the adult behaviour of perching consistently on rocks (feminine adjective).



**Photo 16.** *Elatoneura lapidaria*, male; Chimanimani Mountains, Zimbabwe. Photo: U. Bjelke (03-xii-2013)



**Photo 17.** The rocky Bundi River in the Chimanimani Mountains, Zimbabwe. Type locality of *Elatoneura lapidaria*. Photo: KDBD (02-xii-2013)

### Range and ecology

Unlike most *Elattonneura* species, the *glauca*-group is associated more with exposed and/or elevated habitats than with lowland rainforest. This species occurs along open rocky streams between 1 500 and 1 600 m a.s.l. in the Chimanimani Mountains of eastern Zimbabwe (Photo 17). Both sexes always perched flat on rocks, probably to warm up in their often misty habitat. Its sister-species *E. glauca* was less numerous at the same sites and rested on vegetation like grasses.

### *Elattonneura tarbotonorum* Dijkstra sp. nov. – Stout Threadtail

(Type Photo 10, Fig. 6)

### Taxonomy

Belongs to the *glauca*-group of *Elattonneura* (see *E. lapidaria* sp. nov.). Misidentified by PINHEY (1975) as the South African endemic *E. frenulata*, but both genetics and appendages are distinct from other species (Tree 1).

### Material studied

**Holotype** ♂. RMNH.INS.500352, Angola, Huila Province, SW of Lubango, Humpata area, Neve stream, 2 069 m a.s.l. (14.5559°S 13.2031°E), 11–17-i-2009, leg. W. Tarboton, RMNH.

**Further material.** ANGOLA: 1♂ (RMNH.INS.500353), as holotype, RMNH. 1♂ 1♀, Tunda Vala, x-1973, leg. Bampton, NMBZ.

### Genetics

Two unique haplotypes (n = 2) are most distinct within the *glauca*-group, of which only *E. pasquinii* was not sampled (Tree 1).

### Male morphological diagnosis

Fairly small damselfly (Hw 18.0–19.0 mm; n = 2) that recalls *E. cellularis* and *E. frenulata* by (a) much of the body including the frons and most of the thorax, legs and abdomen being pruinose with maturity; and (b) the ventral process of the cerci ending in a single tip (Fig. 6). However, (1) is notably more stout, Hw has 57–59 % length of entire body and reaches to base of S7, rather than 51–53 % and halfway S6; (2) the ventral portion, including met-

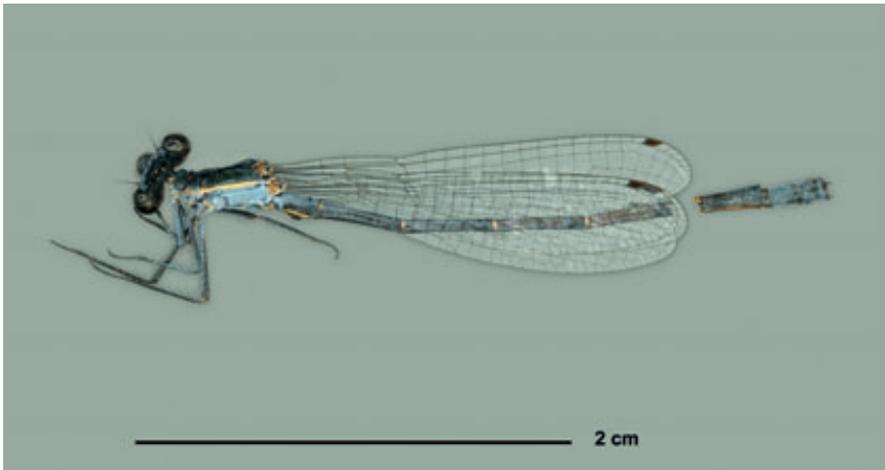
episternum and metepimeron, is the blackest and most densely pruinose part of the thorax with a bold yellow stripe spared out down the full length of the metepisternum, running through the metastigma; (3) Fw and Hw Pt have rather acute distal corners, with the anterior and distal borders of similar length and distinctly longer than the posterior and proximal borders respectively, rather than the anterior and posterior borders being more similar and typically longer than the proximal and distal borders; and (4) the cerci have a more slender apex and an abruptly narrowed ventral process with a blunt rather than sharp tip (Fig. 6).

### Etymology

Named in honour of the holotype's collector Warwick Tarboton and his wife Michèle, who advanced the identification of African Odonata, most recently with their South African fieldguide (plural genitive noun).

### Range and ecology

Presumably endemic to Angola, where found at an open, rocky and fast-flowing stream at 2 069 m a.s.l. together with *Pseudagrion greeni* Pinhey, 1961 and the also endemic *Chlorocypha bamptoni* Pinhey, 1975.



**Type Photo 10.** Holotype of *Elatoneura tarbotonorum* sp. nov., RMNH (horizontally mirrored from original).

**Coenagrionidae*****Aciagrion bapepe* Dijkstra sp. nov. – Congo Slim**

(Type Photo 11, Photos 18, 40, Fig. 7)

**Taxonomy**

Morphologically and ecologically nearest to *A. balachowskyi* Legrand, 1982 and *A. nodosum* (Pinhey, 1964) but genetically nearer *A. gracile* (Sjöstedt, 1909) and treated as a distinct species on account of its unique male appendages by DIJKSTRA & CLAUSNITZER (2014).

**Material studied**

**Holotype** ♂. RMNH.INS.502135, Congo-Kinshasa, Province Equateur, Lower Itimbiri, Loeka River (= Gwolo) mouth, tributary, forest and Itimbiri around mouth, 360 m a.s.l. (2.038°N 22.826°E), 16-v-2010, leg. K.-D.B. Dijkstra, RMNH.

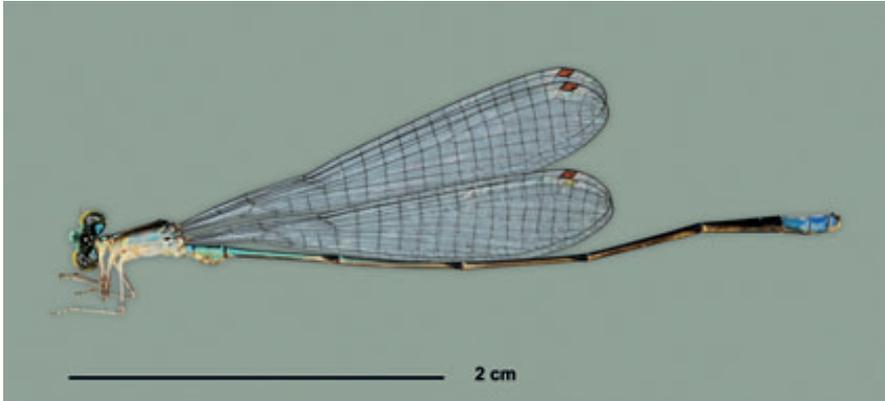
**Further material.** CONGO-KINSHASA (Province Equateur): 3♂, as holotype. 1♂ 1♀, Lower Itimbiri, 2 km downstream of Kona camp, swamp forest, 401 m a.s.l. (2.013°N 22.782°E), 17-v-2010, leg. K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.502128), 2 ♀ (RMNH.INS.502153), Lower Itimbiri, Kona forest, swamp forest, 362 m a.s.l. (2.040°N 22.788°E), 12-v-2010, leg. K.-D.B. Dijkstra, RMNH.

**Genetics**

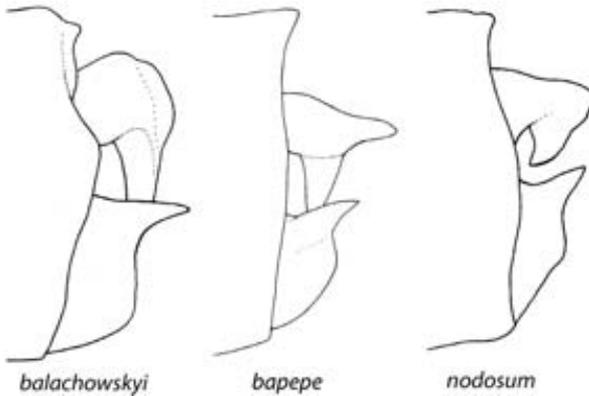
Two unique haplotypes (n = 3) nearest to *A. gracile*.

**Male morphological diagnosis**

Most similar to *A. balachowskyi* and *A. nodosum* by (a) the complete black middorsal stripe on the mesepisterna; (b) the cerci that are about as long as the paraprocts and bear a conspicuous ventral process in lateral view; and (c) the large tooth surpassing the base of the paraprocts (Fig. 7). However, (1) is larger, Hw 23.0–25.0 mm (n = 5) rather than 19.0–21.0 mm; (2) Pt are reddish brown with maturity, instead of blackish; (3) S10 is largely blue and not at least dorsally extensively black; and (4) the cerci have a distinctly pointed apex that is abruptly separated from the triangular ventral process, rather than being more or less continuous with it (Fig. 7).



**Type Photo 11.** Holotype of *Aciagrion bapepe* sp. nov., RMNH.



**Figure 7.** Male appendages in lateral view of African *Aciagrion* species with cerci that are about as long as the paraprocts and bear a conspicuous ventral process, as well as a large tooth surpassing the base of the paraprocts.



**Photo 18.** Forest near the mouth of the Itimbiri River in the Congo River in Congo-Kinshasa. *Aciagrion bapepe* and *Ceriagrion obfuscans* were found in the understory. Photo: KDBD (13-v-2010)

### Etymology

Name is derived from a local word meaning dragonfly or damselfly (noun in apposition).

### Range and ecology

Discovered in forest understory around 360 and 400 m a.s.l. close to the large blackwater Itimbiri River (Photo 18) in central Congo-Kinshasa, probably breeding in floodwater pools. Found with *Pseudagrion malagasoides* Pinhey, 1973 that, while not closely related, has a similar habitat and general appearance.

### *Africallagma quingentum* Dijkstra sp. nov. – Green-fronted Bluet (Type Photo 12, Photo 19, Fig. 8)

### Taxonomy

Genetically and morphologically very close to the sympatric *A. sinuatum* (Ris, 1921) but easily separated by details of male coloration and appendages; thus treated as a distinct species by DIJKSTRA & CLAUSNITZER (2014), who used the grammatically erroneous name *A. quingenti*.

### Material studied

**Holotype** ♂. RMNH.INS.505540, Congo-Kinshasa, Katanga, Upemba National Park, Mukana, west of Lusinga, depressions with (seasonal) marsh, bog lakes and gallery forest in open grassy plains, 1 770–1 840 m a.s.l. (8.91°S 27.18°E), 13–14-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** CONGO-KINSHASA (Katanga): 8♂ (RMNH.INS.505526, RMNH.INS.505527, RMNH.INS.505528), 1♀ (RMNH.INS.505529), Upemba National Park, Lufwi, smaller source of Kafwi, dried bog beside gallery forest, 1 825 m a.s.l. (8.9426°S 27.1302°E), 13-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

### Genetics

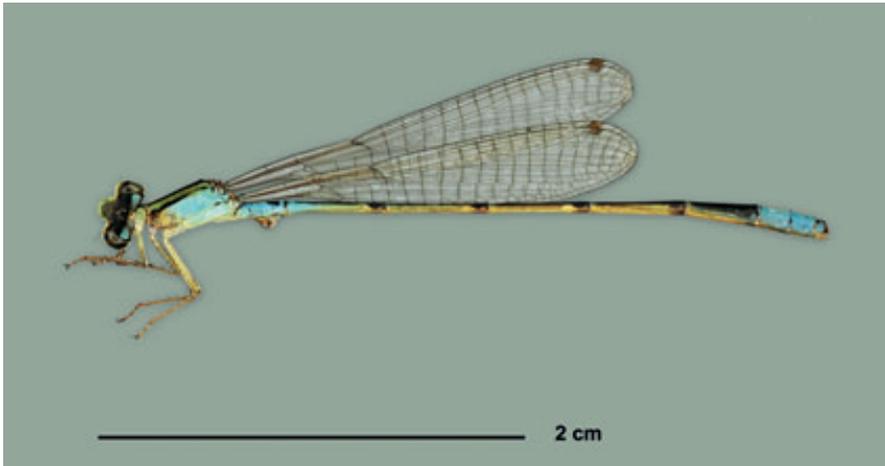
One haplotype (n=5) shared with *A. sinuatum* (n=9; 7 additional haplotypes), which in turn shares one haplotype with *A. fractum* (Ris, 1921) (n=7; 1 additional): the three species are thus probably indistinguishable in COI.

### Male morphological diagnosis

Most similar to *A. sinuatum* by (a) fairly large size, Hw 18.0–19.0 mm (n = 5); (b) mostly blue postclypeus; and (c) cerci that are only slightly longer than paraprocts, sinuous in dorsal view, with rather short apex that is not very distinct from the quite short and strongly hooked ventral process (Fig. 8). However, (1) the face and ante-humeral stripes are pale green, not blue, and thus contrast with the blue sides of the thorax; (2) Pt are pale brown rather than blackish with maturity; (3) the dorsum of S2 is blue with a broad black subapical spot, instead of a continuous though sometimes basally and apically reduced black band; (4) the cerci are narrower in lateral view; and (5) the apical teeth of the paraprocts are reduced to form pale blunt corners (Fig. 8).

### Etymology

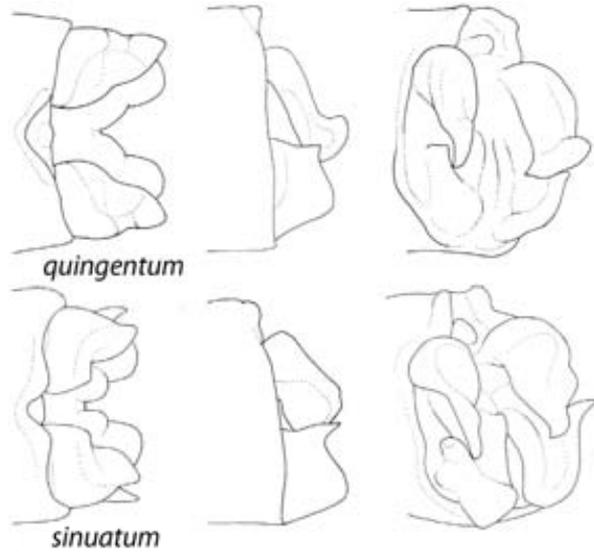
Latin name “of five hundred” alludes to this being the 500<sup>th</sup> species of African Odonata recorded in the field by the lead author (to be treated as a plural genitive noun). Although the normal genitive plural in neuter would be *quingentorum*, we prefer the shorter form *quingentum* used by some older classic authors.



**Type Photo 12.** Holotype of *Africallagma quingentum* sp. nov., RMNH (horizontally mirrored from original).

### Range and ecology

Found with its presumed sister-species *A. sinuatum* among tussocks of grass in an open dried-out bog between 1 770 and 1 840 m a.s.l. on the Kibara Plateau in Upemba National Park (Photo 19).



**Figure 8.** Male appendages in dorsal (left), lateral (middle) and oblique caudal view (right) of two *Africallagma* species.



**Photo 19.** Shallow seasonal pools with dense sedges at Mukana on the Kibara Plateau in Upemba National Park, Katanga, Congo-Kinshasa. Type locality of *Africallagma quingentum* and *Ceriagrion junceum*. Photo: KDBD (14-xi-2011)

***Agriocnemis canuango* Dijkstra sp. nov. – Bog Wisp**

(Type Photo 13, Photo 20, Fig. 9)

**Taxonomy**

Morphologically and genetically unlike any known *Agriocnemis* Selys, 1877 species.

**Material studied**

**Holotype** ♂. RMNH.INS.508419, Angola, Uíge Province, 4 km NE of Negage, Canuango River, open bog adjacent to small blackwater river in palm swamp, 1 225 m a.s.l. (7.7351°S 15.2887°E), 28–29-xi-2012, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** 4♂ (RMNH.INS.508417), 3♀ (RMNH.INS.508418), as holotype, RMNH.

**Genetics**

One unique haplotype (n=3) is distant from other *Agriocnemis* species, which suggests the species has no close relatives.

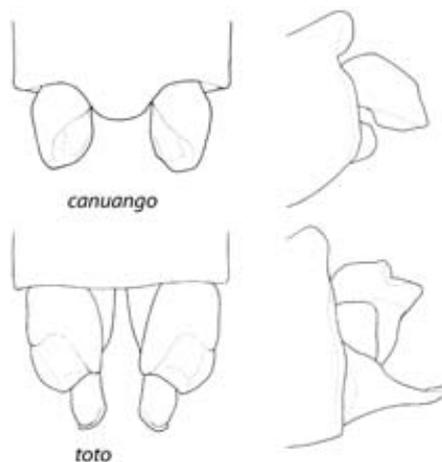
**Male morphological diagnosis**

Unique among African *Agriocnemis* species by the (1) pronotal hindlobe that is entire and extended laterally and folded upwards to form a pair of erect knobs, which are flattened with rounded tips and thus rather spoon-



**Type Photo 13.** Holotype of *Agriocnemis canuango* sp. nov., RMNH.

like; and the terminal abdominal structure with (2) the distal border of S10 extended dorso-medially into a rounded knob that is about half as long as the segment, somewhat like in *A. ruberrima* Balinsky, 1961 but much thicker; (3) the cerci that are almost as long as S10 and over twice as long as the paraprocts, appearing rather thick, down-turned and distally truncated in lateral view, although their inside is hollowed out and thus appears ear-like in dorsal view, with a tiny black tooth directed straight downwards at their extreme base; and (4) the paraprocts reduced and rounded, with a ventral black tooth positioned externally to the cercal tooth, but even smaller and placed even more basally and visible only caudally (Fig. 9). Other notable



**Figure 9.** Male appendages in dorsal (left) and lateral view (right) of two *Agriocnemis* species.



**Photo 20.** Bog with almost no open water near Negage, Angola. Type locality of *Agriocnemis canuango*. Photo: KDBD (28-xi-2012)

features include (5) the small size, Hw 9.3–9.7 mm ( $n=5$ ); (6) the black labrum with a greenish white border; (7) all Pt pale brown with the anterior border about twice as long as the posterior; and (8) the distally orange to reddish abdomen from halfway S7, whether teneral or mature.

### Etymology

Named after the type locality (noun in apposition).

### Range and ecology

Only known from the type locality in northern Angola, just 400 m from that of *A. toto* sp. nov., a small grassy bog with almost no open water (Photo 20), close to a blackwater river with gallery swamp forest on a grassy sandy plateau at 1 225 m a.s.l. Mature adults were found in fair numbers among the tussocks after rain in the late afternoon, but were not seen during sunny weather between late morning and noon a few days later.

### *Agriocnemis toto* Dijkstra sp. nov. – Toto's Wisp

(Type Photo 14, Fig. 9)

### Taxonomy

Superficially like *A. falcifera* Pinhey, 1959 or *A. pinheyi* Balinsky, 1963, but genetically closer to but distinct from *A. maclachlani* Selys, 1877: male appendages render it unmistakable.

### Material studied

**Holotype** ♂. RMNH.INS.559527, Angola, Uíge Province, 4 km NE of Negage, Canuango River, wet depression with reeds near blackwater river, 1 229 m a.s.l. (7.7338°S 15.2837°E), 02-x-2013, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** 2♀ (RMNH.INS.559520, RMNH.INS.559524), as holotype.

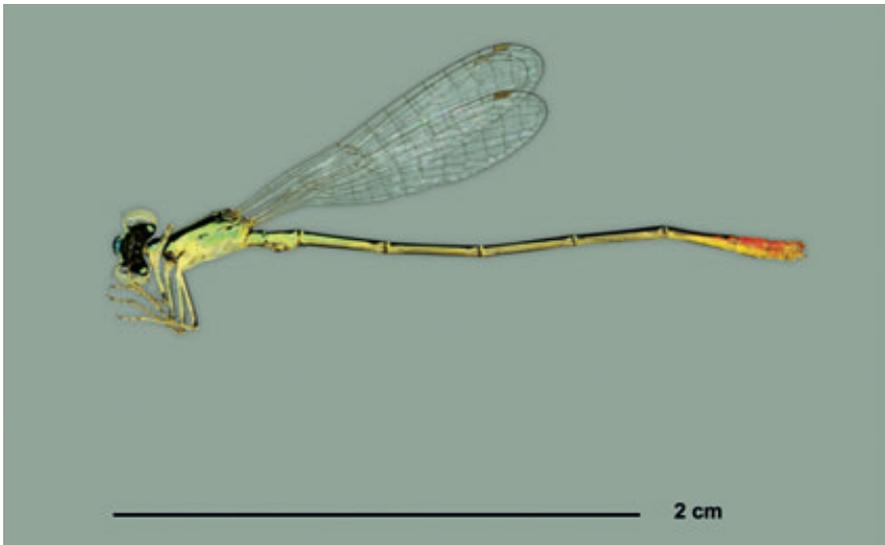
### Genetics

One unique haplotype ( $n=3$ ) nearest to but well-differentiated from *A. maclachlani*, which requires revision as it includes *A. angustirami* Pinhey, 1974 and at least two distinct groups, one of which may refer to *A. aligulae* Pin-

hey, 1974 that was synonymised with *A. maclachlani* by D'ANDREA & CARFI (1997).

### Male morphological diagnosis

Similar to many African *Agriocnemis* species with its (a) moderate size, Hw 12.0 mm (n=1); (b) all-black labrum and postclypeus with metallic purple and blue shine respectively; (c) pronotal hindlobe divided into two small rounded lateral lobes and one larger fanlike central section; (d) all Pt pale brown; and (e) S8–10 orange. However, the appendages are distinctive with structure nearest to *A. falcifera* and *A. pinheyi*, but proportions like *A. gratiosa* Gerstäcker, 1891 and *A. inversa* Karsch, 1899, with (1) the distal border of S10 slightly raised medio-dorsally; (2) the cerci about as long as S10 and the paraprocts about 1.5 times as long; (3) the cerci falcate and hollowed out apically, like *A. falcifera*, *A. pinheyi* and *A. stygia* Fraser, 1954 but much sleeker, with the ventral process exceptionally long and narrow, extending down to reach between the paraprocts; and (4) the paraprocts triangular, i.e., wide at base and tapering distally like *A. falcifera*, with



**Type Photo 14.** Holotype of *Agriocnemis toto* sp. nov., RMNH (horizontally mirrored from original).

horizontally flattened tips terminating in a transverse black ridge recalling *A. maclachlani* (Fig. 9).

### Etymology

Named in honour of Alvaro Bruno Toto Nienguesso, the driving force behind biodiversity research in Uíge Province, Angola (noun in apposition).

### Range and ecology

Only known from the type locality in northern Angola, just 400 m from that of *A. canuango* sp. nov., which is a similar boggy depression on a grassy sandy plateau at 1 225 m a.s.l. but probably drier seasonally and with taller and denser reed-like vegetation.

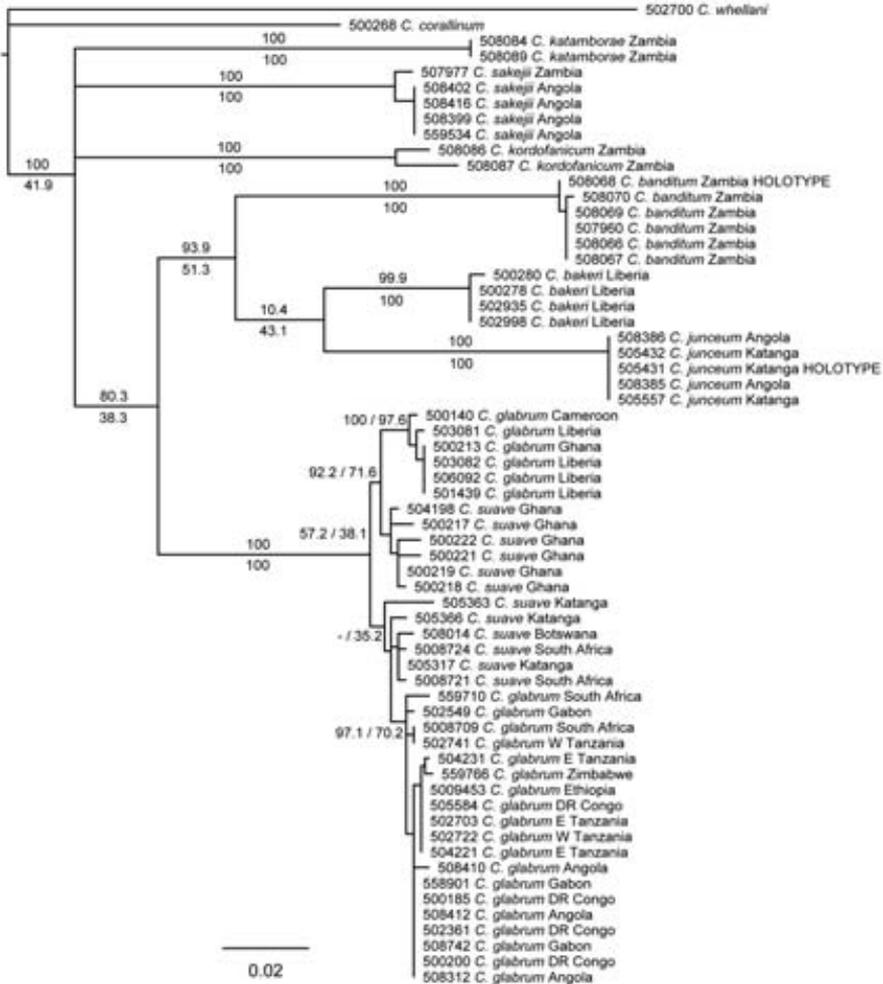
### ***Ceriagrion banditum* Kipping & Dijkstra sp. nov. – Band-eyed Citril**

(Type Photo 15, Photo 21–22, Fig. 10)

### Taxonomy

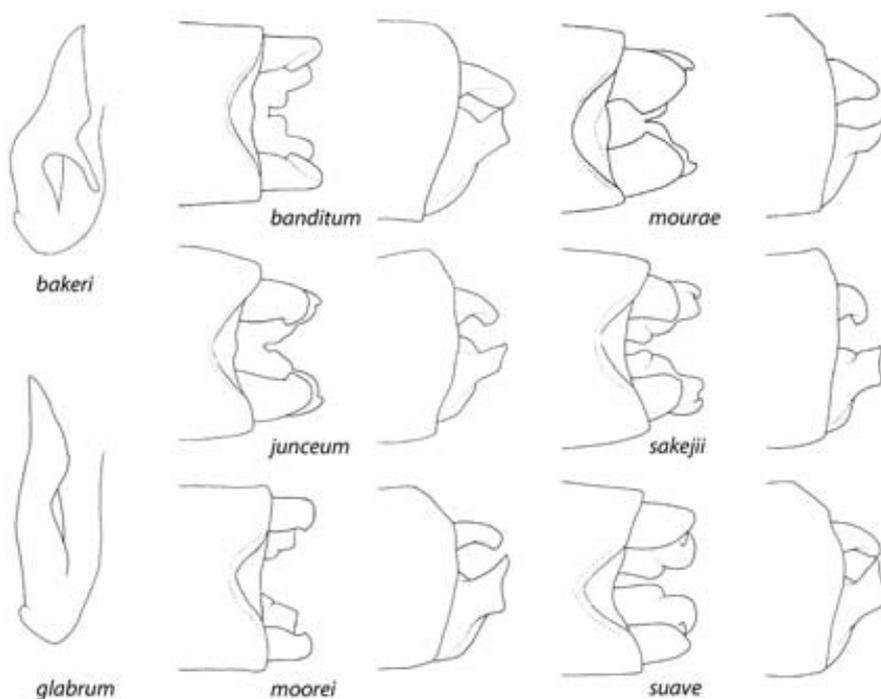
DIJKSTRA (2005a) reviewed the *suave*-complex of *Ceriagrion* and suggested that various taxa may be synonymous. However, up to four superficially similar taxa that differ clearly genetically and subtly in ecology, coloration and morphology overlap in southern central Africa (Tree 2). Additional taxa may occur elsewhere: western African specimens appear similar to *C. suave* Ris, 1921 but are slightly distinct morphologically (Fig. 10) and genetically (Tree 2). These could represent *C. moorei* Longfield, 1952 of which *C. hamoni* Fraser, 1955 is possibly a synonym. MARSHALL & GAMBLES (1977) separated *C. suave* and *C. moorei* from northern Ghana by the penis shape, but while this suggests that similar taxa overlap there too, whether their interpretation agrees with type material must be investigated. DIJKSTRA & CLAUSNITZER (2014) also provided insufficient information to distinguish the various taxa in the complex, which they separated from *C. ignitum* Campion, 1914 and *C. kordofanicum* Ris, 1924 only by (a) the moderate size, Hw 17.0–23.0 mm rather than 15.0–17.0 mm; although (b) the greenish rather than deep reddish eyes with maturity are also diagnostic. All species further have (c) rather dull orange to brown dorsa of the head and thorax; (d) uniformly orange to red abdomen; (e) apically pointed penis with acute

or finger-like lateral lobes; (f) no toothed processes on the apical border of S10; and (g) paraprocts that do not or barely reach beyond the cerci and that have a fairly distinct angular heel ventrally. True *C. suave* favours temporary pools such as rain puddles and, as confirmed with the holotype and



**Tree 2.** 50 % majority rule consensus of 1 000 trees from Maximum Likelihood analysis for the *suave*-complex of *Ceriagrion*, related species and two outgroup taxa. For relevant branches posterior probabilities from Bayesian inference analysis are shown first, as is bootstrap support (both as percentages).

a paratype in MRAC, is (1) notably uniform in colour, brown to orange on the head and thorax grading to yellow on the face and flanks, and typically without a darker greyish or greenish tinge to the head dorsum, nor with distinctly whitish thoracic flanks and/or blackish dots on the humeral and metapleural sutures; (2) often has largely yellow-stained wings; (3) the penis does not have drawn-out finger-like lateral lobes; (4) the dorsal excision of the apical border of S10 is up to half as deep as the segment is dorsally long, and its borders are pale; (5) the cerci have the apical black teeth turned downward and thus usually not visible in dorsal view; and (6) the tips of the paraprocts reach at most as far as those (or even the apical teeth) of the cerci (Fig. 10). The *suave*-complex species' similarity stems from the shared lack of conspicuous characters rather than from common ancestry (Tree 2):



**Figure 10.** Male appendages in dorsal (left) and lateral view (right) of *suave*-complex of *Ceriagrion*, including the holotype of *C. moorei* currently treated as a synonym of *C. suave*, as well as penis in lateral view (far left) of two related species.

ecology, genetics, coloration and appendages and penis shape indicate that *C. suave* is very close to the ubiquitous *C. glabrum* (Burmeister, 1839), while two new species described here are nearer *C. bakeri* Fraser, 1941 but lack its bright blue head and thorax. Known only from the coastal plain of Mozambique and Tanzania, the similarly dull *C. mourae* Pinhey, 1969 differs by having 10 rather than 12–14 Fw postnodal cross-veins, the rectangular rather than trapezoidal Pt, and in the shape of the male appendages (Fig. 10).

### Material studied

**Holotype** ♂. RMNH.INS.508068, Zambia, Northern Province, Lake Chila near Mbala, boggy eastern lake shore, at shallow grassy pools, 1 619 m a.s.l. (8.8341°S 31.3948°E), 08-xii-2014, leg. J. Kipping, RMNH (Photo 21).

**Further material.** MALAWI (Central Region): 2♂, 45 km SW of Lilongwe, Lilongwe District, Dzalanyama Forest Reserve, SE of Dzalanyama Forest Lodge, miombo woodland with rocky areas and marshy grassland, 1 250 m



**Type Photo 15.** Holotype of *Ceriagrion banditum* sp. nov., RMNH.

a.s.l. (14.26°S 33.455°E), 27–29-xii-2001, leg. K.-D.B. Dijkstra, RMNH. 1♂ (identification suspected), MALAWI (Southern Region): Blantyre District, Blantyre, Sunnyside, Smythe Road, rough grass in suburban garden, 1 000 m a.s.l. (15.7922°S 34.9943°E), 06-xi-2001, leg. K.-D.B. Dijkstra, RMNH. MOZAMBIQUE (Zambezia Province): 1♂, 15 km NE of Gurue, Namuli Massif, Muretha Plateau, grassy plateau with streams, boggy pits and forest patches, 1 860–1 890 m a.s.l. (15.3883°S 37.0467°E), 05-xii-2001, leg. K.-D.B. Dijkstra, RMNH. ZAMBIA (Copperbelt Province): 1♂ (RMNH.INS.508067), Chimfunshi Wildlife Reserve near Chingola, shallow pool in grassy dambo near gallery forest, 1 296 m a.s.l. (12.3676°S 27.4831°E), 20-xi-2014, leg. J. Kipping, RMNH. 3♂ 3♀, same locality, same dates, CJKL. ZAMBIA (Northern Province): 1♂ (RMNH.INS.508066), Shiwa N'gandu, Kapishya Hot Springs, shallow grassy pools near Mansha River (Photo 22), 1 434 m a.s.l. (11.1703°S 31.6057°E), 04-xii-2014, leg. J. Kipping, RMNH. 1♂ 1♀, same locality, 06-xii-2014, leg. J. Kipping, RMNH. 1♂ 1♀ same locality, 04-xii-2014, leg. J. Kipping, BMNH. 1♂ 1♀ same locality, 04-xii-2014, leg. J. Kipping, CJKL. ZAMBIA (Northwestern Province): 1♂ (RMNH.INS.507960), Ikelenge, Sakeji School on Hillwood Farm, grassy ditches at forest edge 1 405 m a.s.l. (11.2332°S 24.3125°E), 25-ii-2010, leg. J. Kipping, CJKL. 1♀ (RMNH.INS.508069), as holotype, RMNH. 2♂ (RMNH.INS.508070), 1♀, locality as holotype, 11-xii-2014, leg. J. Kipping, CJKL.

### Genetics

Three unique haplotypes (n = 6) nearest to *C. bakeri* and *C. junceum* sp. nov. (Tree 2).

### Male morphological diagnosis

Distinct within the *suave*-complex (see above) by its (1) greater size, Hw 21.5–22.5 mm (n = 13) rather than 17.0–21.0 mm; (2) sleeker build with the wing tips reaching at most a third down the length of S6, rather than half-way or beyond, and Hw 50–51% of full length (n = 8), versus 51–57% in *C. suave* (n = 9); (3) two narrow horizontal dark bands on the greenish eyes, which are typically lost with maturity in other species; (4) rather intermediate colour of head and thorax, i.e., neither quite uniformly orange like *C. suave*, nor more two-toned brown and cream with dark dots on the su-

tures as *C. sakejii* Pinhey, 1963 and *C. junceum*; (5) often distinctly reddish rather than pale brown Pt; (6) penis with finger-like lateral lobes, rather like *C. bakeri* (Fig. 10); (7) apical excision on S10 being about a third as deep as the segment and bordered with tiny black denticles that appear as dark ridges; (8) cerci that in dorsal view appear narrowed and twisted distally, with



**Photo 21.** *Ceriagrion banditum*, holotype male; Lake Chila, Mbala, Zambia. Photo: JK (08-xii-2014)



**Photo 22.** Shallow temporary pools close to the Mansha River at Shiwa N'gandu, Zambia. Habitat of *Ceriagrion banditum*, *C. junceum* and some other *Ceriagrion*. Photo: JK (05-xii-2014)

the apical black tooth turned in- and base-wards, from above thus being well visible and lying almost halfway the cerci; and (9) tips of the paraprocts that typically fall clearly short of those of the cerci (Fig. 10).

### Etymology

Medieval Latin “banished”, the origin of the word bandit, which refers to the banded eyes recalling the mask of a bandit (neuter adjective).

### Range and ecology

Known from northern Zambia to northern Mozambique between 1 000 and 1 900 m a.s.l. While poorly preserved, males in MRAC from Lubumbashi in southern Congo-Kinshasa also appear to belong to this species (Map 4). Exact habitat difference with other species unclear, but occurs at shallow grassy pools in dambos, open depressions that flood seasonally (see *C. junceum*). Also found away from water in half-open miombo woodland.

### ***Ceriagrion junceum* Dijkstra & Kipping sp. nov. – Spikerush Citril**

(Type Photo 16, Photos 19, 22–24, Fig. 10)

### Taxonomy

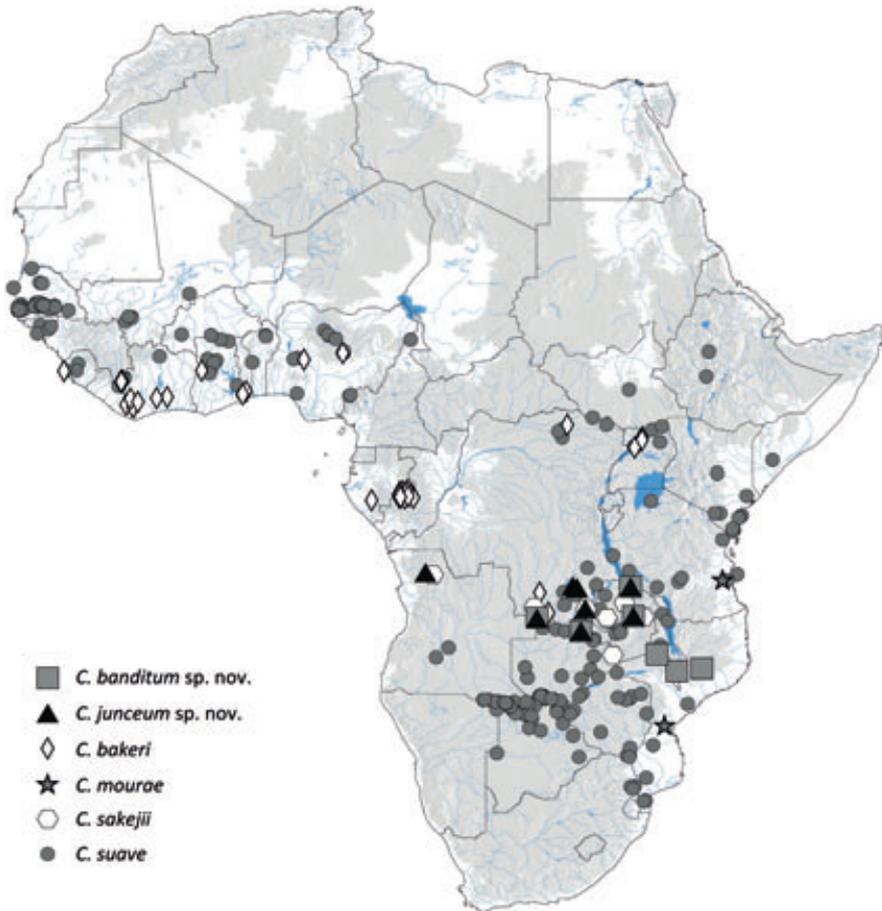
This taxon was mistaken for *C. sakejii* and *C. suave* but is closer to *C. bakeri* in its ecology, genetics and morphology (Tree 2). It was mentioned but not keyed by DIJKSTRA & CLAUSNITZER (2014), who also diagnosed *C. sakejii* poorly. That localised bog species is easily distinguished from other *suave*-complex (see *C. banditum* sp. nov.) species by (1) the thorax with distinct blackish dots in the humeral and metapleural fossae and a sharp contrast between the warm orange brown dorsum and creamish sides; (2) the penis with finger-like lateral lobes, rather like *C. bakeri* (Fig. 10); (3) the dorsal excision of S10 with pale and somewhat thickened and raised borders that bear a distinct gap between them medially; and (4) the notably short cerci that appear almost round in dorsal view (Fig. 10).

### Material studied

**Holotype** ♂. RMNH.INS.505431, Congo-Kinshasa, Katanga, Upemba National Park, Mukana, west of Lusinga, depressions with (seasonal) marsh,

bog lakes and gallery forest in open grassy plains (Photo 19), 1 770–1 840 m a.s.l. (8.91°S 27.18E), 10–14-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** ANGOLA (Uíge Province): 3♂ (RMNH.INS.508385, RMNH.INS.508386), 5 km N of Negage, Canuango source near agricultural school, dammed lake with floating and emergent vegetation, boggy perimeter, 1 240 m a.s.l. (7.7105°S 15.2696°E), 24-xi-2012, leg. K.-D.B. Dijkstra, RMNH. 1♂ 2♂♀, 8 km NNE of Negage, swamp at Cangulo, flooded



**Map 4.** Distribution of the suave-complex of *Ceriagrion* (*C. banditum* sp. nov., *C. junceum* sp. nov., *C. mourae*, *C. sakejii* and *C. suave*) and *C. bakeri*.

depression with emergent vegetation, 1 212 m a.s.l. (7.6936°S 15.2873°E), 29-xi-2012, leg. K.-D.B. Dijkstra, RMNH. CONGO-KINSHASA (Katanga): 4♂ (RMNH.INS.505432), 12♂♀, as holotype RMNH. 3♂, Kundelungu National Park, source area of Lutshipuka, grassy plateau with pools, bog, wet meadows and gallery forest patches, 1 680–1 705 m a.s.l. (10.58°S, 27.83°E), 23–24-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 1♀ (RMNH.INS.505557), Upemba National Park, Kabwekanono, source area of Kafwi, bogs in open grassy plains, 1 770–1 820 m a.s.l. (8.937°S 27.166°E), 15-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 2♂♀, Upemba National Park, source area of Lusunga near park headquarters, small dam, 1 760–1 800 m (8.933°S 27.199°E), 11-xi-2011, leg. K.-D.B. Dijkstra, RMNH. ZAMBIA (Copperbelt Province): 1♂, Chimfunshi Wildlife Reserve near Chingola, shallow pool in grassy dambo near gallery forest, 1 296 m a.s.l. (12.3676°S 27.4831°E), 20-xi-2014, leg. J. Kipping, CJKL. ZAMBIA (Northern Province): 1♂, Lake Chila near Mbala, boggy eastern lake shore, at shallow grassy pools, 1 619 m a.s.l. (8.8341°S 31.3948°E), 11-xii-2014, leg. J. Kipping, CJKL. 2♂♀ 8♂, Kakoma, 19 km N of Mbala, shallow grassy pools at extended marshland, 1 449 m a.s.l. (8.6949°S 31.3013°E), 11-xii-2014, leg. J. Kipping, CJKL. 1♂, Shiwa N'gandu, Kapishya Hot Springs, shallow grassy pools near Mansha River (Photo 23), 1 434 m a.s.l. (11.1703°S 31.6057°E), 06-xii-2014, leg. J. Kipping, CJKL. 6♂, Shiwa N'gandu, farm area, 3.5 km N of eastern entrance, shallow grassy pools near Mansha River, 1 469 m a.s.l. (11.1851°S 31.7878°E), 03-xii-2014, leg. J. Kipping, CJKL. ZAMBIA (Northwestern Province): 2♂♀ 1♂, Sakufofa, 13 km NE of Ikelenge, dambo valley with shallow, slightly acidic pools near Zambezi River, surrounded by miombo woodland (Photo 24), 1 312 m a.s.l. (11.1653°S 24.3565°E), 26-xi-2014, leg. J. Kipping, CJKL.

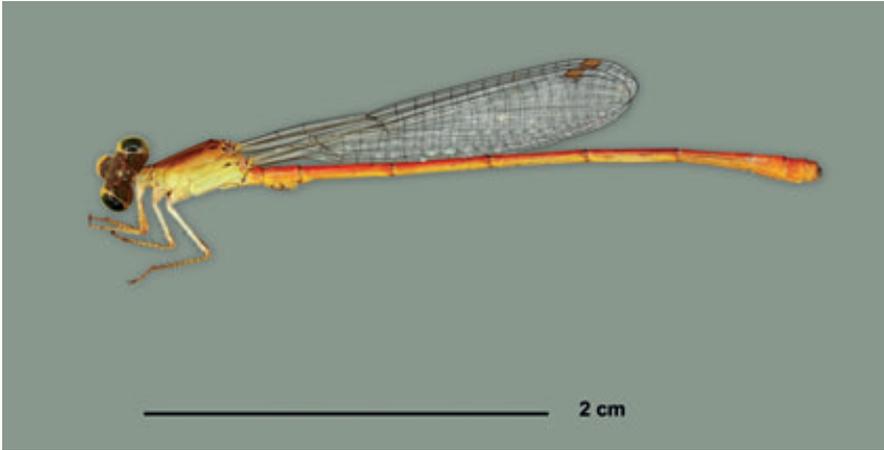
### Genetics

One unique haplotype ( $n = 5$ ) nearest to *C. bakeri* and *C. banditum* (Tree 2).

### Male morphological diagnosis

Combines traits that recall other species in the *suave*-complex (see *C. banditum*) including (1) moderate size, Hw 18.5–20.5 mm ( $n = 24$ ); (2) a rather greyish dorsum of the head; (3) the thorax somewhat like *C. sakejii* with distinct blackish dots in the humeral and metapleural fossae, a warm or-

ange brown dorsum and creamish sides, but only weak contrast between these colours; (4) the penis with finger-like lateral lobes, rather like *C. bakeri* (Fig. 10); (5) the apical excision on S10 about a third as deep as the segment and bordered with tiny black denticles that appear as dark ridges; (6) the



**Type Photo 16.** Holotype of *Ceriagrion junceum* sp. nov., RMNH.



**Photo 23.** *Ceriagrion junceum*, male; Sakufola near Ikelenge, Zambia. Photo: JK (28-xi-2014)

cerci with the apical black tooth close to the tips, turned inwards and thus well-visible in dorsal view; and (7) the relatively slender and weak-heeled paraprocts that extend slightly but clearly beyond the tooth of the cerci (Fig. 10).

### Etymology

Latin “of rushes” refers to the preference for sedge-like vegetation (neuter adjective).

### Range and ecology

Widespread across Katanga, Angola and northern Zambia (Map 4) between 1 200 and 1 850 m a.s.l. at shallow flooded depressions with dense grass-like vegetation, particularly spikerushes (*Eleocharis* sp.). The region is the centre of *Ceriagrion* diversity in Africa, with 13 of the 20 African species present and up to eight at a single site. *Ceriagrion junceum* can share its pools with *C. banditum* sp. nov., *C. corallinum* Campion, 1914, *C. katambo-rae* Pinhey, 1961, *C. kordofanicum*, *C. platystigma* Fraser, 1941 and *C. whel-lani* Longfield, 1952. It occurs rarely with *C. sakejii*, which prefers grassy and mossy seeps and bogs with no or little open water, or with the continent-wide *C. glabrum* and *C. suave* that favour more temporary waters. PINHEY (1984) recorded its nearest relative, the strikingly blue-fronted *C. bakeri*, in northern Zambia and while it has a very similar habitat, we were unable to confirm this overlap despite extensive fieldwork in the region.



**Photo 24.** Shallow pool near Sakufola, Ikelenge, Zambia. The dense sedges are essential for *Ceriagrion junceum*. Photo: JK (28-xi-2014)

***Ceriagrion obfuscans* Dijkstra, Mézière & Kipping sp. nov. –  
Darkening Citril**

(Type Photo 17, Photos 18, 25–26, 39–40, 52, Fig. 11)

**Taxonomy**

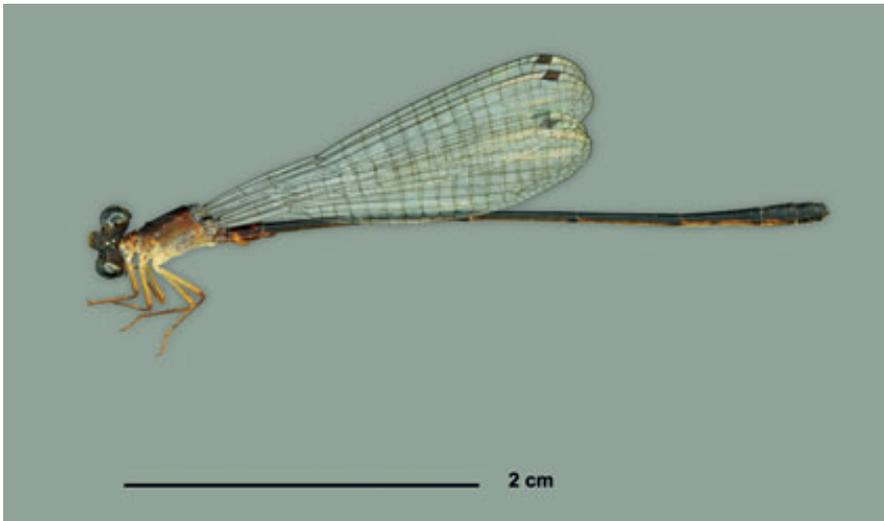
Belongs to the genetically, morphologically and ecologically distinct *varians*-group of *Ceriagrion*, which aside from *C. annulatum* Fraser, 1955 and *C. rubellocerinum* Fraser, 1947 includes *C. platystigma* Fraser, 1941 that DIJKSTRA (2005a) synonymised with *C. varians* (Martin, 1908). The latter two are similar by (a) the never blackened head and only occasionally blackened S3–7; (b) the apex of S10 with fine and often almost indiscernible black denticles; and (c) the narrow cerci that are at most as wide as long, with at most their apical teeth touching (Fig. 11). However, *C. platystigma* is distinguished by (1) the labrum and thorax being pale brown to deep red, rather than orange; (2) the red Pt and S3–7 can become (at least partly) black; (3) the penis' short apex that does not reach the bend of its stem in lateral view; and (4) the cerci being separated by a space that is somewhat wider than their width, with the apical teeth wide apart in dorsal view (Fig. 11) [rejected synonymy]. The synonymy of *C. sanguinostigma* Fraser, 1955 with *C. varians* (Martin, 1908) was reconfirmed in MRAC. The new species is the most distinct one in the group and was treated as such by DIJKSTRA & CLAUSNITZER (2014), overlapping geographically with all other group species except possibly *C. rubellocerinum*.

**Material studied**

**Holotype** ♂. Congo-Kinshasa, Province Orientale, Lower Lomami, Iloko stream on Lieki-Lileke path, swampy blackwater stream, 390 m a.s.l. (0.6548°N 24.2685°E), 27-v-2010, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** CONGO-KINSHASA (Province Equateur): 2♂ 4♀ (RMNH.INS.502151), Lower Itimbiri, Loeka River (= Gwolo) mouth, tributary, forest and Itimbiri around mouth, 360 m a.s.l. (2.038°N 22.826°E), 16-v-2010, leg. K.-D.B. Dijkstra, RMNH. 2♀, Lower Itimbiri, Loeka and Liha streams on Engengele-Yamoenga road, swampy streams in farmbush, 375 m a.s.l. (2.11°N 22.69°E), 13-v-2010, leg. K.-D.B. Dijkstra, RMNH. 1♀, Lower Itimbiri, Kona forest, swamp forest, 362 m a.s.l. (2.040°N 22.788°E), 12-v-2010, leg. K.-D.B. Dijkstra, RMNH. 1♀, Lower Itimbiri, Loeka Riv-

er (= Gwolo), lower 3 km of blackwater tributary, 375 m a.s.l. (2.05°N 22.82°E), 11-v-2010, leg. K.-D.B. Dijkstra, RMNH. CONGO-KINSHASA (Province Orientale): 6♂ (RMNH.INS.502141), 2♀, as holotype, RMNH. 1♂ 2♀, Lower Lomami, Lieki camp, river bank and adjacent forest and farmbush, 420 m a.s.l. (0.685°N 24.240°E), 28-v-02-vi-2010, leg. K.-D.B. Dijkstra, RMNH. 3♂ 2♀ (RMNH.INS.502301), E of Isangi, Yandja River to Yandja Lac (= Etang Loholo), farmbush, swamp forest and blackwater lake, 385 m a.s.l. (0.73°N 24.28°E), 06-v-2010, leg. K.-D.B. Dijkstra, RMNH. 22♂ (RMNH.INS.502198, RMNH.INS.502278, RMNH.INS.502300), 6♀ (RMNH.INS.502286), 2♂♀, between Yangole and Yaeoli on Yaekela-Lilanda road, blackwater swamp forest, 376 m a.s.l. (0.8017°N 24.2978°E), 03-05-v-2010, leg. K.-D.B. Dijkstra, RMNH. 3♀ (RMNH.INS.502188, RMNH.INS.502196), Yaekela, flooded forest and farmbush (Photo 39), 410 m a.s.l. (0.81°N 24. 28°E), 01-02-v-2010, leg. K.-D.B. Dijkstra, RMNH. 1♂, Lower Lomami, research transect at Ekukumu camp near Yabogesa, river bank and adjacent forest and farmbush, 350 m a.s.l. (0.6804°N 24.1903°E), 30-v-2010, leg. K.-D.B. Dijkstra, RMNH. GABON (Haut-Ogooué Province): 1♂ (RMNH.INS.554374), Batéké Plateau, Léconi Valley, Eaux Claires, Camps



**Type Photo 17.** Holotype of *Ceriagrion obfuscans* sp. nov., RMNH.

des Pygmés, swamp and forest along a sandy river, 434 m a.s.l. (1.4549°S 14.1785°E), 16-ix-2012, leg. N. Mézière, RMNH. 1♂, Batéké Plateau, Léconi Valley, Eaux Claires, forest swamp, 440 m a.s.l. (1.4543°S 14.1747°E), 26-i-2012, leg. N. Mézière, A. Günther, J. Kipping & H. Krahnstöver, RMNH. 1♂, Léconi road 5 km after Bongoville, Sablière d'Ekala, forest swamp, 393 m a.s.l. (1.6068°S 13.9137°E), 07-xi-2010, leg. N. Mézière, RMNH. 12♂, Batéké Plateau, 18 km NW of Léconi, sandy stream and swamp in dense gallery forest, 425 m a.s.l. (1.4472°S 14.1661°E), 29-ix-2013, (Photo 25) leg. J. Kipping, CJKL. 3♂ 1♀, same locality, 20-ix-2014, leg. J. Kipping, CJKL.

### Genetics

Four unique haplotypes (n = 10) are very distinct but nearest to the rest of the *varians*-group.

### Male morphological diagnosis

Medium-sized damselfly (Hw 20.0–22.0 mm; n = 16) that belongs to the *varians*-group by (a) the blackish rhomboidal Pt with the anterior border shorter than the posterior; (b) the cerci that are wider than long and (almost) touch each other in dorsal view; and (c) the paraprocts without a heeled lower border in lateral view (Fig. 11). However, unlike other group



**Photo 25.** *Ceriagrion obfuscans*, male; Batéké Plateau, Gabon. Photo: JK (29-ix-2013)

species, (1) the orange to red head, thorax and S1–2 blacken with age; (2) the humeral and metapleural sutures lack dark dots in the fossae, although this character is obscured with the darkening of the body; (3) the penis has a notably long, broad and squarish apex and lacks small horn-like cones on each side of its base; (4) S3–10 are always blackish, while at least S8–10 always remain red in other species; (5) the cerci are round rather than pointed in lateral view; and (6) the paraprocts are just over twice as long as the cerci, rather than under (Fig. 11).

### Etymology

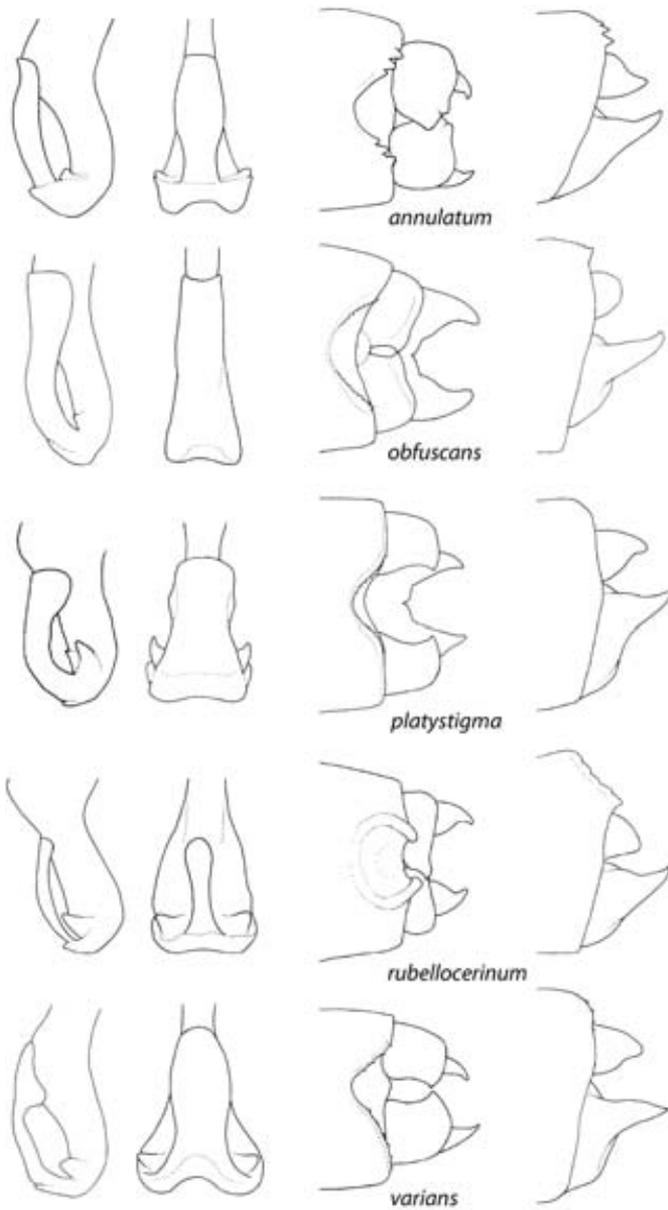
Latin “making dark” refers to the body that blackens with age and the gloomy habitat (present participle of *obfusco* used as adjective).

### Range and ecology

Unlike most *Ceriagrion* species, the *varians*-group prefers rainforest shade. The new species favours deeply shaded standing water with thick detritus between 350 and 440 m a.s.l., often blackwater, probably mostly temporary (e.g., flooded by river water) and typically on sand, e.g., in Gabon known only from the Batéké Plateau (Photo 26). It can be the most abundant odonate in dark flooded forest in the Congo Basin (Photo 39). Conspicuously orange when fresh, adults darken and become increasingly inconspicuous with age.



**Photo 26.** Mosaic of grassland and gallery forest on the sandy Batéké Plateau in Gabon. This landscape holds a unique fauna with *Elattoneura aurifex*, *Ceriagrion obfuscans*, *Pseudagrion aureolum*, *Phyllogomphus bongorum*, *Malgassophlebia andzaba*, *Urothemis venata* and *Zygonyx di-onyx* described here. Photo: NM (05-ii-2011)



**Figure 11.** Penis in lateral and ventral view (left) and male appendages in dorsal (middle) and lateral view (right) of *variens*-group of *Ceriagrion*.

***Pseudagrion aureolum* Dijkstra, Mézière & Kipping sp. nov. –  
Nugget Sprite**

(Type Photo 18, Photos 26–28, 52, 62, Fig. 12)

**Taxonomy**

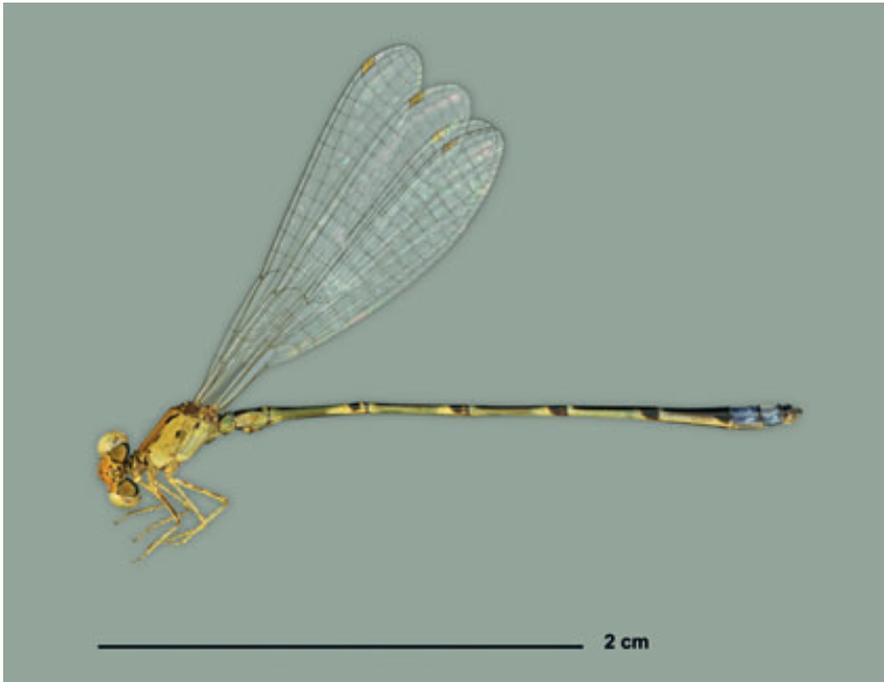
Genetically, morphologically and ecologically unlike any other species of the B-group of *Pseudagrion* Selys, 1876 (see DIJKSTRA et al. 2007).

**Material studied**

**Holotype** ♂. Gabon, Haut-Ogooué Province, Batéké Plateau, road to Léconi Park, Laboumi River, sandy stream (4–6 m), 445 m a.s.l. (1.5232°S 14.2906°E), 30-xii-2008, leg. N. Mézière, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 2♂, as holotype, RMNH. 1♂, locality as holotype, 04-vii-2009, leg. N. Mézière, RMNH. 2♂, Franceville-Kessala Road, Kessala, Mpassa, large sandy river (>20 m wide), 410 m a.s.l. (1.8958°S 13.8975°E), 09-xi-2009, leg. N. Mézière, RMNH. 1♂, Lac aux Caïmans, Léconi, large lake with swamps and pools, 460 m a.s.l. (1.6533°S 14.2763°E), 06-ii-2010, leg. N. Mézière, RMNH. 1♂, same locality, 13-ix-2010, leg. N. Mézière, RMNH. 2♂♀ (RMNH.INS.503281, RMNH.INS.503282), 5 km after Bongoville towards Léconi, Andzaba River, Ekala, sandy and swampy stream (Photo 62), 389 m a.s.l. (1.6319°S 13.8887°E), 28-iii-2010, leg. N. Mézière & J. Renoult, RMNH. 1♂ 2♂♀, Bongoville-Léconi road after Ekala, old village of Boubou, stream (2 m wide) with gravel bottom (Photo 52), 393 m a.s.l. (1.6114°S 13.9105°E), 20-ix-2009, leg. N. Mézière, RMNH. 2♂, Léconi road, Souba, lake in grassland, 428 m a.s.l. (1.5767°S 14.0492°E), 27-xii-2010, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.508773), same locality, 09-iii-2013, leg. N. Mézière, RMNH. 1♂ 2♂♀, Léconi, Les Eaux Claires, Laboumi River, small sandy river (4–6 m) with gallery forest in savanna, and associated swamp and pools, 446 m a.s.l. (1.5753°S 14.2014°E), 29-xii-2009, leg. K.-D.B. Dijkstra, N. Mézière & C. Vanappelghem, RMNH. 2♂, same locality, 04-vii-2009, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.502420), same locality, 20-ix-2009, leg. N. Mézière, RMNH. 2♂ (RMNH.INS.503367), 50 km N of Franceville, Franceville-Okondja Road, Léconi River at bridge N of Onvouri-Olounga, large sandy river, 307 m a.s.l. (1.1776°S 13.5389°E), 10-i-2010, leg. K.-D.B. Dijkstra, N. Mézière & C. Vanappelghem, RMNH. 1♂, 34 km E of Franceville, Franceville-Léconi road, NE

of Bongoville, small streams at forest edge, 417 m a.s.l. (1.6131°S 13.9056°E), 31-xii-2009, leg. K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.508800), Batéké Plateau, Parc de la SPB, Ekala 2, Léconi Valley, forest pond with much leaf litter, 420 m a.s.l. (1.3673°S 14.1463°E), 05-iv-2013, leg. N. Mézière, RMNH. 1♂, Akieni, sandy stream (4–6 m), 474 m a.s.l. (1.1708°S 13.8740°E), 07-ii-2009, leg. N. Mézière, RMNH. 1♂, Léconi, Léconi River near Léconi town, sandy river with gallery forest in savanna (Photo 28), 484 m a.s.l. (1.5847°S 14.2450°E), 30-xii-2009, leg. N. Mézière & C. Vanappelghem, RMNH. 1♂, Batéké Plateau, Léconi, Léconi River, sandy stream (>10 m wide), 527 m a.s.l. (1.5844°S 14.2443°E), 04-vii-2009, leg. N. Mézière, RMNH. 7♂, Batéké Plateau, Laboumi River 7.5 km NE of Léconi, sandy river with very clear water in dense gallery forest, 446 m a.s.l. (1.5232°S 14.2906°E), 25-i-2012, leg. J. Kipping, CJKL. 1♂, Batéké Plateau, Léconi River 2 km W of Léconi,



**Type Photo 18.** Holotype of *Pseudagrion aureolum* sp. nov., RMNH (horizontally mirrored from original).

sandy river with very clear water in open landscape, 440 m a.s.l. (1.5844°S 14.2442°E), 28-i-2012, leg. J. Kipping, CJKL.

### Genetics

Two unique haplotypes (n=7) are well-separated from but nearest to *P. glaucescens* Selys, 1876 and *P. isidromorai* Compte Sart, 1967.

### Male morphological diagnosis

Unlike any *Pseudagrion* of the B-group by the combination of (1) the small size, Hw 15.5–17.5 mm (n=13); (2) the orange-yellow face and front of eyes; (3) the deep rufous back of the eyes, postocular spots and thorax, all almost devoid of black markings; and the male structures that are close to but distinct from those of its (genetically) nearest relatives, especially *P. glaucescens*: (4) the penis is simple and square-ended; (5) the cerci are somewhat longer than the simple paraprocts and have a distinctive though small subapical tooth on the lower flange, which creates a three-pointed tip in dorsal view (Fig. 12).

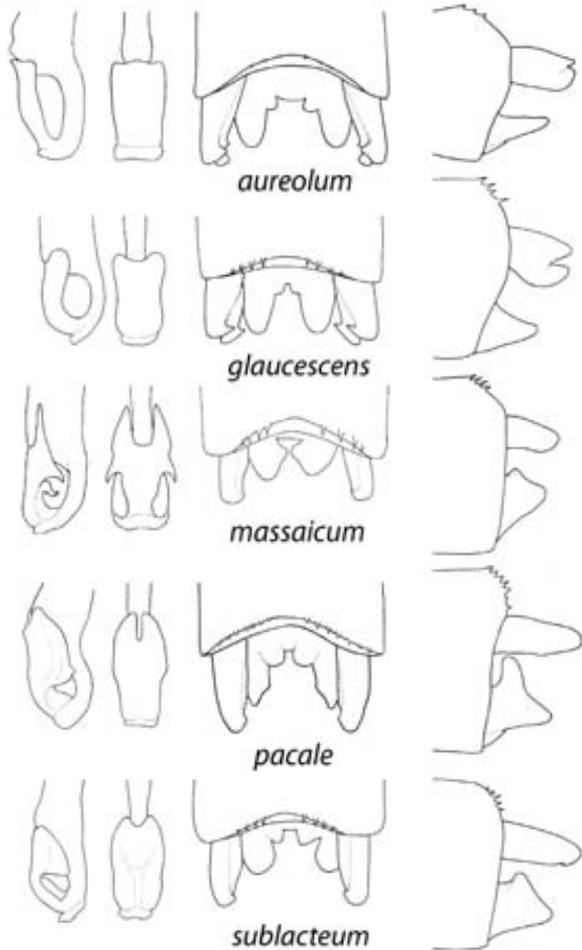
### Etymology

Latin “golden” refers to the rich colour of this species (neuter adjective).



**Photo 27.** *Pseudagrion aureolum*, male; Batéké Plateau, Gabon. Photo: JK (21-ix-2013)

**Photo 28.** The crystal clear Léconi River on the Batéké Plateau, Gabon. *Pseudagrion aureolum* is common on its grassy banks. Photo: JK (22-ix-2013)



**Figure 12.** Penis in lateral and ventral view (left) and male appendages in dorsal (middle) and lateral view (right) of selection of *Pseudagrion* B-group species; *P. tanganyicum* sp. nov. is structurally identical to *P. massaicum*.

### Range and ecology

Open and clear streams, rivers and lakes between 300 and 550 m a.s.l. on the sandy Batéké Plateau in south-eastern Gabon (Photos 26, 28). This is an unusual habitat for the B-group of *Pseudagrion*, which prefers warmer habitats such as sluggish rivers and ponds.

### *Pseudagrion dactylidium* Dijkstra & Mézière sp. nov. – Gabon Slim Sprite

(Type Photo 19, Photos 29–30, Fig. 13)

### Taxonomy

Belongs to the “slim sprites”, a group of slight rainforest *Pseudagrion* A-group species that perch in a hanging position and favour sandy streams (*P. cyathiforme* Pinhey, 1973 and *P. simplicilaminatum* Carletti & Terzani, 1997) or soft-bottomed ponds, seeps and headwaters (*P. hemicolon* Karsch, 1899 and *P. thenartum* Fraser, 1955). The present taxon is probably the sister-species of the similar and sympatric *P. thenartum*, but separated by the male appendages.

### Material studied

**Holotype** ♂. RMNH.INS.502449, Gabon, Haut-Ogooué Province, right-hand road before “Africa No1” radio station in the direction of Franceville, Moyabi, swamps in forest, 482 m a.s.l. (1.6866°S 13.3076°E), 19-v-2011, leg. N. Mézière, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♂, locality as holotype, 21-i-2011, leg. N. Mézière, RMNH. 1♂, same locality, 11-ii-2011, leg. N. Mézière, RMNH. 4♂, same locality, 09–10-iii-2011, leg. N. Mézière, RMNH. 3♂ (RMNH.INS.502435, RMNH.INS.502449), 8 km SW of Moanda, Mouyeugue-Moanda-Bakoumba Road, Mbéréssé River at Mikouangna, sandy and turbid river in farmbush and associated (forested) swamp, 409 m a.s.l. (1.5925°S 13.1550°E), 13-i-2010, leg. K.-D.B. Dijkstra, RMNH. 2♂ (RMNH.INS.503307), Moanda, shaded and well-vegetated (Maranthaceae) forest pool bordering stream, 423 m a.s.l. (1.5555°S 13.1195°E), 07-iii-2010, leg. N. Mézière, RMNH. 1♂, Konda, 11 km W of

Moanda, small sandy streams and pools in forest, 423 m a.s.l. (1.5555°S 13.1195°E), 30-i-2012, leg. J. Kipping, CJKL. 1♂, Moyabi, 18 km SE of Moanda, small pools in forest, 484 m a.s.l. (1.5858°S 13.15631°E), 24-i-2012, leg. J. Kipping, CJKL.

### Genetics

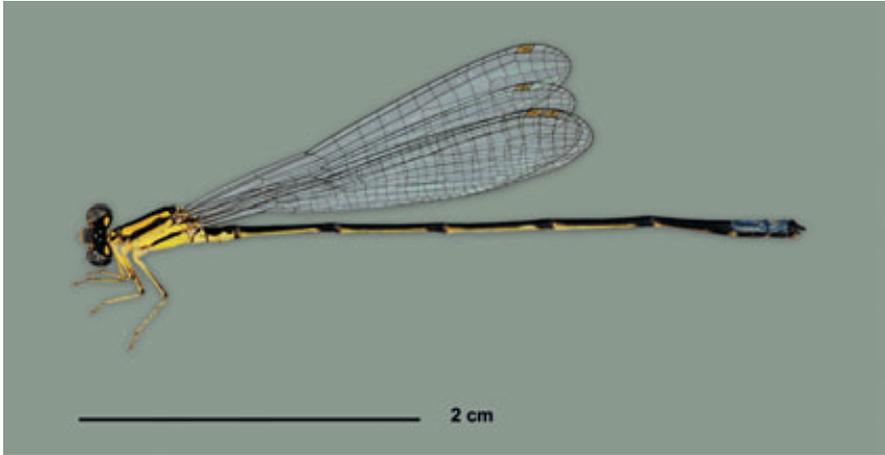
Two unique haplotypes (n=3) nearest to *P. hemicolon* (n=6; five unique haplotypes) and *P. thenartum* (n=1).

### Male morphological diagnosis

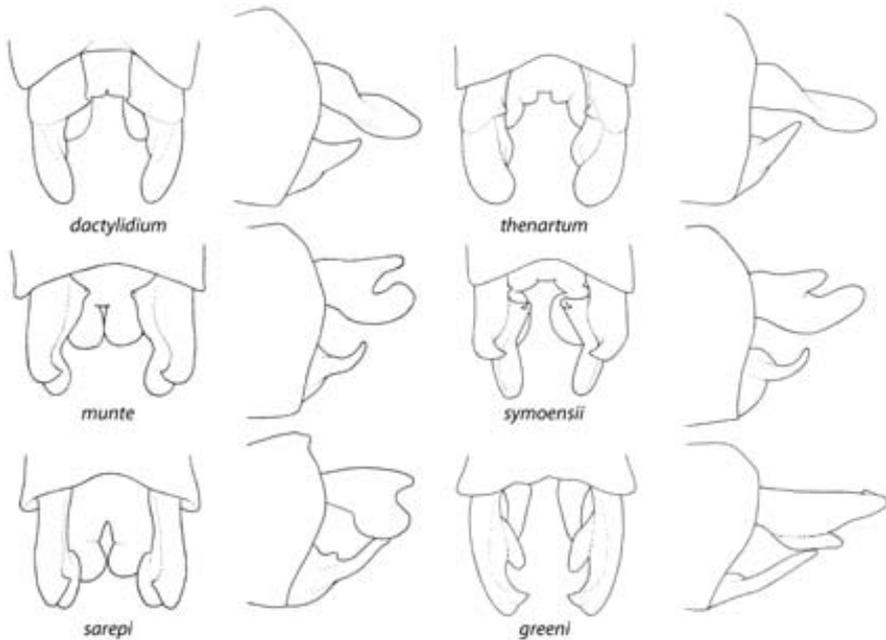
Similar to the sympatric *P. hemicolon* and *P. thenartum* by (a) the small size, Hw 20.5–22.0 mm (n=5); (b) the slender build; (c) the bright orange, though yellow when preserved, postocular spots and thorax, with broad ante-humeral stripes; (d) the largely pale legs; and (e) the reddish Pt, although also yellowish when preserved. Separated reliably from *P. thenartum* only by (1) the sleeker cerci in dorsal view, the distal section being distinctly narrower than the basal section with the lower flange largely reduced (Fig. 13). This shape is intermediate between the also sympatric (but blue-bodied) *P. simplicilaminatum* and *P. thenartum*, in which the tip is at least as wide as the base and the flange is even wider and strongly rounded, often even more so than in Figure 13. Also differs from *P. thenartum* by (2) the blacker thorax, although there is overlap: the orange of the ante-humeral stripe typically touches the humeral suture over a shorter distance and does not cross to the mesepimeron at the posterior end of this suture, the wide part of the black humeral stripe thus appearing less pronounced, and there is always a black stripe along nearly the full length of the metapleural suture, which often reaches the metastigma and even metakatepisternum; the latter is typically ill-defined or even reduced to a black dot at the posterior end of this suture in *P. thenartum*.

### Etymology

Latinised form of the Greek *daktylidion* (little finger) alludes to the shape of the cerci compared with *P. thenartum*, whose cerci FRASER (1955) likened to thumbs, even though *thenar* is Greek for the palm of the hand (noun in apposition).



**Type Photo 19.** Holotype of *Pseudagrion dactylidium* sp. nov., RMNH.



**Figure 13.** Male appendages in dorsal (left) and lateral view (right) of selection of *Pseudagrion* A-group species.

**Range and ecology**

Deeply shaded and often temporary pools with thick detritus in rainforest between 400 and 500 m a.s.l. in south-eastern Gabon (Photo 30). *Pseudagrion thenartum* appears never to be syntopic, favouring similar habitats near sandy springs and seeps.



**Photo 29.** *Pseudagrion dactylidum*, male; near Moanda, Gabon. Photo: NM (17-iv-2013)



**Photo 30.** Small pool in dense rainforest, Konda near Moanda, Gabon. Habitat of *Pseudagrion dactylidum*. Photo: NM (07-x-2010)

***Pseudagrion munte* Dijkstra sp. nov. – Upemba Sprite**

(Type Photo 20, Photo 31, Fig. 13)

**Taxonomy**

Genetically close to the sympatric *P. symoensii* Pinhey, 1967 that is also endemic to Katanga's high plateaus, but morphologically well-separated, and treated as a distinct species by DIJKSTRA & CLAUSNITZER (2014).

**Material studied**

**Holotype** ♂. RMNH.INS.505608, Congo-Kinshasa, Katanga, Upemba National Park, Munte, river with grassy verges, gallery patches and rapids in miombo woodland, 1 450 m a.s.l. (8.77°S 26.84°E), 18-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** 10♂ (RMNH.INS.505607), 1♀ (RMNH.INS.505606), as holotype, RMNH. 1♂, as holotype, CKJL.

**Genetics**

One unique haplotype (n=3) close to four similar but distinct haplotypes (n=7) of the sympatric *P. symoensii*.

**Male morphological diagnosis**

Similar to several highland species of the A-group of *Pseudagrion* by (a) the small size, Hw 18.5–20.0 mm (n=10); (b) the bluish green labrum that is narrowly black at its base, contrasting with black postclypeus; and (c) the frons and dorsum of the thorax and abdomen base that are pruinose with maturity. Differs from the somewhat similar *P. vumbaense* Balinsky, 1963, sympatric *P. inconspicuum* Ris, 1931 and syntopic *P. spernatum* Selys, 1881 by (1) the evenly pruinose dark mesepisternum without defined pruinose or pale ante-humeral stripes with maturity; (2) the black rather than pale brown or reddish Pt; (3) the entire dorsum of S8 but only the basal half of S9 being blue, rather than both segments completely blue dorsally or wholly pruinose; and (4) the cerci nearest to those of *P. symoensii* with an internal flange on the lower branch that extends almost to the base and ends in a sharp up-turned tooth, although this tooth is not as large and there is no additional tooth more basally and dorsally (Fig. 13). Note that latter species,

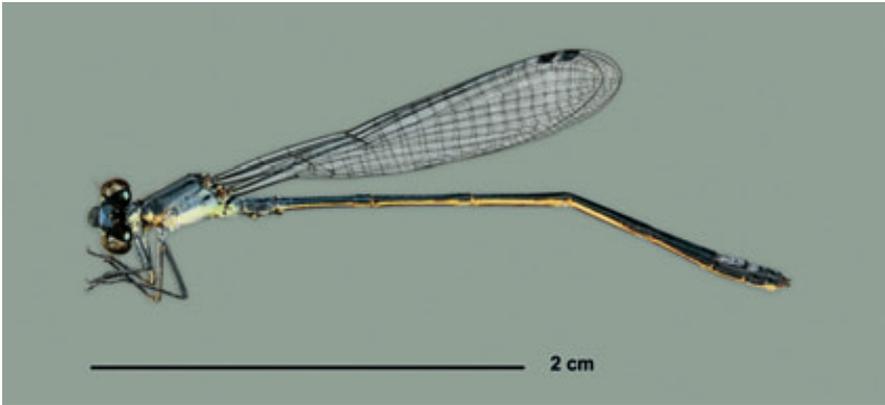
while genetically and geographically close, is otherwise very different, e.g., with orange labrum and frons, and red Pt.

### Etymology

Name refers to the type locality (noun in apposition).

### Range and ecology

Grassy borders of open sections of the Munte, a small swift-flowing black-water river with some gallery forest at 1 450 m a.s.l. on the otherwise open Kibara Plateau of Upemba National Park, Katanga (Photo 31).



**Type Photo 20.** Holotype of *Pseudagrion munte* sp. nov., RMNH.

**Photo 31.** Munte River on the Kibara Plateau in Upemba National Park, Katanga, Congo-Kinshasa. The grassy banks are the type locality of namesake *Pseudagrion munte* and habitat of *Anax gladiator*. Photo: KDBD (18-xi-2011)



***Pseudagrion pacale* Dijkstra sp. nov. – Peace Sprite**

(Type Photo 21, Photos 32, 75, Fig. 12)

**Taxonomy**

Belongs to a subgroup of *Pseudagrion* B-group species that favour larger and swifter flowing waters. These include *P. acaciae* Förster, 1906, *P. sublacteum* (Karsch, 1893), *P. vaalense* Chutter, 1962 and probably *P. niloticum* Dumont, 1978. Present species is morphologically and genetically clearly differentiated.

**Material studied**

**Holotype** ♂. RMNH.INS.501668, Sierra Leone, Eastern Province, 7 km S of Kenema, Moa River at Tilorma, large river with gallery forest and rocky rapids (Photo 32), 147 m a.s.l. (7.8123°N 11.1779°W), 26-ii-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** 2♂ (RMNH.INS.501661, RMNH.INS.501670), 1♀ (RMNH.INS.501669), as holotype, RMNH. 3♂ (RMNH.INS.501674), 1♀, same locality, 15-iii-2011, leg. K.-D.B. Dijkstra, RMNH.

**Genetics**

Two unique haplotypes (n=5) distant from but nearest to *P. sublacteum*; more distant to *P. acaciae* and *P. vaalense*; *P. niloticum* not sampled.

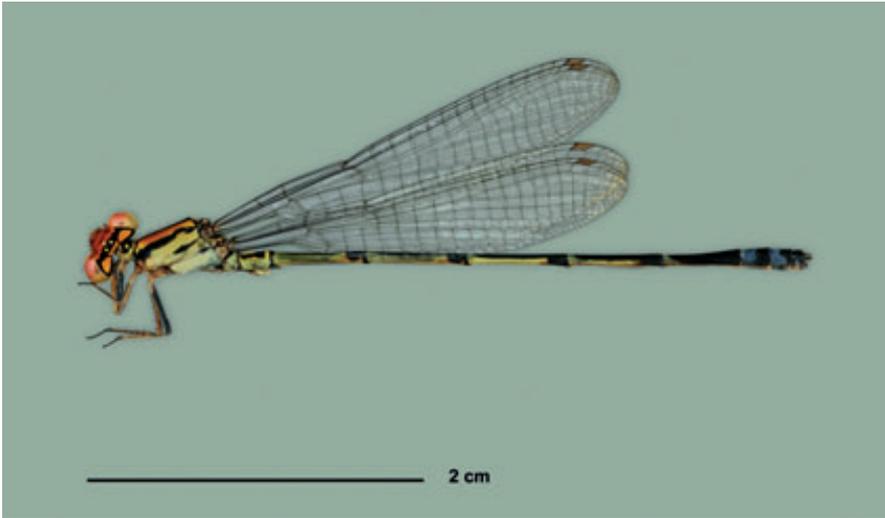
**Male morphological diagnosis**

Nearest to *P. sublacteum* by (a) the essentially similar markings including reddish eyes, face and ante-humeral stripes; (b) the broad lateral and apical lobes of the penis; (c) the narrow and slender cerci that clearly surpass the paraprocts; and (d) the hatchet-shaped paraprocts, with a prominent dorsal knob in lateral view (Fig. 12). However, (1) is larger, Hw 21.5–24.0 mm (n=6) rather than 18.5–21.0 mm (n=6); (2) the postocular spots and ante-humeral stripes become deep orange and the thorax sides pale green with maturity, rather than all turning dark and eventually uniformly pruinose; (3) the postocular spots are clearly framed with black; (4) the apical cleft of the penis is deep and narrow, while its wide lateral lobes bear tiny projections, thus the penis most recalls that of *P. coeleste* Longfield, 1947; (5) the paraprocts are pointed rather than rounded in dorsal view; and (6) the dor-

sal knob of the paraprocts is much higher than deep and thus more pronounced than in other African *Pseudagrion* species (Fig. 12).

### Etymology

Latin “belonging to peace” to contrast with the 1991–2002 civil war in which the Moa River was a frontline and the Ebola epidemic since 2013 of which the Kenema region was the national epicentre (neuter adjective).



**Type Photo 21.** Holotype of *Pseudagrion pacale* sp. nov., RMNH.

**Photo 32.** Rocky section of Moa River at Tilorma, Sierra Leone. Type locality of *Pseudagrion pacale*. Photo: KDBD (25-ii-2011)



### Range and ecology

Rocky sections with rapid flow of the broad Moa River between 120 and 150 m a.s.l. in Sierra Leone; also seen at Tiwai Island, 35 km downstream of the type locality.

### *Pseudagrion sarepi* Kipping & Dijkstra sp. nov. – Sarep Sprite

(Type Photo 22, Photos 33–34, Fig. 13)

### Taxonomy

Genetically, morphologically, ecologically and geographically close to *P. fisheri* Pinhey, 1961 and *P. greeni* Pinhey, 1961; combines characters of both, but genetically distinct from them.

### Material studied

**Holotype** ♂. Angola, Cuando-Cubango Province, Longa River, 82 km E of Menongue at road to Cuito Cuanavale, clear and sandy river in wide open valley (Photo 34), 1 326 m a.s.l. (14.6063°S 18.4673°E), 20-v-2012, leg. J. Kipping, RMNH.

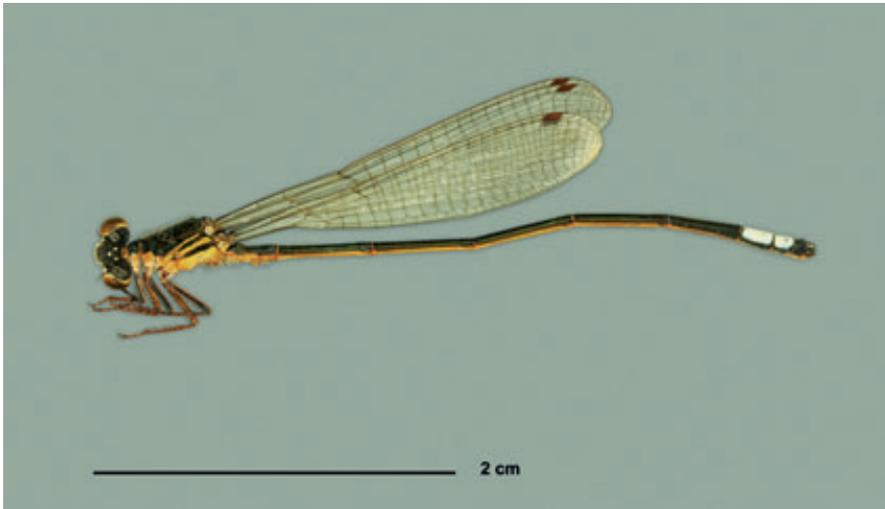
**Further material.** ANGOLA (Cuando-Cubango Province): 1♂ 1♀, as holotype, RMNH. 4♂ 1♀, as holotype, CJKL. 1♂ (RMNH.INS.507931), Cuito River, 9 km N of Cuito Cuanavale, large, clear and sandy river, 1 187 m a.s.l. (15.0872°S 19.1497°E), 19-v-2012, leg. J. Kipping, RMNH. 4♂ 6♀, Luassingua River, 55 km E of Menongue at road to Cuito Cuanavale, clear and sandy river in wide open valley, 1 326 m a.s.l. (14.5899°S 18.1705°E), 20-v-2012, leg. J. Kipping, CJKL. 2♂ (RMNH.INS.507940, RMNH.INS.507941), same locality and date, leg. J. Kipping, RMNH.

### Genetics

Two unique haplotypes (n = 3) nearest to four of *P. greeni* (n = 8) and two of *P. fisheri* (n = 2).

### Male morphological diagnosis

Similar to *P. fisheri* and *P. greeni* by (a) the uniformly orange labrum; (b) the inner border of the cerci lacking a basal tooth or toothed flange in dorsal view; (c) the upper branch of cerci being longer than the lower; and



**Type Photo 22.** Holotype of *Pseudagrion sarepi* sp. nov., RMNH.



**Photo 33.** *Pseudagrion sarepi*, male perching on vegetation low over the water; Longa River, Angola. Photo: JK (20-v-2012)

(e) the paraprocts that are more than half as long as the cerci. However, (1) is distinctly smaller, Hw 18.0–21.0 mm (mean 19.2 mm; n = 10), compared to both *P. fisheri* (21.0–23.5 mm; mean 22.3 mm; n = 14) and *P. greeni* (21.0–23.0 mm; mean 22.0 mm; n = 22); (2) with maturity the dorsa of the head and thorax are wholly dark, rather than with tiny postocular spots and continuous though narrow ante-humeral stripes as in both other species; (3) S8–9 are dorsally wholly blue like in *P. greeni*, not entirely dark like all other segments as in *P. fisheri*; and (4) the upper branch of the cerci is small and in lateral view reaches about as far as the rather deep lower branch as in *P. fisheri*, rather than being huge and reaching far beyond the small lower branch as in *P. greeni* (Fig. 13).

### Etymology

Named after the SAREP (Southern African Regional Environmental Program) field survey during which the species was discovered (neuter singular genitive noun).

### Range and ecology

Like *P. greeni* and *P. fisheri* prefers clear, sandy and swift rivers in open landscapes. Perches low on overhanging grass or floating vegetation. Known from three sites between about 1 150 and 1 350 m a.s.l. in grassy valleys of the Bié highlands between Menongue and Cuito Cuanavale in southern Angola, but probably more widespread.



**Photo 34.** The clear and sandy Longa River, a tributary of the Okavango flowing in the Bié Highlands between Menongue and Cuito Cuanavale, Angola. Type locality of *Pseudagrion sarepi*. Photo: JK (20-v-2012)

***Pseudagrion tanganyicum* Dijkstra & Kipping sp. nov. –  
Tanganyika Sprite**

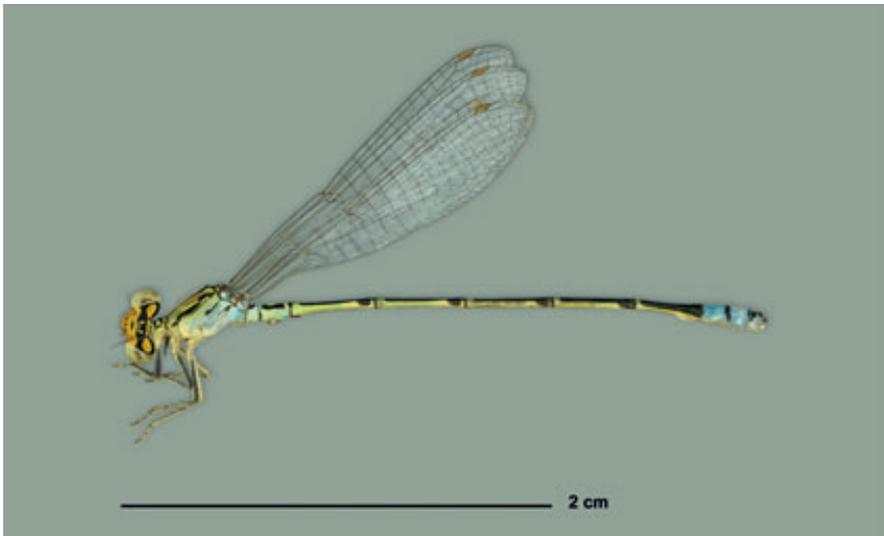
(Type Photo 23, Photos 35–36, Fig. 12)

**Taxonomy**

Structurally probably indistinguishable from *P. massaicum* Sjöstedt, 1909, but coloration and ecology of this potentially sympatric species (Map 5) differ strongly, and the two were treated as distinct by DIJKSTRA & CLAUSNITZER (2014). The two are also inseparable by COI sequence, but this is notably frequent in the *Pseudagrion* B-group, including the well-differentiated pairs *P. acaciae* and *P. vaalense*, *P. camerunense* (Karsch, 1899) and *P. glaucum* (Sjöstedt, 1900), *P. coeleste* Longfield, 1947 and *P. nubicum* Selys, 1876, and *P. commoniae* (Förster, 1902) and *P. hamoni* Fraser, 1955.

**Material studied**

**Holotype** ♂. Tanzania, Kigoma Region, Kibirizi, Lake Tanganyika at Nondwa point, sandy and reedy lakeshore, 770 m a.s.l. (4.86°S 29.61°E), 20-viii-2009, leg. K.-D.B. Dijkstra, RMNH.



**Type Photo 23.** Holotype of *Pseudagrion tanganyicum* sp. nov., RMNH (horizontally mirrored from original).

**Further material.** TANZANIA (Kigoma Region): 11♂ (RMNH.INS.502706, RMNH.INS.502707, RMNH.INS.502715), as holotype, RMNH. 8♂ (RMNH.INS.502811, RMNH.INS.502816, RMNH.INS.502820), 6 km SW of Ilagala, Lower Malagarasi Basin, Lake Tanganyika at mouth of Malagarasi, reedy and sandy lakeshore, 770 m a.s.l. (5.3256°S 29.8021°E), 15-viii-2009, leg. K.-D.B. Dijkstra, RMNH. ZAMBIA (Northern Province): 2♂ (RMNH.INS.508095), Lake Tanganyika, Isanga Bay Lodge, 15 km NE of Mpulungu, rocky and sandy lake shore (Photo 36), 777 m a.s.l. (8.6549°S 31.1932°E), 09-xii-2014, leg. J. Kipping, RMNH. 5♂, same locality, same dates, CJKL. 13♂ 1♀, same locality, 10-xii-2014, leg. J. Kipping, CJKL.

### Genetics

Six haplotypes (n = 7), of which one shared with *P. massaicum* (n = 8; three additional haplotypes); all nine haplotypes are very similar and mixed.

### Male morphological diagnosis

Structurally like *P. massaicum* with (a) the fairly small size, Hw 17.0–19.0 mm (n = 24); (b) the pointed lateral and apical lobes of the penis; (c) the



**Photo 35.** *Pseudagrion tanganyicum*, male resting on rocks on the shore of Lake Tanganyika, Isanga Bay, Zambia. Photo: JK (10-xii-2014)

similarly long cerci and paraprocts; and (c) the paraprocts with a short blunt apex and a prominent dorsal knob in lateral view (Fig. 12). However, with maturity (1) the face, eyes and postocular spots are yellow rather than red; (2) the ante-humeral stripes are green rather than red; and (3) the thorax is quite uniformly pale blue below the humeral suture rather than red grading to bluish pruinose below the metapleural suture.

### Etymology

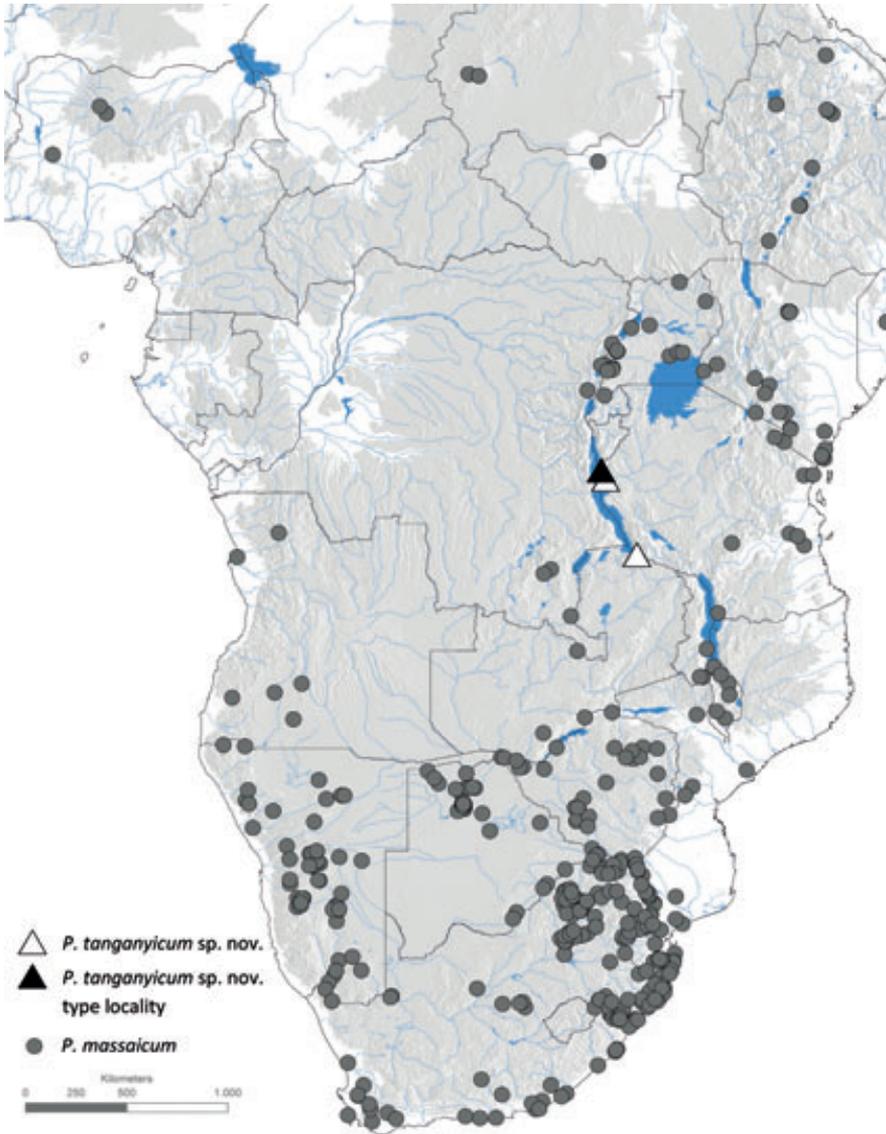
The name is an amalgam of “Tanganyika” and the specific epithet of *P. massaicum* (neuter adjective).

### Range and ecology

Inhabits sandy and rocky beaches and wave-battered reeds in shallows of Lake Tanganyika (elevation around 770 m a.s.l.), i.e., notably different from the marshy fringes of pools and streams favoured by *P. massaicum*. Known sites are over 400 km apart, suggesting the species occurs all around the lake, just like the similarly endemic *Platycypha pinheyi* Fraser, 1950 that prefers rocky shores.



**Photo 36.** Wave-battered shore of Lake Tanganyika in Zambia. *Pseudagrion tanganyicum* was found here more than 400 km south of its type locality in Tanzania. Photo: JK (10-xii-2014)



**Map 5.** Distribution of *Pseudagrion tanganyicum* sp. nov. and its sister-species, *P. massaicum*.

## Aeshnidae

### *Anax gladiator* Dijkstra & Kipping sp. nov. – Swordbearer Emperor

(Type Photo 24, Photos 31, 37–38, Fig. 14)

#### Taxonomy

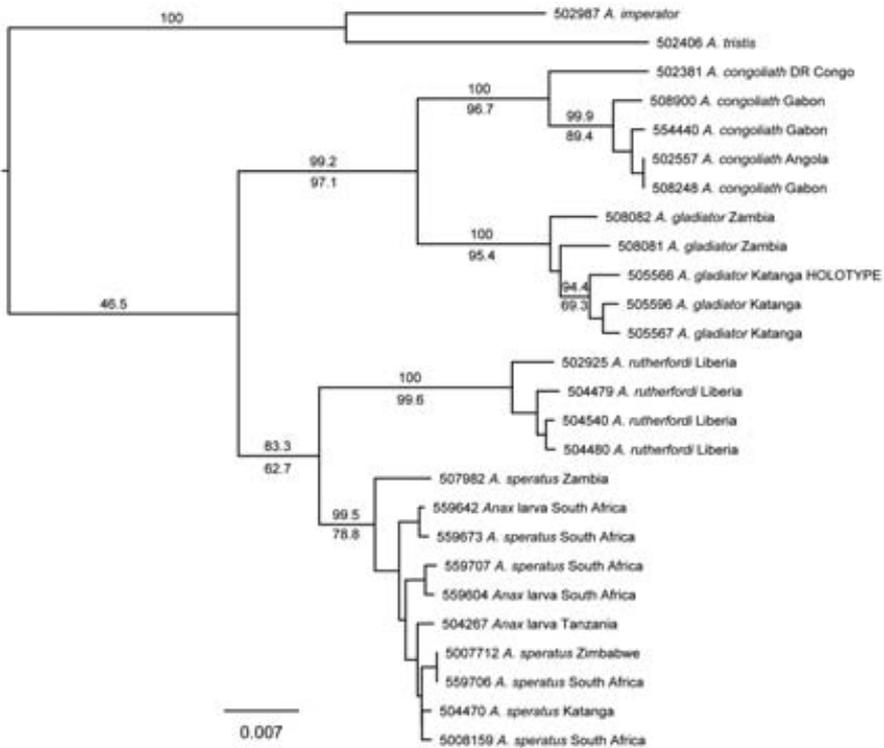
Belongs to the genetically, morphologically and ecologically distinct *speratus*-group of *Anax* Leach, 1815 (see below). Overlaps geographically with *A. speratus* Hagen, 1867 that is most similar in coloration, but probably also with *A. congoliath* Fraser, 1953 that is closer structurally and genetically (Tree 3) (Map 6). However, is highly distinct from both, and treated as such by DIJKSTRA & CLAUSNITZER (2014). A fourth species in this group has long remained in synonymy with *A. speratus* but replaces it from the Cape Verde Islands to Nigeria and possibly further east: *A. rutherfordi* McLachlan, 1883 is distinct genetically (Tree 3) and has (1) smaller size on average, Hw 49.0–54.0 mm (n = 5) rather than 52.0–57.0 mm (n = 10); (2) the apices of the mid and hind femora and antero-exterior side of the front femora black, rather than all femora all red; (3) the apical borders of S2–6 without lateral black dots; (4) the basal half of the dorsal ridge on S10 distinctly raised, rather than low and sloping to apex; and (5) the epiproct 60% as long as the cerci, rather than 50% (Fig. 14) [rejected synonymy].

#### Material studied

**Holotype** ♂: RMNH.INS.505566, Congo-Kinshasa, Katanga, Upemba National Park, Kabwekanono, source area of Kafwi, stream through gallery forest and bogs in open grassy plains, 1 770–1 820 m a.s.l. (8.937°S 27.166°E), 16-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material:** CONGO-KINSHASA (Katanga): 1♂ (RMNH.INS.505567), as holotype, RMNH. 1♂ (RMNH.INS.505596), Upemba National Park, Munte, river with grassy verges, gallery patches and rapids in miombo woodland, 1 450 m a.s.l. (8.77°S 26.84°E), 18-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 3♂, Lubumbashi, xi-1952, leg. C. Seydel, MRAC. 1♂, Karavia (Elisabethville), ix-1951, leg. C. Seydel, MRAC. ZAMBIA (Northern Province): 1♂ (RMNH.INS.508082), Shiwa N'gandu, Kapishya Hot Springs, Mansha River, calm section of clear blackwater river, 1 434 m a.s.l.

(11.1702°S 31.6053°E), 13-xii-2014, leg. J. Kipping, RMNH. 1♂ (Photo 37), same locality, 04-xii-2014, CJKL. 1♂, Shiwa N'gandu, Kapishya Hot Springs, small clear stream and pools W of Kapishya, 1 456 m a.s.l. (11.1939°S 31.5617°E), 06-xii-2014, leg. J. Kipping, CJKL. 1♀, Shiwa N'gandu, Kapishya Hot Springs, ovipositing at small sandy and warm (36°C) stream flowing off hot springs to the nearby Mansha River, 1 434 m a.s.l. (11.1706°S 31.6013°E), 04-xii-2014, leg. J. Kipping, CJKL. ZAMBIA (Northwestern Province): 1♂ (RMNH.INS.508081), Sakeji River S of Sakeji Mission School, E of Ikelenge, calm section of clear blackwater river, 1 385 m a.s.l. (11.2355°S 24.3100°E), 25-xi-2014, leg. J. Kipping, RMNH. 1♂, same locality, same dates, CJKL.



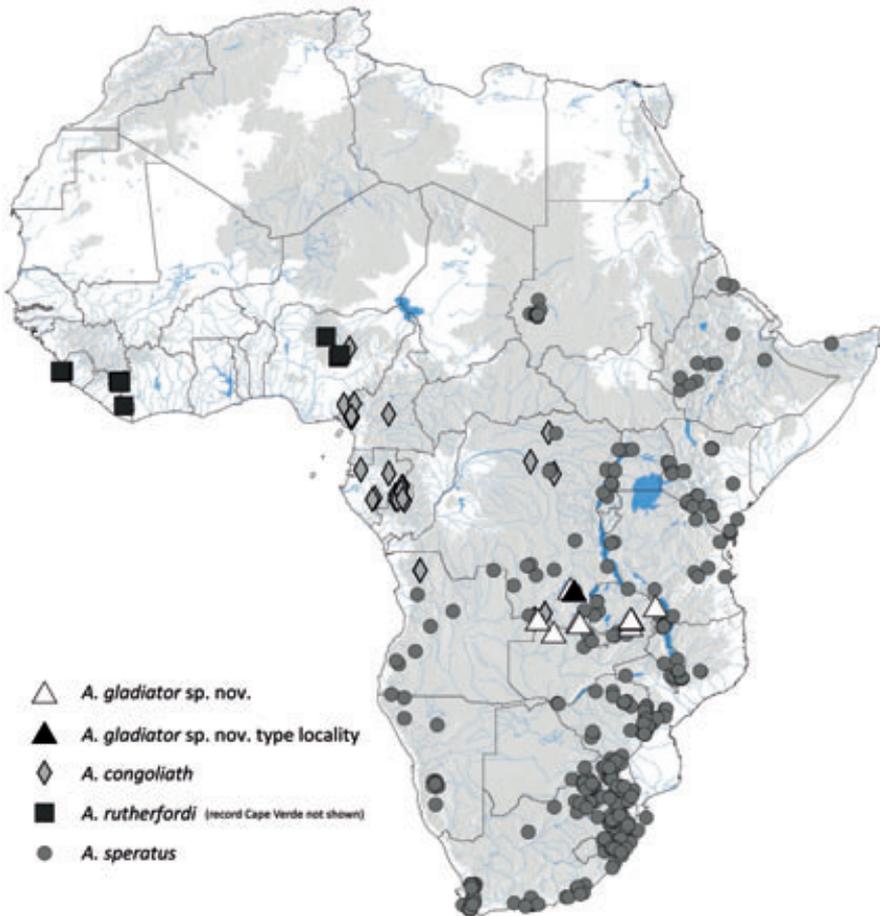
**Tree 3.** COI gene tree from Bayesian inference analysis for the *speratus*-group of *Anax* and two outgroup taxa. For relevant branches posterior probabilities are shown first, as is bootstrap support from a 50 % majority rule consensus of 1 000 trees from Maximum Likelihood analysis (both as percentages).

### Genetics

Five unique haplotypes ( $n=5$ ) nearest to *A. congoliath* (Tree 3).

### Male morphological diagnosis

Belongs to the *speratus*-group on account of (a) the unmarked frons; (b) the reddish femora contrasting with the black tibiae; (c) the presence of an accessory lamina on S10, a small process visible between the cerci in dorsal



**Map 6.** Distribution of the *speratus*-group of *Anax* (*A. gladiator* sp. nov., *A. congoliath*, *A. rutherfordi* and *A. speratus*). *A. speratus* ranges to the Arabian Peninsula.



**Type Photo 24.** Holotype of *Anax gladiator* sp. nov., RMNH.

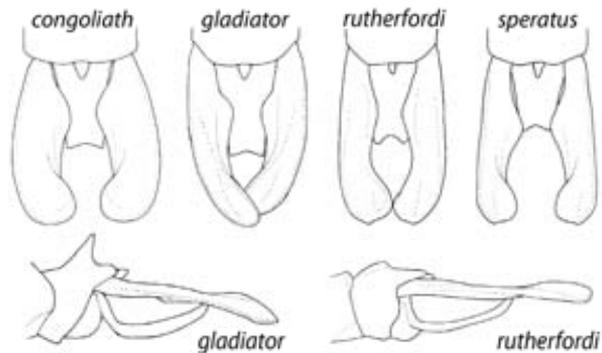


**Photo 37.** *Anax gladiator*, male resting near the Mansha River at Kapishya Hot Springs, Zambia. The blade-like spike at the abdomen tip is well visible. Photo: JK (13-xii-2014)

view; (d) the cerci with broadened and rounded apices; and (e) the epiproct that is at least half as long as the cerci (Fig. 14). Most recalls the sympatric *A. speratus* by (f) the entirely orange to red abdomen. However, is (1) smaller on average, Hw 49.0–54.0 mm (n = 12) rather than 52.0–57.0 mm (n = 11); (2) with maturity the frons and thorax remain green, rather than becoming orange to reddish; (3) the apical borders of S2–6 lack lateral black dots; (4) S10 has its dorsal ridge raised into a high triangular spike, rather than low and sloping down to apex; and (5) the epiproct is well over half as long as the cerci, rather than about half (Fig. 14).

### Etymology

Latin “sword-bearer” refers to the blade-like spike at the abdomen tip (noun in apposition).



**Figure 14.** Male appendages and S10 in dorsal (above) and lateral view (below) of *speratus*-group of *Anax*.

**Photo 38.** Chitunta River with numerous boggy pools and seeps north of Mwinilunga, Zambia. The site harbours a large population of *Anax gladiator*. Photo: JK (29-xi-2014)



### Range and ecology

As with all *speratus*-group species inhabits streams and small rivers, rather than standing waters as other African *Anax*. These are nutrient-poor and slightly acidic with peat moss and/or blackwater, and typically open with some gallery or miombo forest nearby (Photo 38), on sandy plateaus between 1 385 and 1 820 m a.s.l. in Katanga and northern Zambia. Flow can be fast but there are always calm sections, e.g., it was seen in Zambia along a lake below its inflow. Ovipositing females without guarding males were observed on a stream flowing from hot springs and in small pools beside a river. There is an unconfirmed record near the Nyika Plateau of northern Malawi (Allen Barlow pers. comm.) and a possible sighting in suitable habitat near Negage in northern Angola (obs. K.-D.B. Dijkstra) suggesting the species is widespread across the sandy plateaus of southern central Africa.

### ***Gynacantha congolica* Dijkstra sp. nov. – Congo Duskhawker**

(Type Photo 25, Photos 39–40, Fig. 15)

### Taxonomy

DIJKSTRA (2005b) reported several specimens from Congo-Kinshasa that were darker and larger than typical *G. manderica* Grünberg, 1902 and had higher wing vein counts, but hesitated to name them as a distinct taxon. Fresh material revealed additional morphological characters and enabled genetic analysis. While the number of genetic samples is still limited, the distinct morphology and likelihood of geographic overlap are sufficient to separate the two specifically, and they were treated as such by DIJKSTRA & CLAUSNITZER (2014).

### Material studied

**Holotype** ♂. Congo-Kinshasa, Province Orientale, Yaekela, Congo River and village on its bank, 420 m a.s.l. (0.80612°N 24.28389°E), 08-v-2010, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** CONGO-KINSHASA (Equateur): 1♀, Ubangi, Binga, 05-12-iii-1932, leg. H.J. Brédo, MRAC. 1♀, Mobeka, undated, leg. unknown, RMNH. CONGO-KINSHASA (Katanga): 1♀, Elisabethville (= Lubumbashi), undated, leg. illegible, MRAC. CONGO-KINSHASA (Province Ori-

entale): 1♂ (RMNH.INS.502331), between Yangole and Yaeoli on Yaekela-Lilanda road, blackwater swamp forest, 376 m a.s.l. (0.80173°N 24.29783°E), 05-v-2010, leg. K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.502214), Yaeke-la, flooded forest and farmbush, 410 m a.s.l. (0.81°N 24.28°E), 02-v-2010, leg. K.-D.B. Dijkstra, RMNH. 1♀, Elisabetha (= Lokutu), 1920, leg. Mme Tinant, MRAC. CONGO-KINSHASA (Kinshasa Province): 1♂, Leopoldville (= Kinshasa), undated, leg. Duvivier, ISNB. 2♀, Kinshasa, 25-iii-1899, leg. Waelbroeck, ISNB.

### Genetics

Two unique haplotypes (n = 2) close to two of *G. manderica* (n = 4) (Tree 4).

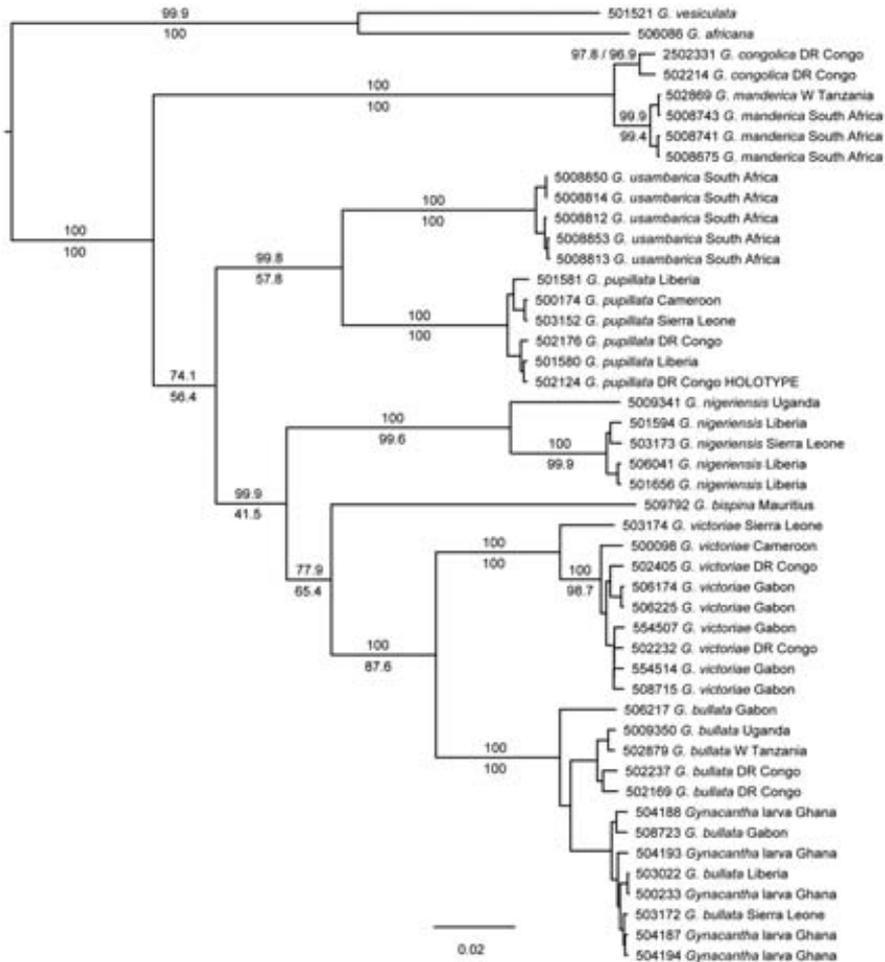
### Male morphological diagnosis

Belongs to the *bullata*-group (see *G. pupillata* sp. nov.) and similar to *G. manderica* by (a) the distinctly blackened triangular depression on the venter of the thorax anterior to the poststernum; (b) the dark mid and hind legs with pale streaks on the tibiae; and (c) the posterior portion of the



**Type Photo 25.** Holotype of *Gynacantha congolica* sp. nov., RMNH (horizontally mirrored from original).

genital fossa border densely set with denticles. However, is (1) larger, Hw 42.0–44.0 mm (n=4) rather than 35.0–39.0 mm (n=17); (2) the mark on the frons is broad and pentagonal, rather than narrow and mushroom-like (Fig. 15); (3) there are no dark dots on the fossae of the humeral and meta-



**Tree 4.** COI gene tree from Bayesian inference analysis for the *bullata*-group of *Gynacantha* and two outgroup taxa. For relevant branches posterior probabilities are shown first, as is bootstrap support from a 50% majority rule consensus of 1 000 trees from Maximum Likelihood analysis (both as percentages).

pleural sutures; (4) the wing bases have distinct dark rays to Ax2–3; and (5) has 22–27 rather than 13–19 Ax in Fw.



**Photo 39.** Flooded forest on the Congo River near Yaekela, Congo-Kinshasa. Habitat of *Gynacantha congolica* and *Ceriagrion obfuscans*. Photo: KDBD (01-v-2010)



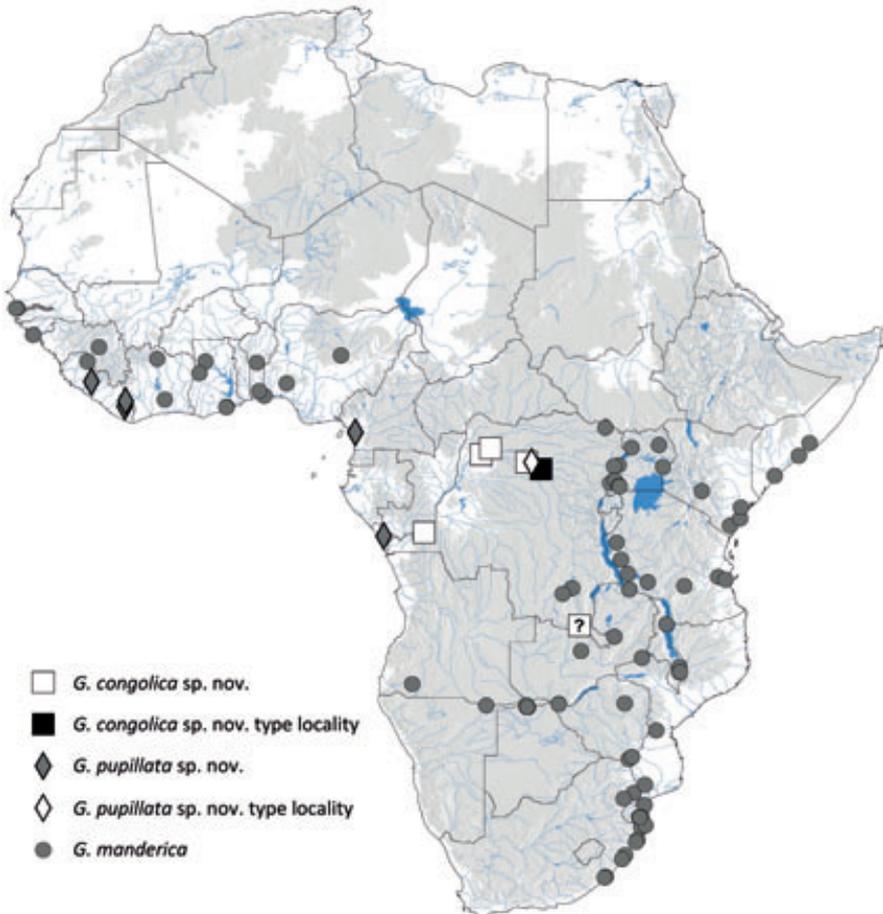
**Photo 40.** The lead-author Klaas-Douwe B. Dijkstra during the Congo River expedition that led to the discovery of *Aciagrion bapepe*, *Ceriagrion obfuscans*, *Notogomphus bosumbuli* and the male of *Gynacantha pupillata*, as well as confirmation that *Gynacantha congolica* collected along the same river in 1899 represents our ‘oldest new species’; near Isangi, Congo-Kinshasa. Photo: K. Pannecoucke (06-v-2010)

### Etymology

The name refers to occurrence in the Congo Basin (feminine adjective).

### Range and ecology

Appears to occur in rainforest throughout the Congo Basin between 300 and 420 m a.s.l., possibly favouring sites flooded by river water (Photo 39). Typical *G. manderica* prefers dense vegetation in savannas. The two species



**Map 7.** Distribution of *Gynacantha congolica* sp. nov., *G. pupillata* sp. nov. and *G. manderica*.

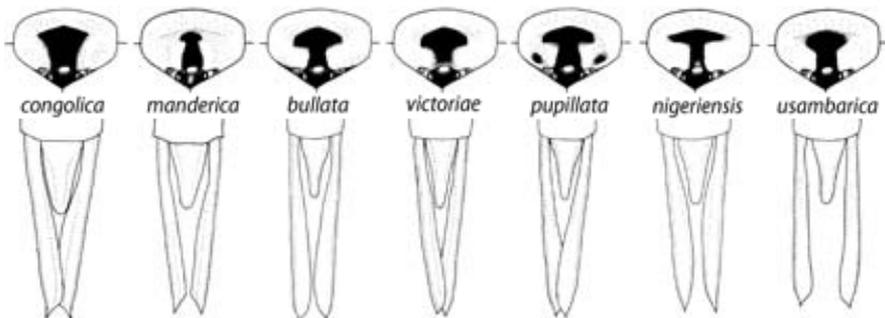
may overlap locally in eastern Congo-Kinshasa, although we doubt the provenance of the undated Lubumbashi record of *G. congolica* sp. nov. (Map 7).

***Gynacantha pupillata* Dijkstra sp. nov. – Spectacled Duskhawker**

(Type Photo 26, Photo 40, Fig. 15)

**Taxonomy**

First recorded as an unidentified female from Liberia by LEMPert (1988). Recent material shows it is widespread and genetically and morphologically distinct: thus treated as a good species by DIJKSTRA & CLAUSNITZER (2014). Belongs to the *bullata*-group of *Gynacantha* Rambur, 1842 with *G. bullata* Karsch, 1891, *G. congolica* sp. nov., *G. manderica*, *G. nigeriensis* (Gambles, 1956), *G. usambarica* Sjöstedt, 1909, and *G. victoriae* (Pinhey, 1961). DIJKSTRA (2005b) synonymised the last with *G. bullata* on account of their (a) small size, Hw 35.0–44.0 mm; (b) pale legs with dark rings around the joints; (c) the absence of denticles in the posterior portion of the genital fossa border; and (d) the ventral carinae of S6–8 lacking denticles. However, *G. victoriae* is genetically distinct (Tree 4) and has (1) the antennal sockets on the frons usually not blackened and thus contrasting with the black vertex (Fig. 15); (2) broad blackish smears over the humeral sutures; (3) blue markings with maturity on the plate between Hw bases, dorsally on apex of S2 and laterally on base of S3; and (4) shorter cerci, 5.0–5.5 mm and less than 3x as long as the epiproct, distinctly shorter than S8–10 combined (Fig. 15) [rejected synonymy].



**Figure 15.** Frons (above) and male appendages (below) in dorsal view of the *bullata*-group of *Gynacantha*.

**Material studied**

**Holotype** ♂. RMNH.INS.502124, Congo-Kinshasa, Province Orientale, Lower Aruwimi, Bomane, Village on Aruwimi River and old oil palm plantation, 427 m a.s.l. (1.27°N 23.73°E), 23-v-2010, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** CAMEROON (Littoral Province): 1♀ (RMNH.INS.500174), 30 km SW of Edéa, Douala-Edéa Reserve, about 3 km east of Marienberg, narrow forest strip along a grassy swamp beside the Sanga River, 10–20 m a.s.l. (3.62°N 9.91°E), 18-vi-2008, leg. K.-D.B. Dijkstra & K. Schütte, RMNH. CONGO-BRAZZAVILLE: 1♀, 36 km north-east of Pointe-Noire, Hinda area, stream forest and good *Hallea* swamp forest, 17 m a.s.l. (4.5937°S 12.1309°E), 23-vi-2014, leg. L. Niemand & C. Ngou-



**Type Photo 26.** Holotype of *Gynacantha pupillata* sp. nov., RMNH (horizontally mirrored from original).

lou, RMNH. CONGO-KINSHASA (Province Orientale): 4♂ (RMNH. INS.502176), as holotype, RMNH. LIBERIA (Grand Gedeh County): 1♂ (RMNH.INS.501580), 1♀ (RMNH.INS.501581), Putu Iron Ore Mining concession, near former village of Boloweah, sandy and gravelly stream running from rainforest into tangly clearing, 260 m a.s.l. (5.6891°N 8.1678°W), 05-ii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. 1♀, NE of Zwedru, high forest away from water near the Cavalla River, 06-iii-1982, leg. & coll. J. Lempert. SIERRA LEONE (Eastern Province): 1♂ (RMNH.INS.503152), Gola Forest, 1 km NE of Mayengema, small stream in forest, 131 m a.s.l. (7.6504°N 10.7838°W), 04-iii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH.

### Genetics

Five unique haplotypes (n = 6) are very distinct but nearest to *G. usambarica* (Tree 4).

### Male morphological diagnosis

Belongs to the *bullata*-group by (a) the distinct black mark on the frons; (b) the pale rim of the metastigma; (c) the presence of brace veins below Pt; (d) the genital fossa border with distinct rows of 8–14 denticles; (e) S3 distinctly waisted near its base; (f) the lateral carinae of S8 normally with denticles, like the ventral carinae; and (g) the cerci of rather even width throughout (Fig. 15). Nearest to *G. nigeriensis* and *G. usambarica* by (h) the uniformly pale legs; and (i) the ventral carinae of S7–8 and sometimes S6 with denticles. However, is (1) smaller, Hw 41.0–44.0 mm (n = 7) rather than 43.0–48.0 mm (n = 33); (2) duller in colour, with an olive rather than grass green thorax, and at most the plate between Hw bases and a dorsal pair of spots on the apex of S2 blue; (3) the frons bears an isolated black dot anterior to each antenna (Fig. 15); (4) the wing bases have distinct dark rays to Ax1–2; and (5) all wings have 5–14 cells doubled between R2 and R3 proximal to the brace vein, i.e., forming 2 cell rows. The dull colour, dotted frons and doubled cell rows are unique within the group.

### Etymology

Named for the pair of pupil-like dots on the frons (feminine adjective).

### Range and ecology

Rather localised but widespread in rainforest from sea level to 430 m a.s.l. in Sierra Leone, Liberia, Cameroon, Congo-Brazzaville and central Congo-Kinshasa, but precise breeding habitat unknown (Map 7).

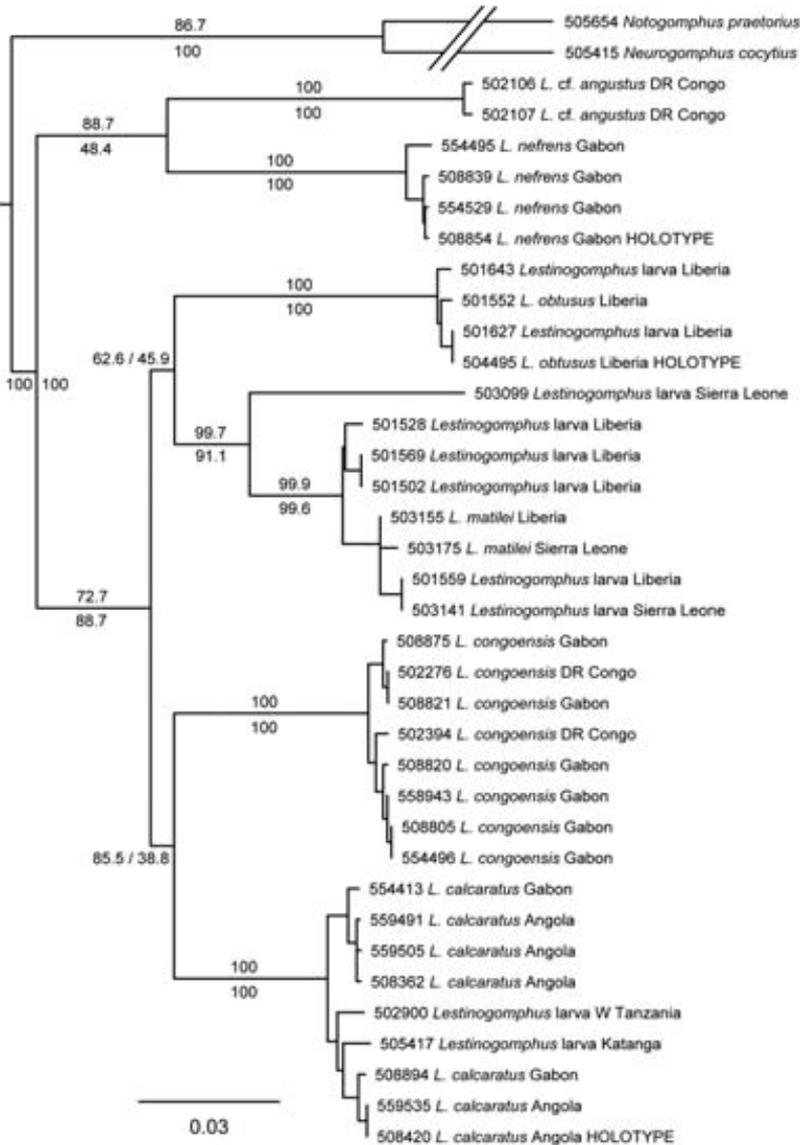
## Gomphidae

### *Lestinogomphus calcaratus* Dijkstra sp. nov. – Spurred Fairytail

(Type Photo 27, Photo 41, Figs 16, 17)

### Taxonomy

*Lestinogomphus* Martin, 1912 is among the few African genera where unnamed species may outnumber named ones. The taxonomy is complicated by imperfect type material, e.g., the male holotype of *L. africanus* (Fraser, 1926) lacks S4–10 and the holotype of *L. minutus* Gambles, 1968 is female. COI analysis, often of more easily obtained larvae and adult females, revealed distinct clusters that we name if good adult male material with distinct appendage morphology is available (Tree 5). Nonetheless females may prove critical in resolving the taxonomy: those associated (often genetically) with *L. congoensis* Cammaerts, 1969, *L. minutus* and the present new species have two prominent spines medially on the occiput, which *L. angustus*, *L. nefrens* sp. nov., *L. obtusus* sp. nov. and the species associated with *L. africanus* (see *L. nefrens*) lack. DIJKSTRA (2007) suggested that the female holotype of *Microgomphus bivittatus* Pinhey, 1961 also belongs to *Lestinogomphus* based on the thoracic markings and stretched S10, as illustrated by PINHEY (1961c). However, in *Lestinogomphus* the collar spots are typically not isolated but connected and continue up the middorsal ridge, while S10 is even longer, lacking the slight dorsal kink illustrated. These features, as well as the illustrated vulvar scale, match the poorly known genus *Mastigogomphus* Cammaerts, 2004 that was formerly a subgenus of *Neurogomphus* Karsch, 1890 (see DIJKSTRA & CLAUSNITZER 2014). As Pinhey's figure matches that of the *M. chapini* (Klots, 1944) holotype by CAMMAERTS (2004; fig. 40e) almost perfectly, and that species is also geographically most proximate, it seems most practical to relegate it to synonymy with that [new synonymy].



**Tree 5.** COI gene tree from Bayesian inference analysis for *Lestinigomphus* and two outgroup taxa. For relevant branches posterior probabilities are shown first, as is bootstrap support from a 50 % majority rule consensus of 1 000 trees from Maximum Likelihood analysis (both as percentages).

### Material studied

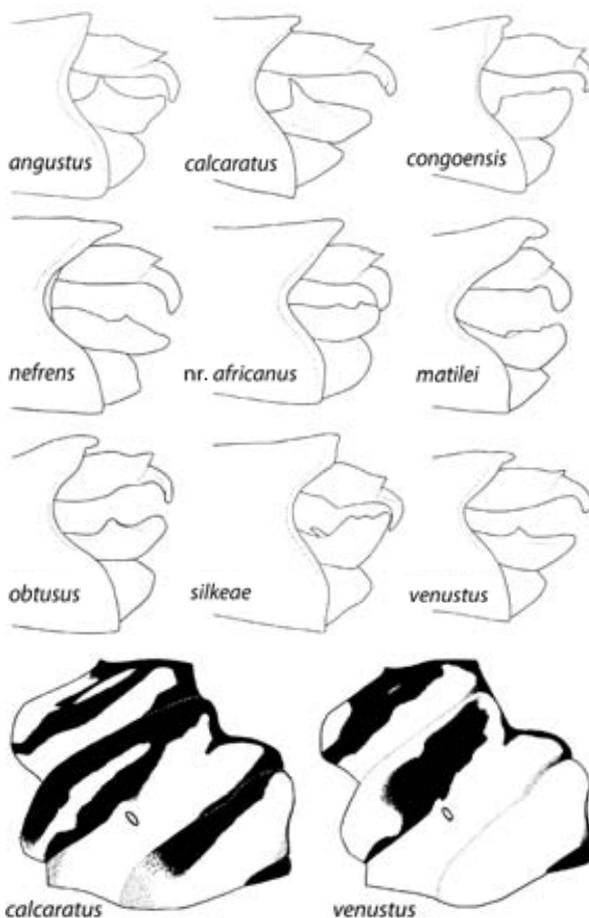
**Holotype** ♂. RMNH.INS.508420, Angola, Uíge Province, 4 km NE of Negage, Canuango river and bog, small blackwater river with sections in palm swamp and others with open marshy borders, and adjacent boggy areas, 1 225 m a.s.l. (7.7351°S 15.2887°E), 29-xi-2012, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** ANGOLA (Uíge Province): 1♂ (RMNH.INS.559535), locality as holotype, 02-x-2013, leg. K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.559491), 6 km N of Quitexe, Lumanie river just E of Quitexe-Uíge road, sandy and rocky river with bushy and reedy banks (Photo 41), 686 m a.s.l. (7.8882°S 15.0434°E), 30-ix-2013, leg. K.-D.B. Dijkstra, RMNH. 1♀ (RMNH.INS.559505), 8 km N of Quitexe, Lumanie river (tributary of Loge) near Quitoque, just E of Quitexe-Uíge road, forested sandy and stony river in farmbush, 677 m a.s.l. (7.8654°S 15.0450°E), 30-ix-2013, leg. K.-D.B. Dijkstra, RMNH. 1♀ (RMNH.INS.508362), 14 km WSW of Uíge, Loge valley, Loge river and two side streams, large murky river and two clear streams in degraded lowland rainforest, 602 m a.s.l. (7.6701°S 14.9381°E), 22-xi-2012, leg. K.-D.B. Dijkstra, RMNH. CONGO-KINSHASA (Katanga): 1 lar-



**Type Photo 27.** Holotype of *Lestinigomphus calcaratus* sp. nov., RMNH (horizontally mirrored from original).

va (RMNH.INS.505417), Kiubo, Lufira (large, Kiubo Falls) and Luvilombo (small, rocky) rivers, and adjacent flooded areas, gallery forest and degraded miombo woodland, 840–880 m a.s.l (9.52°S 27.05°E), 08-xi-2011, leg. K.-D.B. Dijkstra, RMNH. GABON (Haut-Ogoué): 1♀ (RMNH.INS.554413), Franceville-Okondja road, 2 km before Okila, muddy and gravelly (4 m wide, <50 cm deep) forest stream, 364 m a.s.l. (1.0789°S 13.5669°E), 27-ix-2012, leg. N. Mézière, RMNH. 1♀ (RMNH.INS.508894), same locality, 14-x-2013, leg. N. Mézière, RMNH. TANZANIA (Kigoma Region): 1 larva (RMNH.INS.502900), Malagarasi river 6 km upstream of Ilagala, 775 m a.s.l. (5.2010°S 29.9008°E), 14-viii-2009, leg. K.-D.B. Dijkstra, RMNH.



**Figure 16.** Male appendages in lateral view of all *Lestinogomphus* species except *L. africanus* and *L. minutus* for which these structures are unknown.

**Figure 17.** Thorax in lateral view of two *Lestinogomphus* species.

### Genetics

Six unique haplotypes ( $n = 9$ ) nearest to *L. congoensis*, but confirmed *L. angustus* and the somewhat similar *L. silkeae* Kipping, 2006 were not sampled (Tree 5).

### Male morphological diagnosis

Very small dragonfly (Hw 19.0–20.0 mm;  $n = 2$ ) that recalls *L. angustus* Martin, 1912 by (a) the pair of large teeth near the base of the epiproct dorsum (Fig. 16). However, (1) is much darker overall, with a black band on the fronto-clypeal suture and a thick black rim to the labrum, the pale area on the collar not extending posteriorly of the middorsal tooth, the humeral and interpleural black stripes thick and enclosing a narrow green stripe, the metapleural black stripe also thick, and the tibiae black without pale streaks (Fig. 17); (2) the distal border of the posterior hamule is shallowly notched, rather than almost straight; (3) S10 is shorter, its dorsal length is 1.4–1.7× its apical height, rather than 1.7–2.2×; (4) the curved portions of the cerci bear a small external lobe subapically; and (5) the subbasal teeth of the epiproct have a narrower base, thus appearing sharper and leaning into S10 (Fig. 16).

### Etymology

Latin “with spurs” refers to the prominent spines on the epiproct (masculine adjective).

### Range and ecology

The type material is from northern Angola, but females from Gabon and larvae from Katanga and western Tanzania are genetically similar and thus



**Photo 41.** Lumanie River between Uíge and Quitexe, Angola. Habitat of *Lestinogomphus calcaratus* and *Eleuthemis eogaster*. Photo: KDBD (30-ix-2013)

likely to belong to the same species (Tree 5). On this basis, appears to favour fairly open streams and rivers bordered by bushes and trees between 350 and 1 250 m a.s.l.

***Lestinogomphus nefrens* Dijkstra & Mézière sp. nov. –  
Small-toothed Fairytail**

(Type Photo 28, Photo 42, Fig. 16)

**Taxonomy**

While most *Lestinogomphus* species, including the genus's type and three new species described here, possess a pair of large teeth near the base of the epiproct, *L. congoensis* and *L. matilei* Legrand & Lachaise, 2001 have a smaller set nearer the tip. A taxon associated with the holotype of *L. africanus*, which lacks appendages, by FRASER (1928) and PINHEY (1961b) also belongs here, but its identity and that of *L. africanus* remain to be clarified (R. Cammaerts pers. comm.; see DIJKSTRA & CLAUSNITZER 2014). For the time being, we name another taxon that is sympatric with *L. congoensis* in Gabon, but has distinct genetics, male appendages and female occiput (see *L. calcaratus* sp. nov.) (Tree 5). Note that the Upper Guinean *L. matilei* is distinctive by the (1) rather rounded and weakly notched posterior hamule; (2) short S10, its dorsal length being only 1.5–1.7x its apical height; (3) rather thick-tipped cerci (Fig. 16); and (4) epiproct that is not deeply bifid as in other species, but ends in a single blunt tip (best seen in ventral view).

**Material studied**

**Holotype** ♂. RMNH.INS.508854, Gabon, Ngounie Province, Parc National des Monts Birougou, sandy forest stream (1.5 m wide, <20 cm deep), sources and swamp (Photo 42), 747 m a.s.l. (1.9655°S 12.2188°E), 10-ix-2013, leg. N. Mézière, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♂ (RMNH.INS.508839), as holotype, 05-ix-2013, N. Mézière, RMNH. 1♀ (RMNH.INS.554495), Boumango road, Mopia, sandy and muddy forest stream (1 m wide), 433 m a.s.l. (1.8336°S 13.6013°E), 11-xi-2012, leg. N. Mézière, RMNH. 1♀ (RMNH.INS.554529), Moanda-Bakoumba road, forest road on right 25 km from Moanda, Botoso, sandy forest stream, 530 m a.s.l. (1.6939°S 13.0739°E), 24-xi-2012, leg. N. Mézière, RMNH.

### Genetics

Four unique haplotypes ( $n = 4$ ) nearest to two specimens tentatively identified as *L. angustus* from central Congo-Kinshasa, although certain *L. angustus* was not sequenced (Tree 5).



**Type Photo 28.** Holotype of *Lestinogomphus nefrens* sp. nov., RMNH (horizontally mirrored from original).



**Photo 42.** Small sandy forest stream in Parc National des Monts Bi-rougou, Gabon. Type locality of *Lestinogomphus nefrens*. Photo: NM (09-ix-2013)

### Male morphological diagnosis

Very small dragonfly (Hw 20.5 mm; n = 1) that recalls the sympatric *L. congoensis* by (a) being quite dark, with a broad dark band on the fronto-clypeal suture and a thick black rim to the labrum, distinct and straight humeral, interpleural and metapleural black stripes, and the tibiae black without pale streaks; and (b) the pair of small teeth close to the tip of the epiproct dorsum (Fig. 16). However, (1) the pale area on the collar extends posteriorly of the middorsal tooth, at least in females, as the holotype is too teneral to see this, (2) the ventral section of the interpleural black stripe connects to the humeral marking, rather as shown for *L. calcaratus* in Fig. 17, while in *L. congoensis* it extends across the mesepimeron to connect with its dorsal section; (3) the relatively short S10, its dorsal length being 1.8–1.9× its apical height, rather than 2.1–2.2×; and (4) the epiproct is flat rather than raised at its base with longer and more slender branches, the paired teeth are larger and placed basal rather than apical to the deepest point of the notch separating the branches (Fig. 16).

### Etymology

Latin “that cannot bite” refers to the weak teeth on the epiproct (masculine adjective).

### Range and ecology

Known only from small sandy rainforest streams between 400 and 750 m a.s.l. in southern Gabon. Abundant emergence was observed in the dry season at noon around pools formed behind fallen trees in the stream. The sky can be completely overcast in this season and forest habitats very cool, which may explain the emergence at midday.

### *Lestinogomphus obtusus* Dijkstra sp. nov. – Blunt-toothed Fairytail

(Type Photo 29, Photo 43, Fig. 16)

### Taxonomy

See general rationale for *Lestinogomphus* under *L. calcaratus* sp. nov.; LEMPERT's (1988) “*Lestinogomphus* sp. 1” from Liberia is presumed to be this species.

**Material studied**

**Holotype** ♂. RMNH.INS.504495, Liberia, Nimba County, West Nimba Proposed Forest Reserve, side stream of Yiti 2.5 km S of Bentor, mostly sandy (some rocky parts) stream in rainforest (Photo 43), 441 m a.s.l. (7.5025°N 8.6969°W), 24-ii-2012, leg. K.-D.B. Dijkstra & M. Darpay, RMNH.

**Further material.** LIBERIA (Grand Gedeh County): 1♀ (RMNH.INS.501552), Putu Iron Ore Mining concession, stream 3 km SW of Duo Town, muddy stream in rainforest, 221 m a.s.l. (5.7086°N 8.1647°W), 30-i-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. Several larvae (RMNH.INS.501627), Putu Iron Ore Mining concession, 2 km S of Slabbertsville camp, rocky stream in rainforest, 268–326 m a.s.l. (5.6449°N 8.1697°W), 14-ii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. 1 larva (RMNH.INS.501643), Putu Iron Ore Mining concession, Jackson's Camp, muddy, sandy and gravelly stream passing open camp, in rainforest, 242 m a.s.l. (5.6562°N 8.1902°W), 17-ii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH.



**Type Photo 29.** Holotype of *Lestinogomphus obtusus* sp. nov., RMNH.

### Genetics

Three unique haplotypes ( $n = 4$ ) distinct from other *Lestinogomphus* species (Tree 5).

### Male morphological diagnosis

Very small dragonfly (Hw 20.5 mm;  $n = 1$ ) that recalls *L. angustus* by (a) the prominent pair of teeth near the base of the epiproct dorsum (Fig. 16). However, (1) is one of the darkest *Lestinogomphus* known, with a broad black band on the fronto-clypeal suture and a thick black rim to the labrum, the pale area on the collar not extending posteriorly of the middorsal tooth, the black on the humeral and interpleural sutures forming a single broad band, while these are (partly) separate in most species as shown for *L. calcaratus* in Fig. 17, the black metapleural stripe is almost as wide, and the tibiae black without pale streaks; (2) S10 is relatively long, its dorsal length about  $2.1\times$  its apical height, rather than  $1.7\text{--}2.2\times$ ; and (3) the subbasal teeth of the epiproct are short and blunt (Fig. 16).

### Etymology

Latin “blunt” refers to the dulled teeth on the epiproct compared to *L. angustus* (masculine adjective).

### Range and ecology

Only known from rainforest streams between 200 and 450 m a.s.l. in Liberia.

**Photo 43.** Forest stream near Bentor, Liberia. The holotype of *Lestinogomphus obtusus* was found somewhat upstream. Photo: KDBD (28-ii-2012)



***Lestinogomphus venustus* Dijkstra & Mézière sp. nov. – Lovely Fairytail**

(Type Photo 30, Photos 44, 62, Figs 16, 17)

**Taxonomy**

See general rationale for *Lestinogomphus* under *L. calcaratus* sp. nov. No genetic data is available for this taxon, but its markings and morphology are unlike any other species in the genus.

**Material studied**

**Holotype** ♂. Gabon, Haut-Ogooué Province, 5 km after Bongoville toward Léconi, Ekala, Andzaba River, sandy and swampy stream (Photo 62), 389 m a.s.l. (1.6319°S 13.8888°E), 28-iii-2010, leg. N. Mézière & J. Renoult, RMNH.

**Further material.** 1♂, as holotype, RMNH.

**Genetics**

No data available.

**Male morphological diagnosis**

Very small dragonfly (Hw 18.5–19.0 mm; n=2) that recalls *L. angustus* by (a) the fairly long S10, its dorsal length being 1.9–2.0x its apical height; (b) the prominent pair of teeth near the base of the epiproct dorsum (Fig. 16). However, (1) the thoracic markings are unique in the genus: the green on the collar is merged as in all species but barely extends along the middorsal carina; the pale postdorsal stripes are reduced to be virtually invisible; the green ante-humeral stripes are widened to extend well below the humeral suture; the humeral and interpleural black markings are merged to form a broad but isolated black stripe between the ante-humeral stripe and metastigma; and a black metapleural stripe is absent, while it is present in most *Lestinogomphus*, especially if these are so dark, i.e., with extensive black on face, tibiae and abdomen (Fig. 17); (2) the distal border of the posterior hamule is more sharply notched than any other species; and (3) the subbasal teeth of the epiproct, while distinct, are much smaller (Fig. 16).

**Etymology**

Latin “lovely, graceful” for an especially attractive species of this elegant genus (masculine adjective).

**Range and ecology**

The males perched on vegetation above a small sandy stream on the edge of the Batéké Plateau in south-eastern Gabon.



**Type Photo 30.** Holotype of *Lestinogomphus venustus* sp. nov., RMNH (horizontally mirrored from original).



**Photo 44.** *Lestinogomphus venustus*, male; Andzaba River near Ekala, Gabon. Photo: NM (28-iii-2010)

***Notogomphus bosumbuli* Dijkstra sp. nov. – Congo Longleg**

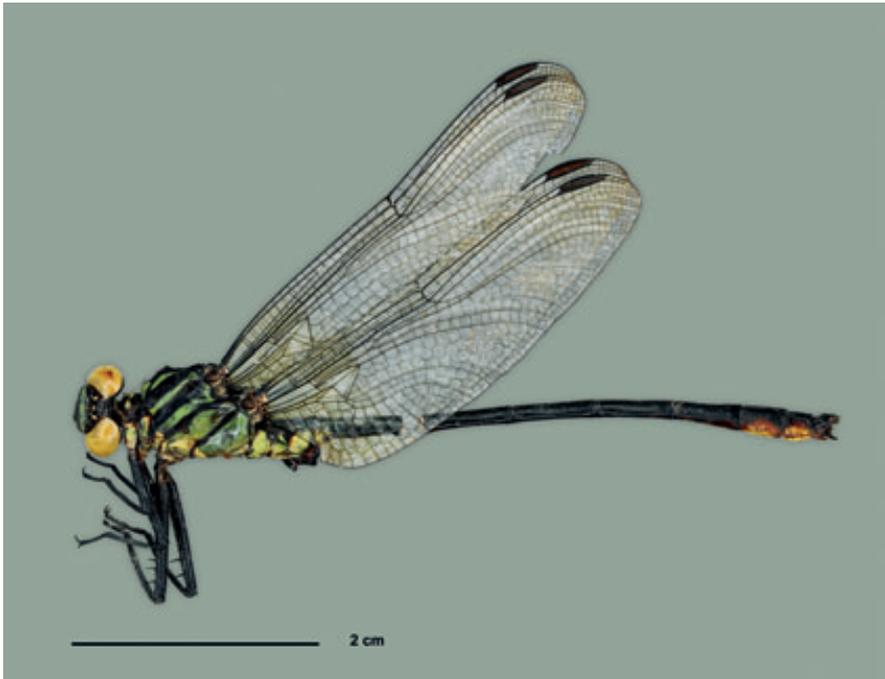
(Type Photo 31, Photos 40, 45, Figs 18, 19)

**Taxonomy**

The genus *Notogomphus* Selys, 1858 is typically associated with highlands and this is the first species to be found in the central Congo Basin (Map 8). Although not all potentially close relatives are available for genetic comparison, it is distinct, also in morphology, and has already been treated as such by DIJKSTRA & CLAUSNITZER (2014).

**Material studied**

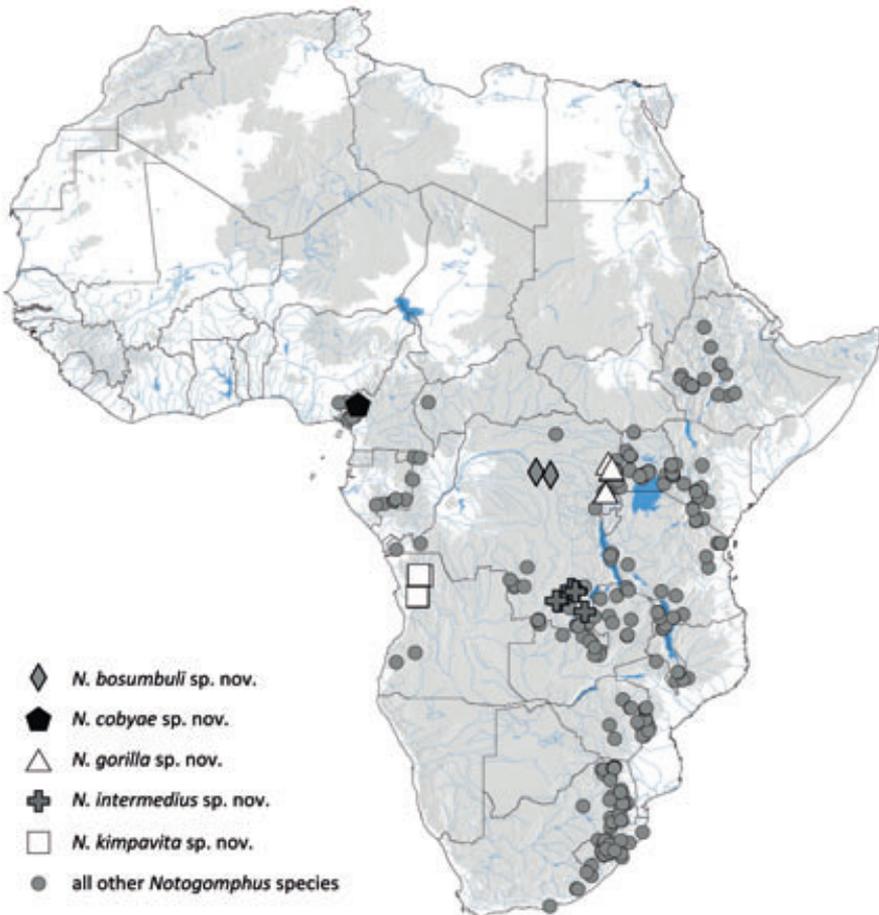
**Holotype** ♂. RMNH.INS.502416, Congo-Kinshasa, Province Orientale, Lower Lomami, Yendega, Bosega and Bogunu streams in forest west of Djabir and Yaengo, shallow streams and springs with sand, gravel and leaf



**Type Photo 31.** Holotype of *Notogomphus bosumbuli* sp. nov., RMNH (horizontally mirrored from original).

litter in forest (Photo 45), 380 m a.s.l. (0.51°N 24.16°E), 03-vi-2010, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** 3♂ (RMNH.INS.502259), 1♀ (RMNH.INS.502411), as holotype, RMNH.



**Map 8.** Distribution of *N. bosumbuli* sp. nov., *N. cobyae* sp. nov., *N. gorilla* sp. nov., *N. intermedius* sp. nov., *N. kimpavita* sp. nov. and all other species of *Notogomphus*.



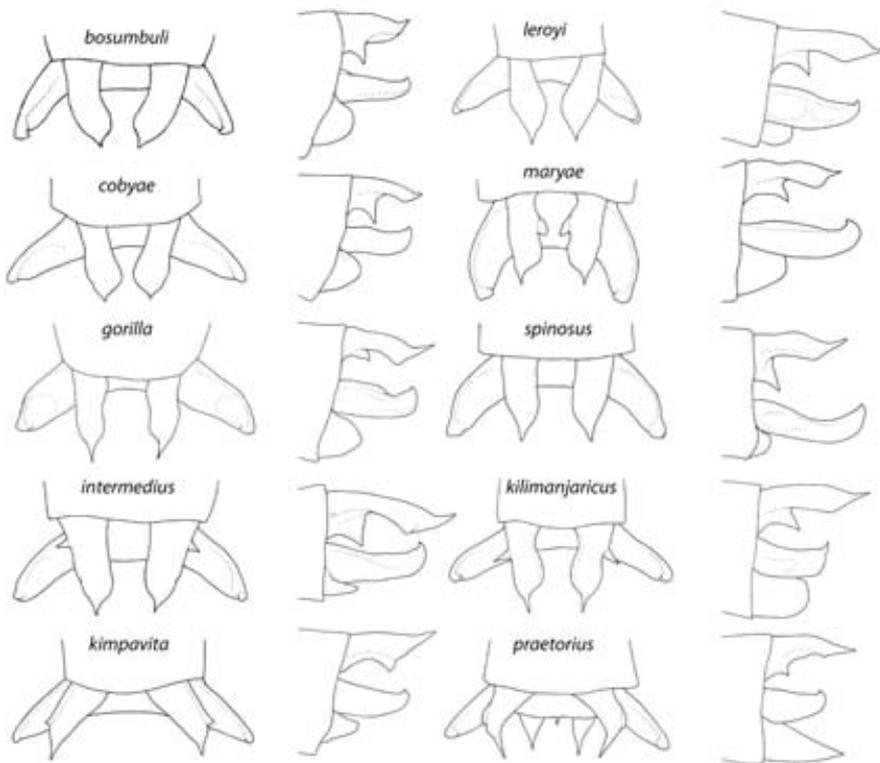
**Figure 18.** Head in rostral (left) and thorax in dorsal (middle) and lateral view (right) of dark *Notogomphus* species of central Africa; *N. bosumbuli* sp. nov. is not shown but the head is like *N. leroyi* and thorax like *N. gorilla* sp. nov.

**Genetics**

Two unique haplotypes (n = 3) nearest to female from Uganda identified as *N. lujai* (Schouteden, 1934), but *N. leroyi* (Schouteden, 1934) was not sampled.

**Male morphological diagnosis**

Recalls *N. leroyi* by its (a) largely black lower frons, clypeus and labrum, the latter with a pair of large basal pale spots (like *N. leroyi* in Fig. 18); (b) black occiput; (c) broad and complete black interpleural and metapleural stripes on the thorax as well as well-defined pale postdorsal and ante-humeral



**Figure 19.** Male appendages in dorsal (left) and lateral view (right) of selection of *Notogomphus* species.

stripes separated from each other and the pale area of the middorsal carina (like *N. gorilla* in Fig. 18); (d) the smooth curve of the anterior border of the posterior hamule; (e) the somewhat convergent cerci with a ventral tooth that is directed straight downwards and thus not visible in dorsal view; and (f) the strongly diverging branches of epiproct (Fig. 19). However, it is (1) larger on average, Hw 34.0–35.0 mm (n = 4) rather than 31.0–34.0 mm (n = 4); (2) the abdomen is parallel-sided, with S7–9 scarcely expanded and S8 longer than high or wide; (3) S8–9 are black marked laterally rather contrastingly with yellow, rather than uniformly dark rufous; and (4) the cerci are of rather even width throughout in dorsal view, rather than expanded distally (Fig. 19).

### Etymology

Name is derived from a local word “bosumbulisumbuli” meaning dragonfly (noun in apposition).

### Range and ecology

Only known from sandy rainforest streamlets about 30 km south of Isangi but also seen in the Yoko Forest near Kisangani, 130 km to the east; both sites are at only around 400 m a.s.l. in the central Congo Basin.



**Photo 45.** Sandy and shallow rainforest stream south of Isangi, Congo-Kinshasa. The holotype of *Notogomphus bosumbuli* was found somewhat upstream. Photo: KDBD (01-vi-2010)

***Notogomphus cobyae* Dijkstra sp. nov. – Coby's Longleg**

(Type Photo 32, Photo 46, Figs 18, 19)

**Taxonomy**

VICK (2003) revised the *Notogomphus* species of Cameroon. Of the potentially sympatric species, the present male is both morphologically and genetically clearly separable from *N. moorei* Vick, 2003 and *N. spinosus* (Karsch, 1890), but it could only be compared morphologically to *N. maryae* Vick, 2003, which also appears sufficiently distinct.

**Material studied**

**Holotype** ♂. RMNH.INS.500119, Cameroon, Northwest Province, 10 km SSE of Bamenda, Lake Awing, outlet stream of crater lake in eucalypt plantation and arable fields (Photo 46), 2 050 m a.s.l. (5.864°N 10.197°E), 30-v-2008, leg. K.-D.B. Dijkstra, RMNH. No further material.



**Type Photo 32.** Holotype of *Notogomphus cobyae* sp. nov., RMNH.

### Genetics

One unique haplotype ( $n = 1$ ) nearest to *N. spinosus* and *N. moorei*.

### Male morphological diagnosis

Recalls *N. leroyi* by its (a) largely black lower frons, clypeus and labrum; (b) broad and complete black interpleural stripes on the thorax as well as well-defined pale postdorsal and ante-humeral stripes separated clearly from each other; (c) the smoothly curved anterior border of the posterior hamule; (d) the convergent cerci that gradually widen from base, being widest one-quarter of their length from the abruptly narrowed apex, with the ventral tooth directed straight downwards, not visible in dorsal view; and (e) the strongly diverging branches of the epiproct (Fig. 19). Differs in (1) its small size, Hw 28.5 mm ( $n = 1$ ) rather than 31.0–34.0 mm ( $n = 4$ ); (2) the absence of pale basal spots on the black labrum; (3) the wholly green occiput with a shallowly but distinctly W-shaped border, rather than black with rounded border; (4) the yellow of the collar extending between the middorsal carina and postdorsal stripes, being indistinctly separated from the latter; (5) the metapleural suture having at most a black trace at its dorsal



**Photo 46.** Outlet stream of Awing crater lake near Bamenda, Cameroon. Only known locality of *Notogomphus cobyae*. Photo: KDBD (30-v-2008)

end, rather than a broad black stripe along its full length (Fig. 18); (6) the parallel-sided abdomen with S7–9 only slightly expanded and S8 about 1.5× as long as wide; and (7) having S8–9 black dorsally grading through rufous to yellow sides, rather than more uniformly dark rufous. The potentially sympatric *N. maryae* has a similar facial coloration and abdomen shape, but is larger (Hw 34 mm; n = 1) and has parallel-sided cerci with inward-directed ventral teeth visible in dorsal view (Fig. 19).

### Etymology

The species was discovered shortly after the tenth anniversary of the death of the first author's mother Jacoba "Coby" Dijkstra-Stutvoet (feminine singular genitive noun).

### Range and ecology

Outlet stream of Lake Awing near Bamenda in Cameroon, a crater lake with forested borders in eucalypt plantation and arable fields at about 2 050 m a.s.l (Map 8).

## ***Notogomphus gorilla* Dijkstra sp. nov. – Gorilla Longleg**

(Type Photo 33, Figs 18, 19)

### Taxonomy

PINHEY (1961b) described a pair of »large *Notogomphus*, closely allied to *butoloensis*« from Bwamba Forest (= Semliki National Park) in western Uganda under the name *N. leroyi*. NMBZ has the male of this pair and two from sites nearby, all identified as *N. leroyi*. These agree with two large males collected recently in south-western Uganda. The holotypes of *N. butoloensis* Fraser, 1952 (BMNH) and *N. leroyi* (MRAC) are similar in their moderate size, markings (Fig. 18), clubbed abdomen and distinctive appendages (Fig. 19). While apparently conspecific with each other [new synonymy], they differ from the large males. The female holotype of *N. anaci* Fraser, 1955 (MRAC) is large and from the same type locality as *N. leroyi*. Three matching topotypical males agree with the holotypes of *N. spinosus* (ZMHB) and *N. verschuereni* (Schouteden, 1934) (MRAC) in their large size, facial markings (Fig. 18), appendages (Fig. 19), and unique green dorsum of S2

with only two apical black marks. The head structure and vulvar scale, as well as size and coloration, of the *N. anaci* holotype and topotypical females of *N. spinosus* in ZMHB and ISNB also agree. However, while *N. anaci* and *N. verschuereni* thus appear conspecific with *N. spinosus* [new synonymies], Pinhey's species differs and remains unnamed. No genetic data is available, but the species was treated as distinct by DIJKSTRA & CLAUSNITZER (2014) on account of its morphology.

### Material studied

**Holotype** ♂. Uganda, Western Region, Kanungu District, Bwindi Impenetrable National Park, Buhoma, Munyaga Valley, Munyaga Stream, 1 600 m a.s.l. (0.9916°S 29.6083°E), 17-v-2003, leg. K.-D.B. Dijkstra, ZMMU.

**Further material.** CONGO-KINSHASA (Province Orientale): 1♂, Ituri, Mont Hoyo, 1 250 m a.s.l., 05-x-1957, leg. E.S. Ross & R.E. Leech, NMBZ. UGANDA (Western Region): 1♂, Kanungu District, Bwindi Impenetrable National Park, Buhoma, Munyaga Valley, Bizenga Stream, 1 500 m a.s.l. (0.5912°S 29.3642°E), 2002–2003, leg. J.J. Kisakye & S.G. Kyobe, ZMMU. 1♂, Bundibugyo, Bwamba, v-1954, leg. T.H.E. Jackson, NMBZ. 1♂, Kigezi, Kayonzi, v-1957, leg. unknown, NMBZ.

### Genetics

No data available.

### Male morphological diagnosis

Nearest to *N. leroyi* by its dark coloration with (a) largely black lower frons, clypeus and labrum; (b) distinct black interpleural and metapleural stripes on the thorax as well as well-defined pale postdorsal and ante-humeral stripes separated from each other and the pale area of the middorsal carina (Fig. 18); (c) widely clubbed S7–9, with S8 about as long as high or wide; (d) quite uniformly dark rufous S8–10; and (e) strongly diverging branches of epiproct (Fig. 19). Differs, and nearer *N. spinosus*, by its (1) great size, Hw 36.0–38.0 mm (n=5) rather than 31.0–34.0 mm (n=4); (2) very small pair of basal green spots on the black labrum; (3) green rather than black occiput, although with a broad black border; (4) humped rather than smoothly curved anterior border of the posterior hamule; and (5) cerci parallel and

of rather even width throughout in dorsal view, rather than converging and distally widened (Fig. 19). Unlike both *N. leroyi* and *N. spinosus* (6) the dorsum of S7 is black with only yellow smears laterally; and (7) the cerci have a relatively small ventral tooth.

### Etymology

This large dark species is named after the Mountain Gorilla (*Gorilla beringei beringei*), for which its type locality is best known (noun in apposition).

### Range and ecology

Forest streams between about 700 and 1 600 m a.s.l. in western Uganda and adjacent Congo-Kinshasa (Map 8).



**Type Photo 33.** Holotype of *Notogomphus gorilla* sp. nov., ZMMU (horizontally mirrored from original).

***Notogomphus intermedius* Dijkstra sp. nov. – Katanga Longleg**

(Type Photo 34, Photos 47, 64, Figs 19, 20)

**Taxonomy**

FRASER (1955) illustrated a female from Upemba National Park in Katanga as *N. lujai*, but identified (in lit.) a similar but teneral male from nearby Kalule (near Lubudi on the southern edge of the park) as *N. meruensis* (Sjöstedt, 1909). SJÖSTEDT (1909) described the latter from a teneral and damaged male from Mt Meru, while describing *N. kilimandjaricus* (Sjöstedt, 1909) from a mature female from neighbouring Mt Kilimanjaro. The *N. meruensis* holotype is accompanied in NHRS by a teneral female labelled »Cotypus«, collected at the same site two days earlier. This female and the *N. kilimandjaricus* holotype agree in head armature and markings. The *N. meruensis* holotype's markings are largely indiscernible, but similar on face, mesepisternum and S9–10. The appendages are lost, with the exception of the base of the cerci and their ventral teeth, whose shape agrees with males identified as *N. kilimandjaricus* from northern Tanzania and southern Kenya, as does its secondary genitalia. Sjöstedt's two species thus appear identical and the obscurity of *N. meruensis* warrants selection of *N. kilimandjaricus* as the taxon's valid name [new synonymy]. The facial patterns of both Fraser's Katanga specimens agree and are unlike that of any other *Notogomphus* species. Recent material of both sexes matched this pair and confirmed that they represent a morphologically and genetically distinct species, which DIJKSTRA & CLAUSNITZER (2014) have already treated as such.

**Material studied**

**Holotype** ♂. RMNH.INS.505650: Congo-Kinshasa, Katanga, Kundelungu National Park, Masansa, small river with some gallery forest and falls in miombo woodland, 1 440–1 480 m a.s.l. (10.532°S 27.978°E), 22-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** CONGO-KINSHASA (Katanga): 1♂, as holotype, RMNH. 1♂ (RMNH.INS.505521), Upemba National Park, Lusinga valley 3 km E of park headquarters, stream with patches of gallery and swamp forest, open swamp and arable fields, 1 570–1 590 m a.s.l. (8.93°S 27.23°E), 13-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 1♀ (RMNH.INS.505581), Upemba National Park, broken bridge on Lusinga, river with gallery forest in

miombo woodland, 1 475 m a.s.l. (8.8998°S 27.2827°E), 16-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 1♂, Kalule, 820–840 m a.s.l., i-1934, leg. Ch. Seydel, MRAC. 1♀, Upemba National Park, Mubale River, 01–20-v-1947, leg. G.F. de Witte, MRAC.

### Genetics

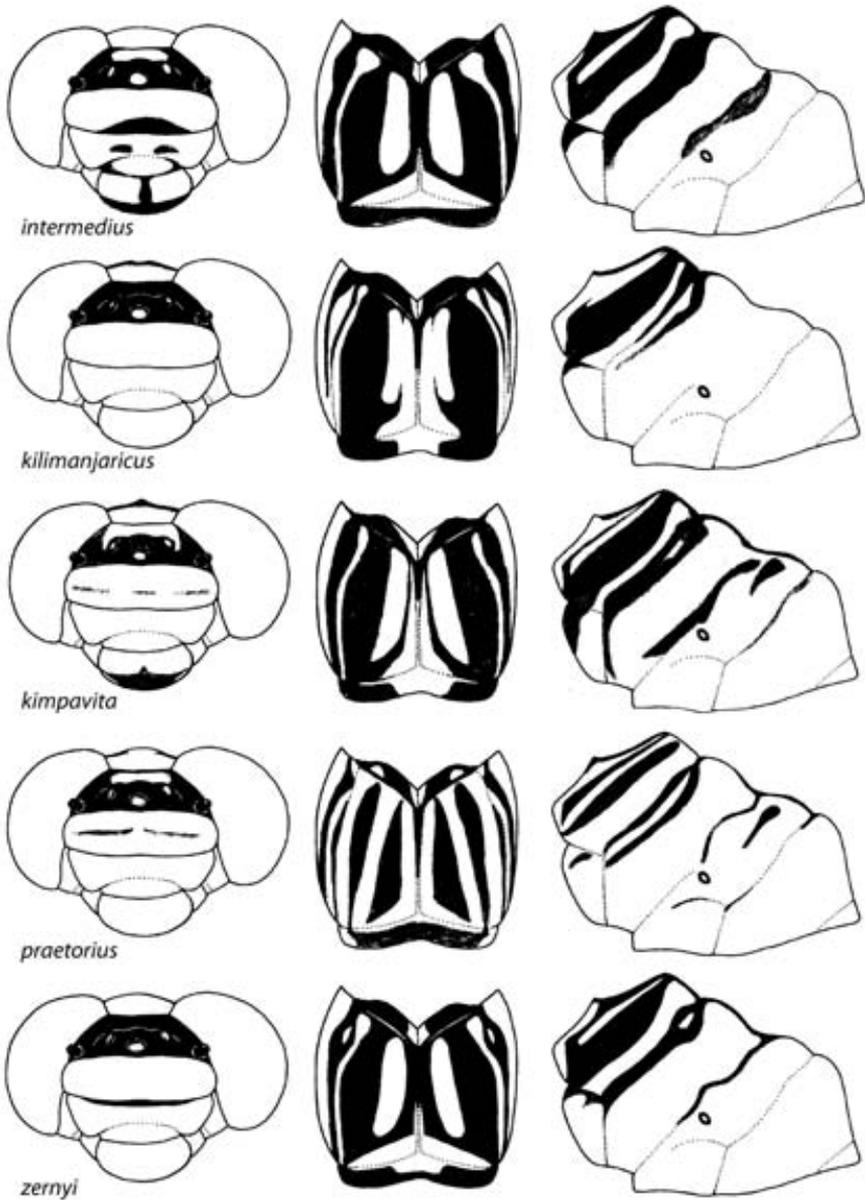
Two unique haplotypes (n = 3) well-separated from other *Notogomphus* species including *N. zernyi* (St. Quentin, 1942), but most of the numerous paler species were not sampled.

### Male morphological diagnosis

Recalls *N. zernyi* and other pale *Notogomphus* by (a) small size, Hw 28.5–29.5 mm (n = 4); and (b) the largely pale yellow face, thorax sides, Pt, hind



**Type Photo 34.** Holotype of *Notogomphus intermedius* sp. nov., RMNH.



**Figure 20.** Head in rostral (left) and thorax in dorsal (middle) and lateral view (right) of selection of pale *Notogomphus* species.

femora and complete dorsal and lateral stripes on S1–7. However, (1) while labrum and postclypeus are largely pale, the lower borders of antefrons, anteclypeus and labrum are darkened, a distinctive pattern within the genus (Fig. 20); (2) the tibiae are all black, without yellow streaks; (3) the costa is dark, rather than yellow; (4) the dorsum of S8–10 is black without a pale yellow stripe and the sides of S8–9 are dark yellow; and (5) the cerci are rather simple in shape with ventral teeth directed outwards and visible in dorsal view (Fig. 19).

### Etymology

Intermediate in characters between the pale highland and dark forest species, but not particularly distinctive in other features (masculine adjective).

### Range and ecology

Small rivers in miombo woodland flowing off the Kibara, Manika and Kundelungu plateaus in Katanga (Photo 64), roughly between 800 and 1 600 m a.s.l (Map 8).



**Photo 47.** Lutshipuka River before it drops off the steep escarpment of the Kundelungu Plateau in Katanga, Congo-Kinshasa. The river harbours *Onychogomphus undecim* and *Zygonyx denticulatus*, while *Notogomphus intermedius* was found on the nearby Masansa. Photo: KDBD (26-xi-2011)

***Notogomphus kimpavita* Dijkstra & Clausnitzer sp. nov. –  
Angola Longleg**

(Type Photo 35, Photo 48, Figs 19, 20)

**Taxonomy**

Morphologically and genetically nearest to *N. praetorius* (Selys, 1878) and assumed to be its sister-species, but easily separated on details.

**Material studied**

**Holotype** ♂. RMNH.INS.508370, Angola, Uíge Province, 8 km W of Uíge, new university campus site, Cazenga stream below confluence of Cassanga, NE of Cunga-Quiximba, murky stream in farmbush and forest remnants, 789 m a.s.l. (7.6060°S 14.9913°E), 23-xi-2012, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** ANGOLA (Uíge Province): 1♀ (RMNH.INS.508331), locality as holotype, 19-xi-2012, leg. V. Clausnitzer & K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.508342), same locality, 21-xi-2012, leg. K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.508291), 2♀ (RMNH.INS.508292), 9 km W of Uíge, new university campus site, Cazenga stream SW of Cunga-Quiximba, large murky stream in farmbush, 789 m a.s.l. (7.6196°S 14.9754°E), 16-xi-2012, leg. V. Clausnitzer & K.-D.B. Dijkstra, RMNH.

**Genetics**

Three unique haplotypes (n = 5) nearest to *N. praetorius*.

**Male morphological diagnosis**

Shares only with *N. praetorius* (a) the dark smudges below the crest of the frons, which however may be absent in either species; (b) the dark streak on the metepisternum abutting but separate from the interpleural markings; (c) the strongly diverging cerci bent inward at their finely pointed apices; and also falls within that species' size-range of Hw 29.0–33.0 mm (n = 5) with (d) Hw 31.5–32.5 mm (n = 3). However is much darker, mainly black with green markings rather than yellow marked with black, including (1) the largely green face with a dark anterior border to the labrum, a distinctive pattern within the genus; (2) the pale postdorsal stripes shifted middorsally and the ante-humeral stripes narrower, leaving a much broader black area between them; (3) the thick and nearly complete black interpleural stripe

running anteriorly of the metastigma (Fig. 20); (4) the largely black rather than yellow-streaked femora and tibiae; (5) the black rather than yellow



**Type Photo 35.** Holotype of *Notogomphus kimpavita* sp. nov., RMNH.

**Photo 48.** View on the site of the planned new campus for the Universidade Kimpa Vita near Uíge, Angola. Type locality of *Notogomphus kimpavita* and the origin of its name. Photo: KDBD (15-xi-2012)



costa; and (6) the largely black abdomen with only S1–2 extensively green, rather than all segments with broad lateral and dorsal yellow stripes over their full lengths. Morphologically distinct by (7) the medially clearly raised and pointed border of the occiput (Fig. 20); (8) the large ventro-lateral tooth of the cerci, rather than a round swelling and reduced tooth; and (9) the reduced paraprocts falling short of the epiproct, rather than extended into acute points that reach clearly beyond it (Fig. 19).

### Etymology

Named after Kimpa Vita, name-giver and patron saint of Universidade Kimpa Vita, on whose new campus grounds the species was discovered (noun in apposition).

### Range and ecology

Known with certainty from somewhat forested streams at about 790 m a.s.l. in northern Angola near Uíge (Photo 48), but seen near Negage at 1 123 m and possibly near Ndalatando at 612 m about 185 km south. The species is not yet known to overlap with its sister-species *N. praetorius*, which occurs from southern Angola to Katanga, Malawi and South Africa (Map 8).

### *Onychogomphus undecim* Dijkstra sp. nov. – Katanga Claspertail

(Type Photo 36, Photos 47, 49–50, Fig. 21)

### Taxonomy

DIJKSTRA (2007) reviewed the taxonomy of the *supinus*-group of *Onychogomphus* Selys, 1854, which probably deserves generic status, but whose species are extremely homogeneous structurally. The genetics and coloration of the present species are, however, distinct and it was treated as such by DIJKSTRA & CLAUSNITZER (2014).

### Material studied

**Holotype** ♂. RMNH.INS.505480, Congo-Kinshasa, Katanga, Upemba National Park, source area of Lusinga near park headquarters, spring streams in gallery forest and adjacent bog, dam and channel (Photo 50), 1 760–1 800 m a.s.l. (8.933°S 27.199°E), 11-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

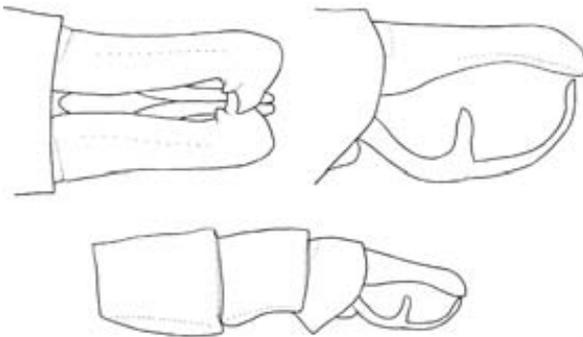
**Further material.** CONGO-KINSHASA (Katanga): 2♂ (RMNH. INS.505474, RMNH.INS.505485), as holotype, RMNH. 2♂ (RMNH. INS.505572), Upemba National Park, Kabwekanono, source area of Kafwi, stream through gallery forest and bogs in open grassy plains, 1 770–1 820 m a.s.l. (8.933°S 27.166°E), 16-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 1♀ (RMNH.INS.505520), Upemba National Park, Lusinga valley 3 km E of park headquarters, stream with patches of gallery and swamp forest, open swamp and arable fields, 1 570–1 590 m a.s.l. (8.93°S 27.23°E), 13-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 4♂ 4♀ (RMNH.INS.505663), Kundelungu National Park, Lutshipuka, small river with some gallery forest and falls in miombo woodland (Photo 47), 1 500–1 530 m a.s.l. (10.557°S 27.958°E), 22–26-xi-2011, leg. K.-D.B. Dijkstra, RMNH.



**Type Photo 36.** Holotype of *Onychogomphus undecim* sp. nov., RMNH.



**Photo 49.** *Onychogomphus undecim*, male; Lusinga, Upemba National Park, Katinga, Congo-Kinshasa. Photo: KDBD (11-xi-2011)



**Figure 21.** Male appendages in dorsal (left) and lateral view (right) and S8–10 in lateral view (below) of *Onychogomphus undecim* sp. nov.

### Genetics

Four unique haplotypes ( $n = 6$ ) are distinct but nearest to *O. supinus* Hagen in Selys, 1854.

### Male morphological diagnosis

Typical of the *supinus*-group by (a) the rather straight cerci in lateral view with a strong inward-directed apical and subapical tooth visible in dorsal view; and (b) the elongate dorsal process at midlength of each branch of the epiproct (Fig. 21). Nearest to the potentially sympatric *O. supinus* and *O. kitchingmani* by (c) the entirely pale face; (d) the black humeral stripe being narrower than the pale stripes bordering it; and (e) the tibiae with pale streaks. However, has (1) greater size, Hw 27.0–30.0 mm ( $n = 5$ ) rather than 24.0–27.0 mm ( $n = 4$ ); (2) an entirely pale costa contrasting with the black Pt, rather than a black costa anterior to a pale Pt; and (3) the foliations on S8 about one-sixth as deep as the segment is high, and deeper than those on S9, the latter with a concave border (Fig. 21). The character of the costa and Pt is unique in the group, but recalls the genera *Ceratogomphus* Selys, 1854 and *Crenigomphus* Selys, 1892.



**Photo 50.** Channel flowing from the Lusinga springs on the Kibara Plateau in Upemba National Park, Katanga, Congo-Kinshasa. Type locality of *Onychogomphus undecim*. Photo: KDBD (11-xi-2011)

### Etymology

Latin “eleven” refers to species’ discovery on the 11th day of the 11th month of the year 2011 (indeclinable numeral).

### Range and ecology

Open streams and small rivers between about 1 500 and 1 800 m a.s.l. on the Kibara and Kundelungu Plateaus of Katanga.

### *Paragomphus cammaertsi* Dijkstra & Papazian sp. nov. – Cammaerts’s Hooktail

(Type Photo 37, Fig. 22)

### Taxonomy

DIJKSTRA & CLAUSNITZER (2014) noted that the taxonomic problems in *Paragomphus* Cowley, 1934 reside largely among the species with truncated diverging cerci, which they dubbed the *cognatus*-group, although not all related species may share this character (see *P. clausnitzerorum* sp. nov.). CAMMAERTS (1968) clarified the identity of *P. cognatus* (Rambur, 1842) and compared the holotypes of *P. bredoi* (Schouteden, 1934), *P. longiventris* Fraser, 1955 and *P. xanthus* Pinhey, 1966 that all originate from north-eastern Congo-Kinshasa and are kept in MRAC. He synonymised the first two but was hesitant to include the latter, although it matches well morphologically and its paler appearance is explained by its more teneral state. Similar males have been found in Gabon, Nigeria, Benin, Togo, Ghana, Liberia and Sierra Leone: the species thus ranges widely across central and western Africa, warranting re-examination of the *Onychogomphus serrulatus* Baumann, 1898 holotype from Togo in ZMHB, which was recognised as pertaining to *Paragomphus* by Erich Schmidt (in lit. 1943). This female has an occiput adorned with two series of six large denticles (hence the specific name) and markings like those of females associated with the *P. bredoi* and *P. xanthus* holotypes, and we place all under the name *P. serrulatus* [new synonymies]. The species differs from the largely allopatric *P. cognatus* of eastern and southern Africa (but see Tree 6) by the (1) complete pale metepisternal stripe interrupted only in very dark specimens, rather than typically interrupted at least above metastigma and often broken up into three spots; (2) apical segment of the

penis bearing a small but prominent dorsal hook on each side; (3) narrower tips of the cerci, with one prominent and often spine-like posterior tooth and several often indistinct anterior ones, rather than several coarse similarly-sized teeth (Fig. 22); and (4) clearly longer than wide epiproct in ventral view, rather than almost as wide as long. By this definition, a similarly pale species that is almost topotypical with the *P. serrulatus* holotype, but has distinct markings and male appendages, although no genetic data, thus represents a new taxon.

### Material studied

**Holotype** ♂. Ghana, Volta Region, Agumatsa River between Wli waterfalls and village, 340 m a.s.l. (7.1166°N 0.5833°E), 26-iv-2000, leg. K.-D.B. Dijkstra, RMNH.



**Type Photo 37.** Holotype of *Paragomphus cammaertsi* sp. nov., RMNH (horizontally mirrored from original).

**Further material.** GHANA (Volta Region): 2♂♀, as holotype, leg. K.-D.B. Dijkstra, RMNH. NIGERIA (Kaduna Province): 1♂, hill stream near Kagoro, 995 m a.s.l. (9.5973°N 8.4014°E), 08-iii-1962, leg. R.M. Gambles, BMNH. 1♂, Jemaa, 525 m a.s.l. (9.4596°N 8.3796°E), 23-iv-1962, leg. R.M. Gambles, BMNH. NIGERIA (Plateau Province): 1♂, Jal, 924 m a.s.l. (9.6634°N 8.6328°E), 25-v-1952, leg. R.M. Gambles, BMNH.

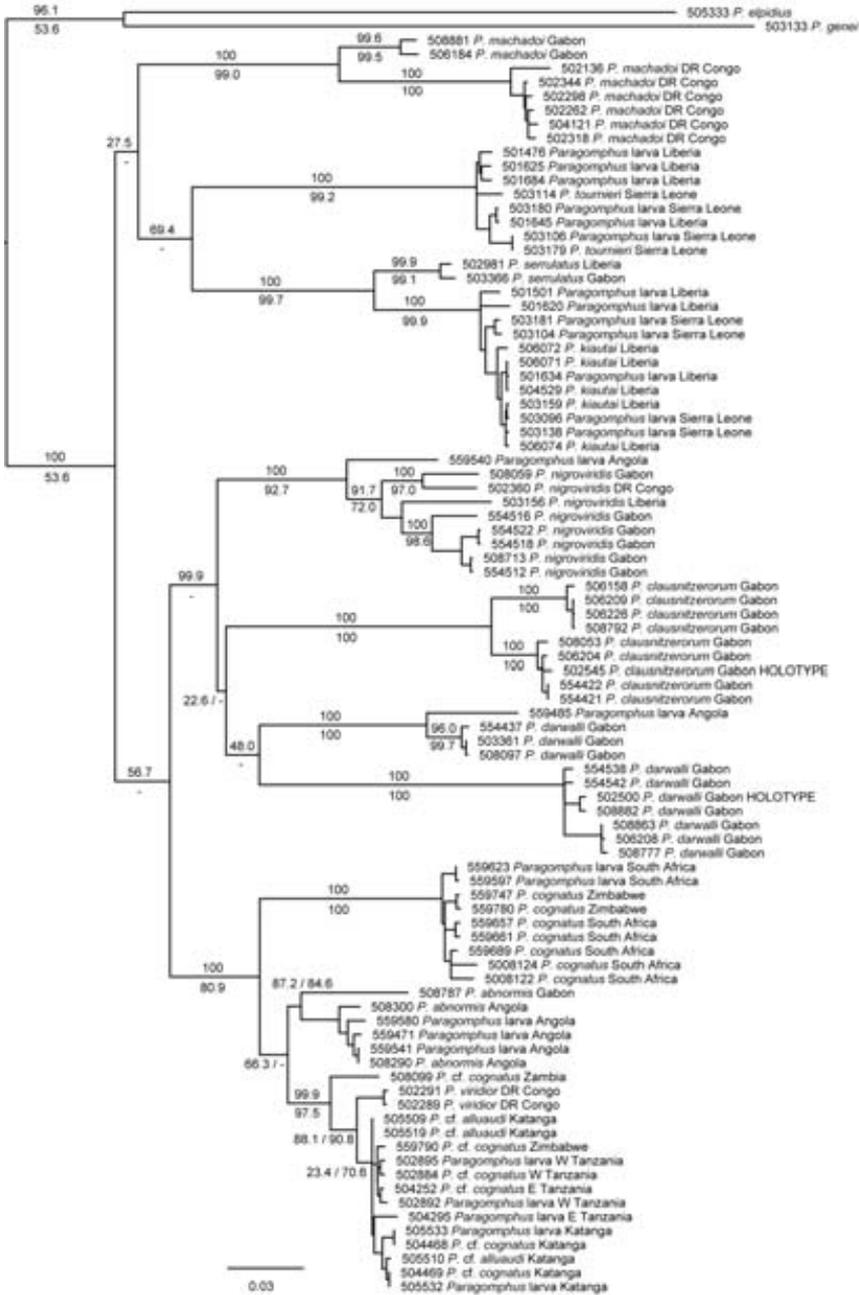
### Genetics

No data available.

### Male morphological diagnosis

Recalls *P. cognatus* and the potentially sympatric *P. serrulatus* by (a) the moderate size, Hw 22.5–23.5 mm ( $n = 3$ ) and rather intermediate extent of dark markings, with the (b) pale occiput and narrowly black-edged and -based labrum contrasting with the largely dark vertex, antefrons and postclypeus; (c) ante-humeral and metepisternal stripes almost as prominent as the other pale thoracic markings; and (d) S3–6 laterally pale over much of their length; as well as (e) apices of the cerci that diverge in dorsal view (Fig. 22). However, (1) the pale ante-humeral and metepisternal markings consist of a stripe and a separate dorsal spot, while typically in *P. serrulatus* they form complete stripes and in *P. cognatus* they are broken up into three spots; (2) the black S8–10 and appendages are marked laterally with some reddish brown, rather than being contrastingly marked with yellow at least on the appendages; (3) the appendages are short, the cerci being less than twice as long as S10 and the epiproct about half as long S10, rather than at least twice and just as long respectively, thus being intermediate between *P. nyasicus* Kimmins, 1955 (Fig. 25) and *P. crenigomphoides* Clausnitzer & Dijkstra, 2005 (Fig. 22); and (4) the curved section of the cerci is notably short and sharply bent in lateral view, with thick and rounded tips with 6–7 rather in-

**Right page – Tree 6.** COI gene tree from Bayesian inference analysis for the extended *cognatus*-group of *Paragomphus* and two outgroup taxa. For relevant branches posterior probabilities are shown first, as is bootstrap support from a 50% majority rule consensus of 1 000 trees from Maximum Likelihood analysis (both as percentages).



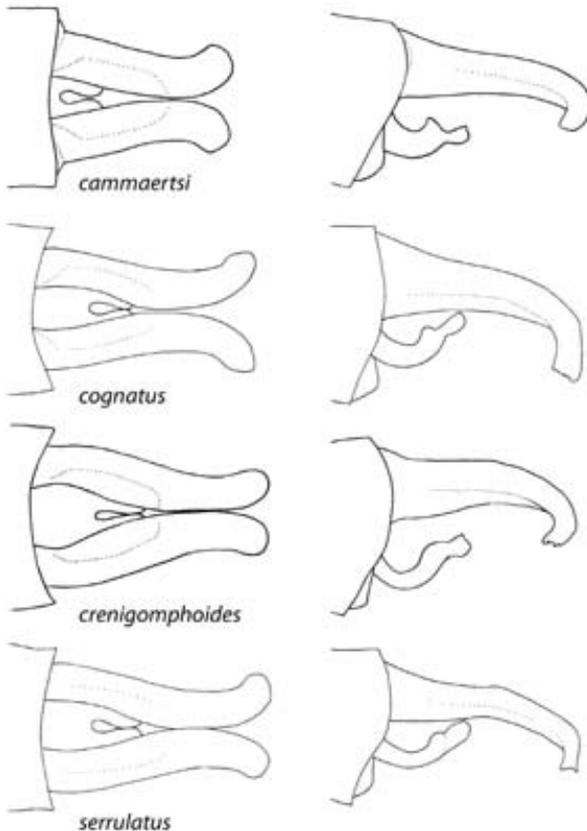
distinct teeth, rather than square-ended with quite distinct and well-spaced teeth (Fig. 22).

### Etymology

Named in honour of Dr Roger Cammaerts who made great contributions to gomphid taxonomy and first recognised this species (in lit.) in BMNH (masculine singular genitive noun).

### Range and ecology

Known between 340 and 995 m a.s.l. from hilly regions in the transition from rainforest to humid savannah in Ghana and Nigeria; in Ghana found by a rocky stream at the base of a waterfall in a forested gorge.



**Figure 22.** Male appendages in dorsal (left) and lateral view (right) of the African *Paragomphus* species with thick diverging tips of the cerci and a black thorax with five well-defined yellowish stripes on each side.

***Paragomphus clausnitzerorum* Dijkstra, Mézière & Papazian sp. nov. –  
Clausnitzers' Hooktail**

(Type Photo 38, Fig. 23)

**Taxonomy**

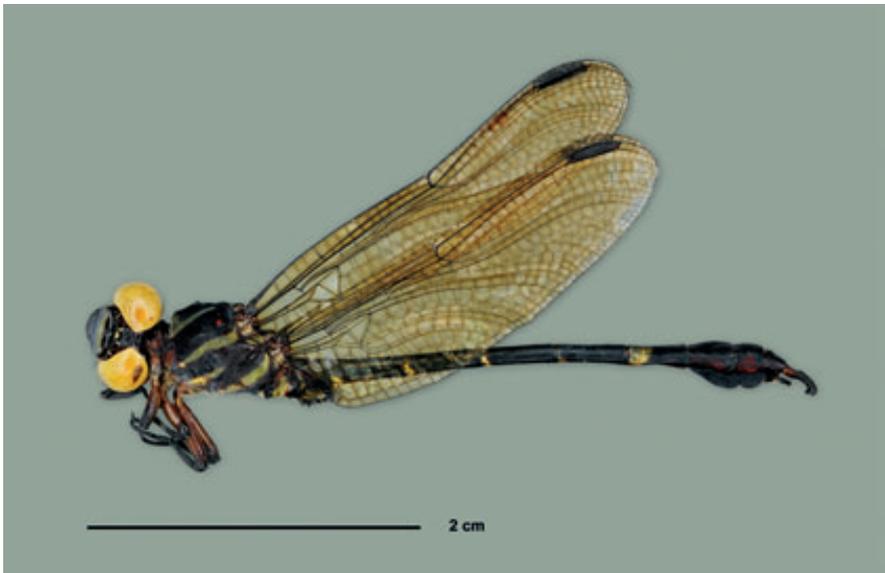
The black *Paragomphus* species of rainforest are often identified as *P. nigroviridis* Cammaerts, 1969, which DIJKSTRA & CLAUSNITZER (2014) included in the *cognatus*-group (see *P. cammaertsi* sp. nov.). COI analysis, often of more easily obtained larvae and female adults, showed that not all species with truncated and diverging cerci are closely related and that *P. cognatus* itself may be a species-complex (Tree 6). Moreover, distinct and geographically overlapping clusters are apparent among these dark forest specimens. By male morphology these could be assigned to *P. nigroviridis* as well as *P. kiautai* Legrand, 1992, *P. machadoi* Pinhey, 1961, *P. tournieri* Legrand, 1992 and at least two clades from Gabon with no available name. The latter have distinctive male appendages, as well as other morphological differences, and are named here. The holotype of *P. machadoi* in MRAC lacks its secondary genitalia and appendages, but is close to *P. interruptus* Cammaerts, 1968 in coloration and the shape of the anal triangle (CAMMAERTS 1968). PINHEY (1961a) illustrated similar cerci and the Angolan type locality lies between records from Congo-Kinshasa and Gabon, so we propose to synonymize them [new synonymy]. The species recalls *P. nigroviridis* by (a) the largely black face and occiput; and (b) the largely black thorax with narrow but prominent green postdorsal, mesepimeral and metepimeral stripes, but variable and typically strongly reduced or fragmented ante-humeral and metepisternal stripes [S3–6]. However, (1) may be slightly larger, Hw 24.0–27.0 mm (n = 6) rather than 23.5–24.0 mm (n = 2); (2) the postdorsal stripes are clearly separated from the collar; (3) the outer border of the anal triangle is sharply, almost rectangularly, kinked at its most distal cell, rather than shallowly excavated; and (4) the cerci narrow quite abruptly at their tips, often bearing a prominent distal spine (Fig. 23).

**Material studied**

**Holotype** ♂. RMNH.INS.502545, Gabon, Haut-Ogooué Province, 34 km SE of Franceville, Franceville-Kessala Road, second stream E of Onkoua,

sandy river in rainforest, 403 m a.s.l. (1.8181°S 13.8446°E), 09-i-2010, leg. N. Mézière, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♂ (RMNH.INS.506158), Moanda-Bakoumba road, forest road on right 25 km from Moanda, Botoso, springs and streamlets (less than <1 m wide) with muddy and swampy edges, 530 m a.s.l. (1.6939°S 13.0739°E), 14-ii-2012, leg. N. Mézière, RMNH. 1♂, forest behind CLAO, Osskama, sandy stream in forest (near source, 3–4 m wide, 40 cm deep), 444 m a.s.l. (1.1116°S 13.8740°E), 16-i-2011, leg. N. Mézière, RMNH. 1♂, Franceville-Okondja road, 2 km before Okila, muddy and gravelly stream in forest (4 m wide, <50 cm deep), 364 m a.s.l. (1.0790°S 13.5669°E), 23-ix-2010, leg. N. Mézière, RMNH. 2♀ (RMNH.INS.554421, RMNH.INS.554422), Alanga-Aboumi road, Moyo, gravelly and sandy forest river (2–3 m wide, 10–50 cm deep), 424 m a.s.l. (0.8403°S 13.9386°E), 28-ix-2012, leg. N. Mézière, RMNH. GABON (Ngounie Province): 3♂ (RMNH.INS.506204, RMNH.INS.506209, RMNH.INS.506226), Mimongo-Mouila road, mountain stream with falls, rapids and large rocks, 478 m a.s.l. (1.7289°S 11.3072°E), 07-iv-2012, leg. N. Mézière,



**Type Photo 38.** Holotype of *Paragomphus clausnitzerorum* sp. nov., RMNH.

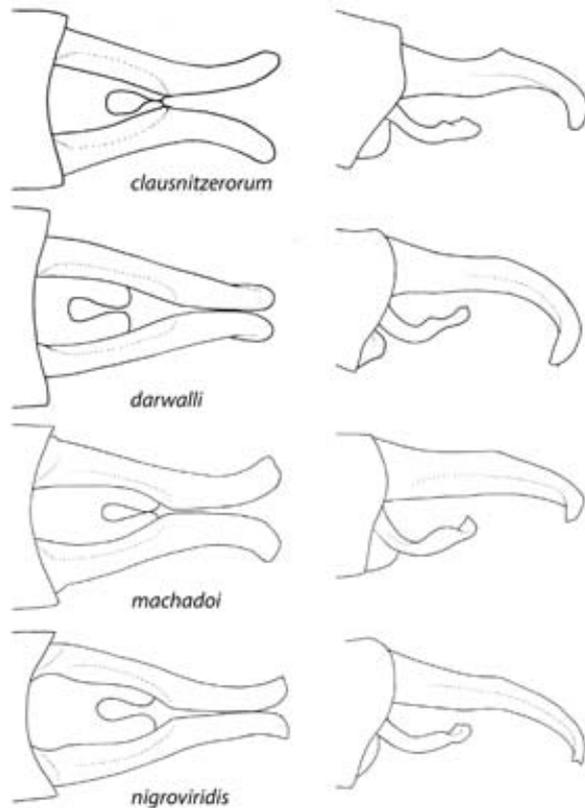
RMNH. 1♀ (RMNH.INS.508792), same locality, 26-iii-2013, leg. N. Mézière, RMNH. GABON (Ogooué-Ivindo Province): 1♂ (RMNH.INS.508053, 5 km SE of Bakouaka at Okondja-Makokou road, sandy stream in dense forest, 531 m a.s.l. (0.1298°N 13.6772°E), 23-ix-2014, leg. J. Kipping, CJKL.

### Genetics

Seven unique haplotypes (n = 9); a possible relationship with *P. darwalli* sp. nov. and *P. nigroviridis* is poorly supported (Tree 6).

### Male morphological diagnosis

Recalls *P. nigroviridis* by (a) the largely black face including the occiput; (b) the largely black thorax with prominent green postdorsal, mesepimeral



**Figure 23.** Male appendages in dorsal (left) and lateral (right) of the central African *Paragomphus* species with a black thorax with only three well-defined greenish stripes on each side.

and metepimeral stripes, but reduced ante-humeral and metepisternal stripes; (c) the postdorsal stripes fused to the collar, together appearing like an inverted seven; and (d) the apices of the cerci that diverge in dorsal view (Fig. 23). However, (1) may be slightly larger, Hw 24.5–26.0 mm (n=5) rather than 23.5–24.0 mm (n=2); (2) the black labrum typically bears a pair of green spots, rather than having these fused into a single bar; (3) the ante-humeral stripe is usually completely absent, rather than reduced to a spot that lies close to the dorsal end of the postdorsal stripe; (4) in lateral view the cerci are more markedly curved up in their basal half and down in their apical half, with a prominent angle between these halves dorsally; and (5) the tips of the cerci are more strongly curved and relatively thick and rounded, with four large and equal teeth, rather than curved more gradually, tapering to a slender and truncated tip with about seven smaller teeth, of which the most terminal stands apart and is often longer (Fig. 23).

### Etymology

Named in honour of Mr Hans-Joachim Clausnitzer and his daughter Dr Viola Clausnitzer, chair of the IUCN Dragonfly Specialist Group, who together made many contributions to the knowledge of African Odonata (plural genitive noun).

### Range and ecology

Sandy and gravelly rainforest streams between 350 and 550 m a.s.l. in southern Gabon.

### ***Paragomphus darwalli* Dijkstra, Mézière & Papazian sp. nov. – Darwall's Hooktail**

(Type Photo 39, Photos 51–52, Fig. 23)

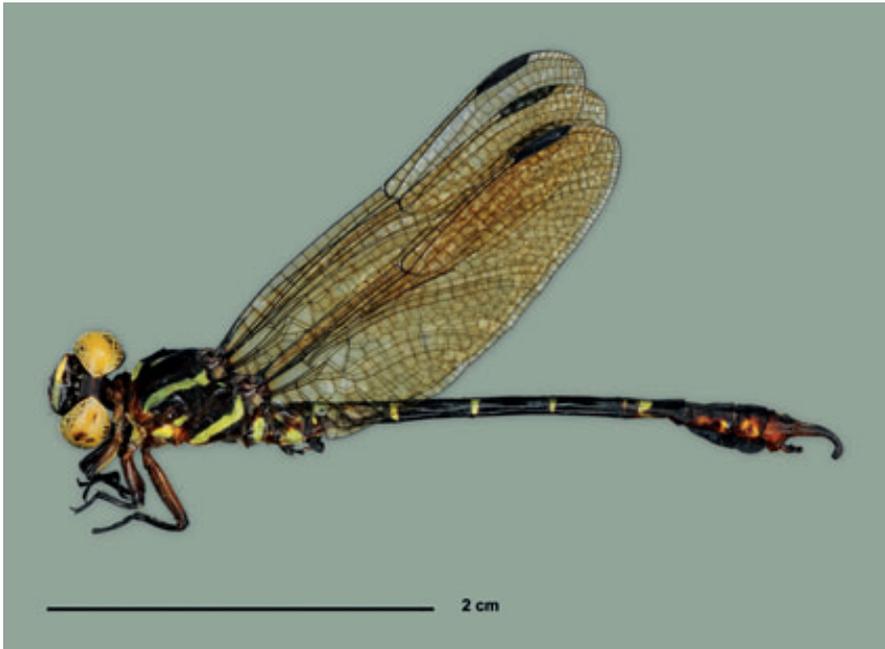
### Taxonomy

See general rationale for the dark forest *Paragomphus* species under *P. clausnitzerorum* sp. nov. Recalls *P. tournieri* Legrand, 1992 from western Africa, the only other largely black African *Paragomphus* species with parallel cerci, but genetically distant and morphologically distinct (Tree 6).

**Material studied**

**Holotype** ♂. RMNH.INS.502500, Gabon, Haut-Ogooué Province, 34 km E of Franceville, Franceville-Léconi Road, NE of Bongoville, 417 m a.s.l. (1.6130°S 13.9055°E), 31-xii-2009, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** ANGOLA (Cuanza Norte Province): 1 larva (RMNH.INS.559485\*), 16 km WNW of Camabatela, Quitexe-Camabatela road, Seque stream near Bindo, partly forested sandy and muddy stream, 810 m a.s.l. (8.1634°S 15.2209°E), 29-ix-2013, leg. K.-D.B. Dijkstra, RMNH. GABON (Haut-Ogooué Province): 1♂ (RMNH.INS.503361\*), Bakoumba River between Bakoumba-Ville and -Village, sandy river in rainforest, 544 m a.s.l. (1.8576°S 13.0148°E), 02-i-2010, leg. N. Mézière, RMNH. 1♀ (RMNH.INS.554437\*), Bakoumba road, Kounda, Mbéréssé, sandy forest river, partly open and sunny (3 m wide, 50–100 cm deep), 484 m a.s.l. (1.5859°S 13.1563°E), 06-x-2012, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.554542),



**Type Photo 39.** Holotype of *Paragomphus darwalli* sp. nov., RMNH (horizontally mirrored from original).

1♀ (RMNH.INS.554538), Bongoville-Léconi road, Boubou River, Ekala, sandy forest stream (1–2 m wide, 5–10 cm deep), muddy edges, 427 m a.s.l. (1.6133°S 13.9125°E), 09-xii-2012, leg. N. Mézière & J. Lekogo, RMNH. 1♂, Bongoville-Léconi road after Ekala, old village of Boubou, stream (2 m wide) with gravel bottom, 393 m a.s.l. (1.6114°S 13.9105°E), 20-ix-2009, leg. N. Mézière, RMNH. 1♂, same locality, 07-ii-2010, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.508863), 2♀ (RMNH.INS.508882), Batéké Plateau, Léconi Valley, Eaux Claires, Camps des Pygmés, sandy streams (1 m and 4–5 m wide) at forest edge, 434 m a.s.l. (1.4549°S 14.1785°E), 28-ix-2013, leg. N. Mézière, J. Kipping & H. Krahnstöver, RMNH. 1♀ (RMNH.INS.508777), same locality, 10-iii-2013, leg. N. Mézière, RMNH. 1♀ (RMNH.INS.508097\*), Moyabi, 17 km SSE of Moanda (1.7082°S 13.2518°E), 01-x-2013, leg. N. Mézière, RMNH. 1 adult (RMNH.INS.506208), no further locality data, i–iv-2012, leg. N. Mézière, RMNH.



**Photo 51.** *Paragomphus darwalli*, male; Boubou stream near Bongoville, Gabon. Photo: NM (20-xi-2011)

### Genetics

The holotype belongs to a cluster of five unique haplotypes ( $n=7$ ). Specimens marked with a star above form a second cluster of four unique haplotypes ( $n=4$ ), whose sister-group relationship with the first is poorly supported, but we have no morphological arguments to separate them specifically. The relationships of these distinct clusters with further species are also weakly supported (Tree 6).

### Male morphological diagnosis

Recalls *P. tournieri* by (a) the largely black face and occiput; (b) the largely black thorax with prominent green postdorsal, mesepimeral and metepimeral stripes, but almost entirely reduced ante-humeral and metepisternal stripes; (c) the postdorsal stripes that are clearly separated from the collar; (d) the cerci that in dorsal view are parallel to each other to their end; and (e) the cerci that in lateral view are strongly and evenly curved, like a walking cane, and terminate in blunt tips (Fig. 23). However, (1) notably small, Hw 21.5–22.0 mm ( $n=4$ ) rather than 23.5–24.0 mm ( $n=2$ ); (2) the labrum is uniformly brown, becoming even a fraction paler towards the border, rather than black and darkest on the border enclosing a green bar; (3) the ante-humeral stripe is absent, rather than reduced to a spot that lies close to the dorsal end of the postdorsal stripe; (4) the curved section of the cerci is longer and more slender; and (5) the tips of cerci may bear a small subapical spine, although possibly this breaks off easily in either species (Fig. 23).

**Photo 52.** Boubou Stream near Bongoville at the foot of the Batéké Plateau, Gabon. Habitat of *Africocypha varicolor*, *Elattoneura aurifex*, *Ceriagrion obfuscans*, *Pseudagrion aureolum*, *Paragomphus darwalli*, *Malgassophlebia andzaba*, *Neodythemis infra*, *Porpax mezierei*, and *Trithemis hinnula*. Photo: NM (20-xi-2011)



### Etymology

Named in honour of Dr William Darwall, head of the IUCN Freshwater Biodiversity Unit (masculine singular genitive noun). Darwall and his team were instrumental in synthesising the threat status of Africa's aquatic nature. Such facilitators are the unsung heroes of conservation efforts worldwide.

### Range and ecology

Clear sandy streams in gallery forest between 350 and 550 m a.s.l., especially around the Batéké Plateau in south-eastern Gabon. Males were found in forest clearings and on small sand banks in the streams. The record of a genetically similar larva at 810 m a.s.l. in northern Angola requires confirmation (Tree 6).

### *Paragomphus dispar* Dijkstra, Mézière & Papazian sp. nov. – Amazing Hooktail

(Type Photo 40, Photos 2, 6, 53, Fig. 24)

### Taxonomy

An extremely distinctive species that only recalls *P. aureatus* Pinhey, 1971 and especially *P. maynei* (Schouteden, 1934), which are both known solely from their holotypes from Gabon and Congo-Kinshasa respectively. Only the latter in MRAC could be examined and is unique by the wholly dark thorax marked only with a pair of short green postdorsal stripes.

### Material studied

**Holotype** ♂. RMNH.INS.554489, Gabon, Haut-Ogooué Province, right-hand road before “Africa No1” radio station in the direction of Franceville, Moyabi, small gravelly and sandy forest stream bordered by swamp and springs, 474 m a.s.l. (1.6877°S 13.3113°E), 10-xi-2012, leg. N. Mézière, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 5♂ (RMNH.INS.554500, RMNH.INS.554505, RMNH.INS.554506, RMNH.INS.554511, RMNH.INS.554533), 1♀ (RMNH.INS.554475), locality as holotype, 06–21-xi-2012, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.508711), 1♀ (RMNH.INS.508712), same locality, 13-i-2013, leg. N. Mézière, RMNH. 1♂ (RMNH.

INS.508098), same locality, 17-ix-2013, leg. J. Kipping, CJKL. 1♀ (RMNH. INS.506220), same area, sandy and gravelly stream in forest (4 m wide, 50–100 cm deep) with swamps, 483 m a.s.l. (0.6476°S 13.6800°E), 24-iii-2012, leg. N. Mézière, RMNH.

### Genetics

Three unique haplotypes ( $n = 11$ ) distant from all other *Paragomphus* sampled, although *P. aureatus* and *P. maynei* were not available.

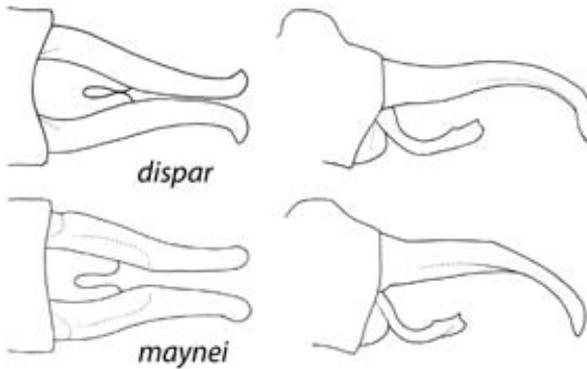
### Male morphological diagnosis

Nearest to the poorly known *P. maynei* by its (a) great size, Hw 27.0–33.0 mm ( $n = 7$ ); (b) largely black face and occiput; (c) entirely green S2 that contrasts with the mostly dark abdomen; (d) abrupt dorsal hump on S10; (e) slender and tapering cerci that terminate in a saw-like ridge of about six equal teeth; and (f) epiproct that is almost half as long as the cerci (Fig. 24). However, (1) the black labrum is darkest on the border, enclosing a greenish



**Type Photo 40.** Holotype of *Paragomphus dispar* sp. nov., RMNH.

bar, rather than being quite uniformly brown and even a fraction paler on the border; (2) the mesepisterna are entirely yellow-green except for a thick



**Figure 24.** Male appendages in dorsal (left) and lateral view (right) of the two African *Paragomphus* species with a humped S10. Note that the cercal tip of *P. maynei* is similarly saw-like as that of *P. dispar* n. sp.



**Photo 53.** *Paragomphus dispar*, male, near Moyabi, Gabon. When flying rapidly low over the water, males are hard to see except for their unique markings. Photo: JK (17-ix-2013)

black border along the humeral suture and a thin black line on the posterior half of the middorsal carina (Photo 53), rather than all dark with only small isolated postdorsal stripes; (3) the sides of the thorax are black with complete broad greenish stripes on the mesepimeron and metepimeron, rather than wholly dark; (4) S3–10 are black with only a pair of green spots on the basal fifth of S3 and brown sides to S8–10, rather than largely pale on the sides of S3 and S7, and extensively rusty on S8–10; and (5) the cerci are more smoothly curved (Fig. 24). The large size, dark face and bright thoracic front recall *P. aureatus*, but that has a pale metepisternal stripe that is of similar length and width as the mesepimeral and metepimeral stripes, pale markings on S4–5 and S7, a flat-topped S10, rather straight and thick cerci with abruptly down-curved tips, and an epiproct that is well over half as long as the cerci.

### Etymology

Latin “different” refers to the very distinct appearance of this species (adjective).

### Range and ecology

Known from one area around 480 m a.s.l. in south-eastern Gabon with clear (or somewhat turbid) sandy streams in rainforest between 1–4 m wide (Photos 2, 6). Adults appear to spend most of their time in the canopy, only descending to sun spots around noon.

### *Paragomphus lemperti* Dijkstra & Papazian sp. nov. – Lempert’s Hooktail

(Type Photo 41, Photo 54, Fig. 25)

### Taxonomy

One of several *Paragomphus* species of open rivers and lakes with a green thorax and parallel cerci (Fig. 25), listed as *Paragomphus* sp. nov. 1 by LEMPERT (1988). Morphologically and genetically it is nearest to *P. elpidius* (Ris, 1921) from eastern and southern Africa, and presumably also close to *P. lacustris* (Karsch, 1890) of Lake Tanganyika, but sufficiently distinct to be named as a new species.

### Material studied

**Holotype** ♂. RMNH.INS.504530, Liberia, Nimba County, West Nimba Proposed Forest Reserve, Yiti at camp south of Bentor, just before confluence with St John River, small river with forested rocky and open section with sandbanks (Photo 54), 400 m a.s.l. (7.5165°N 8.7044°W), 27-ii-2012, leg. K.-D.B. Dijkstra & M. Darpay, RMNH.

**Further material.** LIBERIA (Nimba County): 1♂ (RMNH.INS.504518), as holotype, RMNH. 1♀ (RMNH.INS.506070), same locality, 08-iii-2012, leg. K.-D.B. Dijkstra & M. Darpay, RMNH. SIERRA LEONE (Eastern Province): 2♂ (RMNH.INS.503130, RMNH.INS.503131), 1♀ (RMNH.INS.503132), Gola Forest, Mogbai river upstream from Mogbaima, mostly gravelly and rocky (some sand) river in forest, 139 m a.s.l. (7.6596°N 10.7676°W), 03-iii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. 1 larva (RMNH.INS.503095), Gola Forest, Moro River (international border with Liberia, Gbarpolu County) south of Mogbaima and Money Camp, large riv-



**Type Photo 41.** Holotype of *Paragomphus lemperti* sp. nov., RMNH (horizontally mirrored from original).

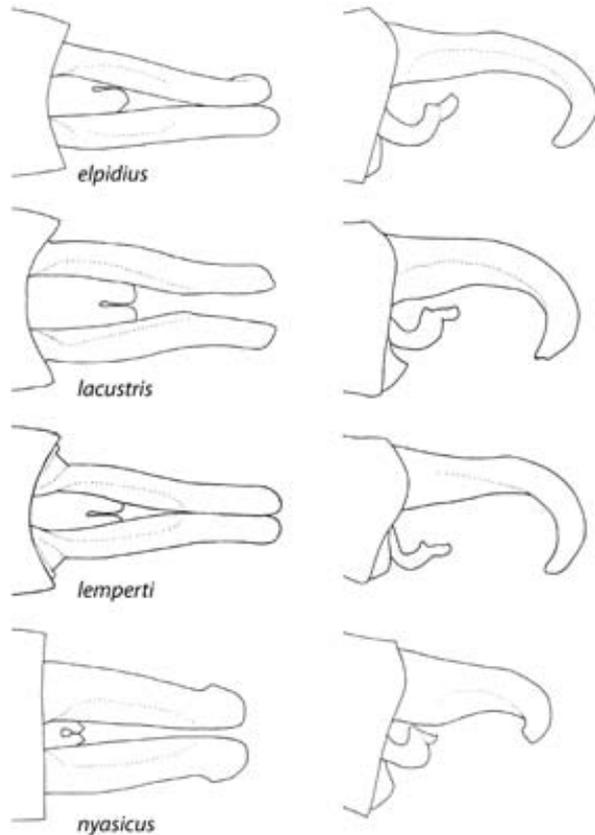
er with rocky and sandy sections and forested banks, 151 m a.s.l. (7.6479°N 10.7734°W), 28-ii-2011, leg. K.-D.B. Dijkstra & A. Dayaker, RMNH.

### Genetics

Four unique haplotypes (n=7) nearest to *P. elpidius*.

### Male morphological diagnosis

Nearest to *P. elpidius* by (a) the moderate size, Hw 23.0–24.0 mm (n=4); (b) the green frons, clypeus and labrum with only indistinct brown smudges; (c) the largely green thorax with quite reduced but distinct brown stripes that delimit green postdorsal and ante-humeral stripes; (d) the brown Pt that contrast weakly with their black veins; (e) the cerci that in dorsal view



**Figure 25.** Male appendages in dorsal (left) and lateral view (right) of the African *Paragomphus* species with parallel tips of the cerci, the epiproct about a third the length of the cerci, and a largely green thorax with limited brown markings; not shown is *P. cataractae* with very thin cerci and an (almost) unmarked thorax.

are parallel to each other to their end; (f) the cerci that in lateral view are strongly and evenly curved, like a walking cane, and terminate in thick blunt tips but lack the prominent ventral tooth of *P. lacustris*; and (g) the epiproct that is only about a third as long as the cerci (Fig. 25). Differs by (1) the thoracic stripes being straight and continuous, e.g., the green ante-humeral and metepisternal stripes and brown interpleural stripes extend uninterrupted between the leg and wing bases, whereas in *P. elpidius* they are often dead-ended or broken; (2) the foliations on S8–9 are reduced, at most one quarter as deep as the segment is high, rather than over half; and (3) the curved section of the cerci is longer and more slender (Fig. 25).

### Etymology

Named in honour of Mr Jochen Lempert whose 1988 study of Liberian Odonata was one of the first to address tropical odonate ecology in detail and who first recognised this species as well as *Eleuthemis umbrina* sp. nov. (masculine singular genitive noun).

### Range and ecology

Streams and rivers in Liberia and adjacent Sierra Leone. LEMPERT (1988) found the species on the Sinoe and Cavalla Rivers; the latter forms the border with Côte d'Ivoire. All sites are rather open, although enclosed by rain-forest, have large sandy sections, and lie between 100 and 400 m a.s.l.



**Photo 54.** Small forest stream south of Bentor, Liberia. Type locality of *Paragomphus lemperti*. Photo: KDBD (26-ii-2012)

***Phyllogomphus bongorum* Kipping, Mézière & Dijkstra sp. nov. –  
Bongo Leaftail**

(Type Photo 42, Photos 26, 55–56, Fig. 26)

**Taxonomy**

Belongs to the three-striped group of *Phyllogomphus* Selys, 1854 (DIJKSTRA et al. 2006) and morphologically nearest to the sympatric *P. annulus* Klots, 1944 but distinct in details of genetics, coloration and male appendages (Fig. 26).

**Material studied**

**Holotype** ♂. RMNH.INS.508064, Gabon, Haut-Ogooué Province, Batéké Plateau, 18 km NW of Léconi, sandy stream in dense gallery forest, tributary to Léconi River, at forest edge, 425 m a.s.l. (1.447218°S 14.166175°E), 29-ix-2013, leg. J. Kipping, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♂ as holotype, leg. N. Mézière, CJKL. 1♂ (RMNH.INS.508045), 1♀ (RMNH.INS.508044), same locality, 10-ix-2014, leg. J. Kipping, CJKL.



**Type Photo 42.** Holotype of *Phyllogomphus bongorum* sp. nov., RMNH.

### Genetics

Three unique haplotypes ( $n = 3$ ) nearest to but well-separated from nine of *P. annulus* ( $n = 10$ ).

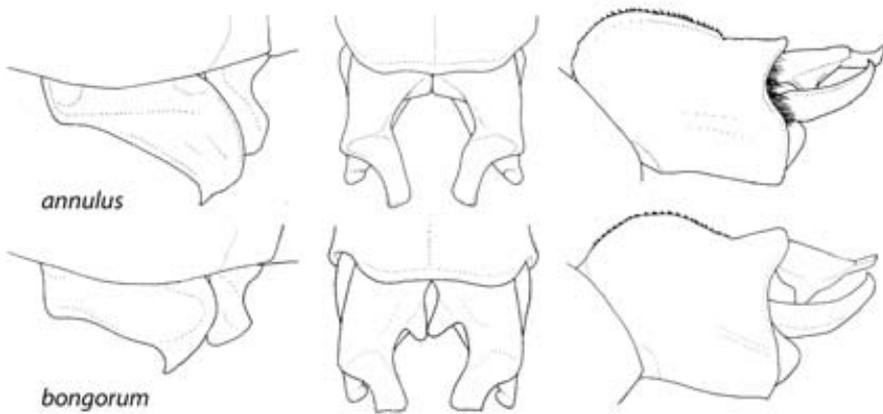
### Male morphological diagnosis

Nearest to the sympatric *P. annulus* by (a) large size, Hw 40.0–40.5 mm ( $n = 2$ ); (b) the entirely dark brown labrum, clypeus, frons, vertex and occiput with only a narrow green bar centrally across the frons; (c) the smooth border of the occiput without denticles; (d) the complete yellow postdorsal, mesepimeral and metepimeral stripes on the thorax but no ante-humeral and metepisternal stripes; (e) the stout posterior hamule with its posterior border semi-circular (Fig. 26); (f) the black S4–6 with pairs of yellow basal spots; (g) the uniformly reddish brown S8–10; (h) the many anteriorly-directed denticles on the hump of the dorsal crest of S10; and (j) the brown cerci that are scarcely longer than the epiproct and have broad truncate apices and a rectangularly kinked outer border (Fig. 26). However, (1) the posterior hamule is even less drawn out (Fig. 26); (2) the yellow basal spots on S4–7 extend onto the underside of the abdomen, i.e., are not interrupted by black ventrally or even completely reduced; (3) the denticles on the hump



**Photo 55.** *Phyllogomphus bongorum*, rather fresh male; Batéké Plateau, Gabon. Photo: JK (28-ix-2013)

of S10 are relatively larger and thus fewer in number, i.e., 25–26 instead of 31–42; (4) the lateral excavations of the apical border of S10 lack fringes of hair; (5) the apices of the cerci are even shorter; (6) the ventral flanges of the cerci that can be seen touching each other between the cerci in dorsal view have an acute rather than obtuse border; (7) the ventral tooth of the cerci is long and sharply pointed, rather than round and blunt; and (8) the epiproct is not abruptly widened close to its base, i.e., the subbasal hump visible in lateral view on its dorsal profile in *P. annulus* is absent (Fig. 26).



**Figure 26.** Posterior hamules (left) and male appendages and S10 in dorsal (middle) and lateral view (right) of two *Phyllogomphus* species.

**Photo 56.** Forest-savannah transition on the sandy Batéké Plateau, Gabon. A clear sandy stream flows through the gallery forest. *Phyllogomphus bongorum* was only found here, foraging along the forest edge among many hundreds of other gomphids and few individuals of *Zygonyx dionyx*. Photo: JK (29-ix-2013)



### Etymology

Named after the Bongo pygmies that live under harsh conditions where the species was found (plural genitive noun).

### Range and ecology

Known only from a very clear sandy stream in dense gallery forest at 425 m a.s.l. on the sandy Batéké Plateau in south-eastern Gabon. Both sexes were found hunting along forest edges (Photo 56) in the forest-grassland mosaic among the much more numerous *P. annulus*.

### *Tragogomphus grogonfla* Dijkstra sp. nov. – Western Horntail

(Type Photo 43, Photo 57, Fig. 27)

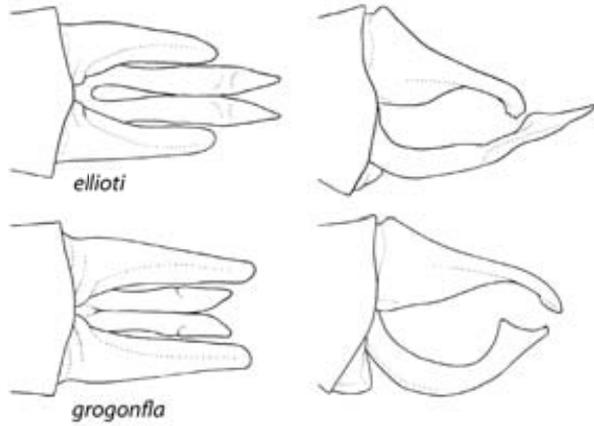
### Taxonomy

DIJKSTRA (2007) proposed to restrict the genus *Tragogomphus* Sjöstedt, 1900 to the type species *T. aurivillii* Sjöstedt, 1900 from Cameroon and the closely similar *T. ellioti* Legrand, 2002 from Gabon. Populations in the Upper Guinea are genetically distinct from *T. ellioti* and differ clearly from both species in the male appendages (Fig. 27).

### Material studied

**Holotype** ♂. RMNH.INS.503176, Sierra Leone, Eastern Province, Gola Forest, Sembahun (abandoned village), sandy stream and adjacent spring area in forest, 219–233 m a.s.l. (7.7598°N 10.7174°W), 11-iii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH.

**Further material.** LIBERIA (Grand Gedeh County): 1 larva (RMNH.INS.501515), Putu Iron Ore Mining concession, Biodiversity Camp, sandy and gravelly streams and muddy seepage in rainforest, 299 m a.s.l. (5.6592°N 8.2041°W), 22-i-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. 1 larva (RMNH.INS.501529), Putu Iron Ore Mining concession, Jerry's Camp, complex of streams, seepages and (goldmining) pools east of camp in rainforest, 283 m a.s.l. (5.6732°N 8.2245°W), 24-i-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. 1 larva (RMNH.INS.501648), same locality, 19-ii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. LIBERIA (Nimba County): 1♀ (RMNH.INS.506080), West Nimba Proposed Forest Reserve, Van-



**Figure 27.** Male appendages in dorsal (left) and lateral view (right) of two *Tragogomphus* species.



**Type Photo 43.** Holotype of *Tragogomphus grogonfla* sp. nov., RMNH.

yanpa Camp, 3.5 km S of Bentor, small sandy and rocky stream in rainforest, 447 m a.s.l. (7.4922°N 8.6998°W), 09-iii-2012, leg. K.-D.B. Dijkstra & M. Darpay, RMNH. 1♂ (RMNH.INS.501463), 1♀ (RMNH.INS.501462), 2 larvae (RMNH.INS.501474, RMNH.INS.501475), Mt Tokadeh, “ladder falls” on road to old mine, springs, sandy stream and swampy forest (Photo 57), 600–660 m a.s.l. (7.445°N 8.658°W), 13–14-i-2011, leg. K.-D.B. Dijkstra, RMNH. 2 larvae (RMNH.INS.501683, RMNH.INS.501685), same locality, 18–19-iii-2011, leg. K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.506057), 1 larva (RMNH.INS.506060), Mt Beeton, stream towards summit, small rocky stream in rainforest, 785 m a.s.l. (7.5299°N 8.6638°W), 06-iii-2012, leg. K.-D.B. Dijkstra & M. Darpay, RMNH. 1 larva (RMNH.INS.505694), eastern flank Mts Gangra and Yuelliton, lower Yehwah valley, rocky stream in forest, 505–522 m a.s.l. (7.5567°N 8.6153°W), 04-iii-2012, leg. K.-D.B. Dijkstra & M. Darpay, RMNH. SIERRA LEONE (Eastern Province): 1 larva (RMNH.INS.503182), as holotype, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. 1 larva (RMNH.INS.503124), Gola Forest, Gagbe stream, 1 km W of Mogbaima, stream from uppercourse in forest to heavily disturbed area with diamond pits, 136 m a.s.l. (7.6574°N 10.7788°W), 03-ii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH.

### Genetics

Seven unique haplotypes ( $n = 16$ ) nearest to but distinct from *T. ellioti* from Gabon, although *T. aurivillii* from Cameroon was not sampled.

### Male morphological diagnosis

Similar to *T. ellioti* and presumably the poorly known *T. aurivillii* by (a) fairly large size, Hw 31.0–33.0 mm ( $n = 2$ ); (b) the pale medially narrowed bar across anterior half of the brown labrum; (c) the centrally depressed vertex, without a ridge between the lateral ocelli; (d) the denticles on the occipital ridge; (e) the anterior hamule’s short and curved hook on a low rounded base; (f) the wide-based cerci in lateral view with a sub-basal hump and concave dorsal profile; and (g) the up-curved branches of the epiproct thickened and somewhat recurved subapically (Fig. 27). However, (1) the dark interpleural and metapleural stripes are wider than the green stripes flanking them; (2) the most posterior black stripe on the thorax sides ex-

tends across the lower corner of the metepimeron, not dead-ended; (3) the epiroct branches have a marked dorsal angle subapically; and (4) the epiroct's apices beyond the dorsal angle are short, not reaching beyond the tips of the cerci (Fig. 27).

### Etymology

Name alludes to the pronunciation of 'dragonfly' by Mr Edward Rose, who assisted the author in Liberia (noun in apposition).

### Range and ecology

Sandy and gravelly headwater streams between 150 and 800 m a.s.l. in rain-forest in Liberia and adjacent Sierra Leone. The first true *Tragomorphus* species found outside Cameroon and Gabon.



**Photo 57.** Sandy forest stream on Mt Tokadeh near Yekepa, Liberia. Habitat of *Tragomorphus grogonfla*. Photo: KDBD (13-i-2011)

## Libellulidae

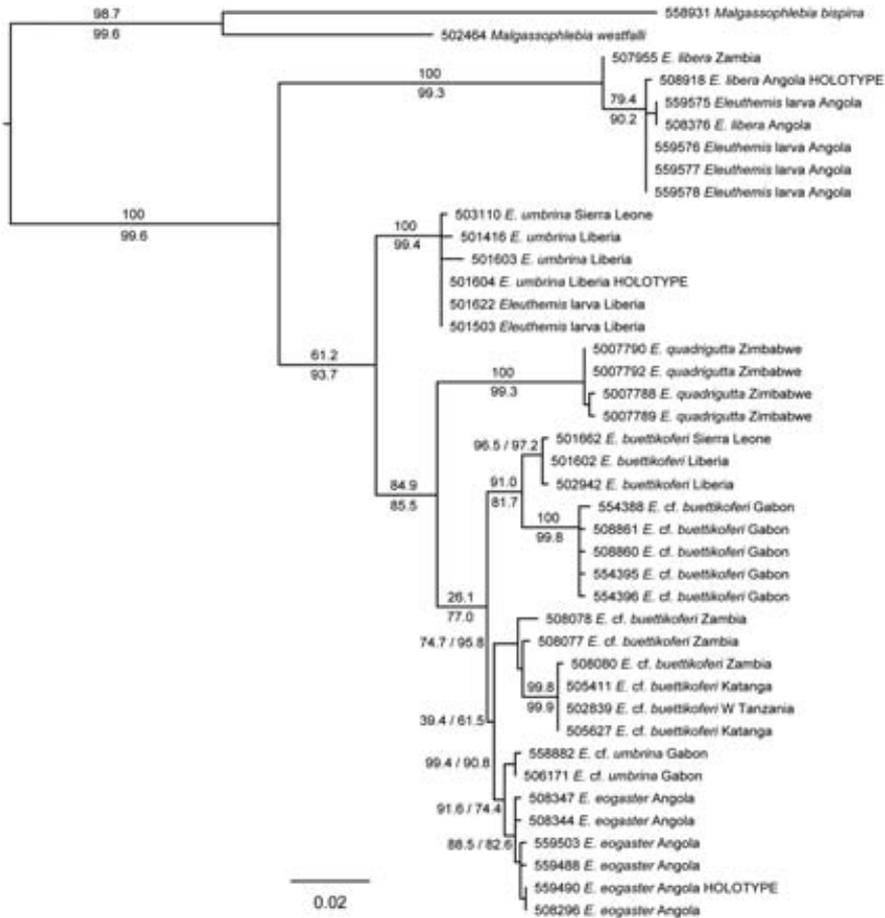
### *Eleuthemis eogaster* Dijkstra sp. nov. – Sunrise Firebelly

(Type Photo 44, Photo 58, Fig. 28)

#### Taxonomy

The genus *Eleuthemis* Ris, 1910 has generally been treated as monotypic (DIJKSTRA 2007), although LEMPERT (1988) noted males with differently coloured abdomen undersides and distinct habitat preferences occurring together in Liberia. As the abdomen's bright white back and coloured underside are used in display behaviour, the two forms may represent distinct species, which is confirmed by genetic data (see *E. umbrina* sp. nov.). Moreover, at least five other distinct genetic clusters are apparent within *Eleuthemis* that also overlap partly geographically and differ in coloration (Tree 7). The morphologically most distinct clades are named here, bringing the genus to five species, although we believe at least three more exist: two co-occurring in Gabon appear as rather dark *E. buettikoferi* Ris, 1910 and *E. umbrina* respectively, while that from Katanga, Tanzania and Zambia looks like a paler *E. buettikoferi* (Map 9). Typical *E. buettikoferi* Ris, 1910 occurs from Sierra Leone east at least to Ghana and has (1) a thick black border to the labrum; (2) Fw with darkened tip that just touches the distal end of Pt; (3) the vertex and occipital triangle blackened at least basally; (4) Fw discoidal field entirely of two or more rows of cells; (5) the abdomen dorsum entirely whitish pruinose with maturity; (6) the abdomen underside largely orange, at least S6–9 without black on the ventral carinae; (7) largely blackish secondary genitalia; and (8) an acute tip to the hook of the hamule (Fig. 28). PINHEY (1974) described *E. b. quadrigutta* from only two females from the Zimbabwe-Mozambique border, yet later raised it to species level (PINHEY 1984). DIJKSTRA (2007) synonymised it with *E. buettikoferi* on account of the variation in what was then considered a monotypic species. However, recent toptypical males are genetically distinct (Tree 7) and unique within the genus by (1) the very distinct dark tip to Hw as well as Fw; (2) the black-rimmed orange epiproct that contrasts with the wholly black cerci, rather than both being either all dark or partly orange; and (3) the presence of a second ventral tooth somewhat basal to

the tooth on the thickening of the cerci. Thus *E. quadrigutta* Pinhey, 1974 must be treated as a distinct species. The taxon treated here is also genetically distinct (Tree 7), has abdominal coloration unlike any other dragonfly known, and was illustrated by DIJKSTRA & CLAUSNITZER (2014) as a good species.

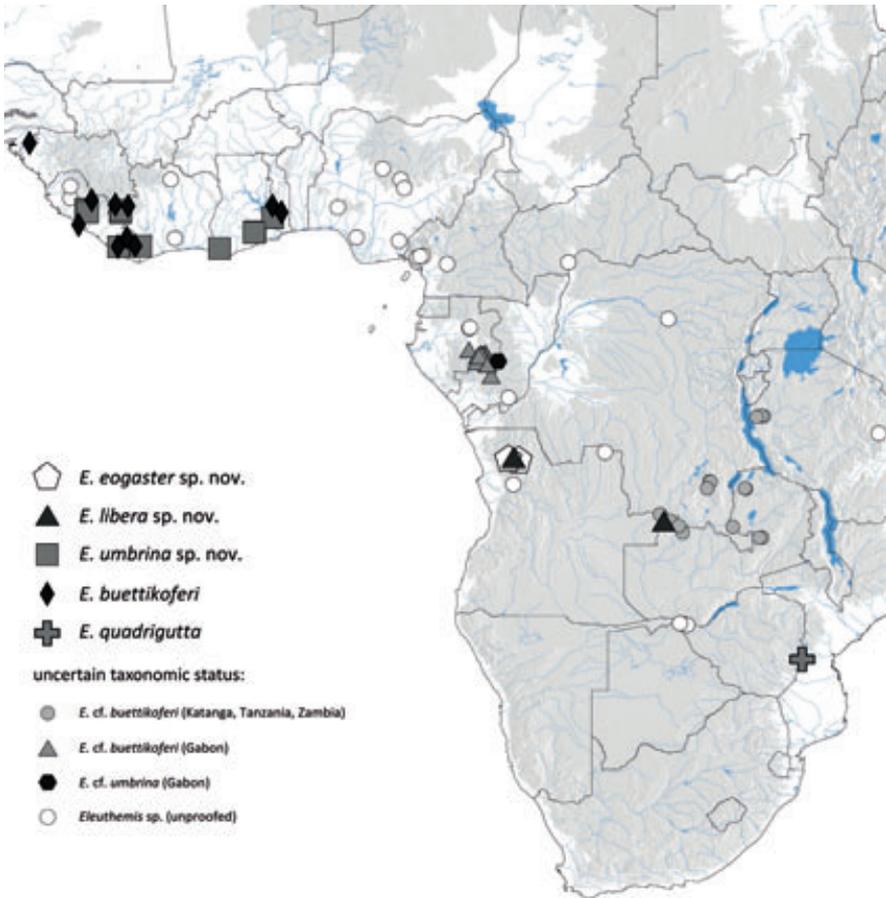


**Tree 7.** 50 % majority rule consensus of 1 000 trees from Maximum Likelihood analysis for *Eleuthemis* and two outgroup taxa. For relevant branches posterior probabilities from Bayesian inference analysis are shown first, as is bootstrap support (both as percentages).

### Material studied

**Holotype** ♂. RMNH.INS.559490, Angola, Uíge Province, 8 km N of Quitexe, Lumanie river (tributary of Loge) near Quitoque, just E of Quitexe-Uíge road, forested sandy and stony river in farmbush, 677 m a.s.l. (7.8654°S 15.045°E), 30-ix-2013, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** ANGOLA (Uíge Province): 4♂ (RMNH.INS.559503), 1♀ (RMNH.INS.559488), as holotype, RMNH. 6♂ (RMNH.INS.508344,



**Map 9.** Distribution of the genus *Eleuthemis*: *E. eogaster* sp. nov., *E. libera* sp. nov., *E. quadrigutta*, *E. umbrina* sp. nov., confirmed records of *E. buettikoferi* and records of uncertain taxonomic status formerly treated as the latter.

RMNH.INS.508347), 14 km WSW of Uíge, Loge valley, Loge River and two side streams, large murky river and two clear streams in degraded lowland rainforest, 602 m a.s.l. (7.6701°S 14.9381°E), 22-xi-2012, leg. K.-D.B. Dijkstra, RMNH. 1♂, same locality, 03-x-2013, leg. K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.508296), 9 km W of Uíge, new campus site and environs, Cazenga stream SW of Cunga-Quiximba, large murky stream in farmbrush, 789 m a.s.l. (7.6196°S 14.9754°E), 16-xi-2012, leg. V. Clausnitzer & K.-D.B. Dijkstra, RMNH.

### Genetics

Seven unique haplotypes (n=8) nearest to two from Gabon whose coloration recalls *E. umbrina* (Tree 7).

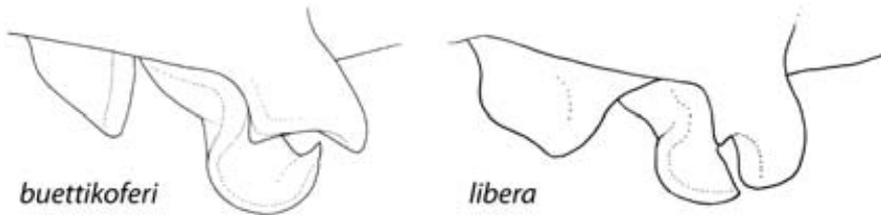
### Male morphological diagnosis

Morphologically like *E. buettikoferi* by (a) the moderate size, Hw 25.2–26.5 mm (n=3); (b) the distinct black border to labrum; (c) Fw with darkened tip that just touches distal end of Pt; (d) the Fw discoidal field entirely



**Type Photo 44.** Holotype of *Eleuthemis eogaster* sp. nov., RMNH.

of two or more rows of cells; (e) the largely orange underside of the abdomen; (f) the largely blackish secondary genitalia; and (g) the acute tip to the hook of the hamule (like Fig. 28). However, (1) the middorsal section of the mesepisterna is brown, distinctly lighter than the blackish lateral thoracic stripes, thus contrasting weakly with the pale ante-humeral stripes; (2) the largely bright orange abdominal dorsum is unique, with S2–3 bearing basal brown smudges, S4–5 pairs of dark subbasal spots, S6–8 two sublateral black



**Figure 28.** Secondary genitalia in lateral view of two *Eleuthemis* species; *E. eogaster* sp. nov. and *E. umbrina* sp. nov. are structurally identical to *E. buettikoferi*.



**Photo 58.** *Eleuthemis eogaster*, male; Lumanie River near Uíge, Angola. Photo: KDBD (03-x-2013)

bands, while S9–10 are (largely) black, and the dark markings on S4–6 and sometimes base of S7 become covered by white pruinosity with maturity; and (3) the cerci are orange at their base, contrasting with the largely to wholly black epiproct.

### Etymology

Greek “dawn belly” refers to the unique abdominal coloration, akin to a sky with white clouds at sunrise (noun in apposition).

### Range and ecology

Common on larger streams and small rivers, typically bordered by forest, between 600 and 800 m a.s.l. south and west of Uíge in northern Angola.

## ***Eleuthemis libera* Dijkstra & Kipping sp. nov. – Free Firebelly**

(Type Photo 45, Fig. 28)

### Taxonomy

The only *Eleuthemis* species that is well-separated from all others by its secondary genitalia, which together with its highly distinct COI haplotypes suggests it is the sister-species of all remaining species. It is potentially sympatric with congeners, being found in Angola 31 km from *E. eogaster* sp. nov. and in north-western Zambia 18 km from a species that morphologically is nearest to *E. buettikoferi* but genetically distinct; see *E. eogaster* (Tree 7).

### Material studied

**Holotype** ♂. RMNH.INS.508918, Angola, Uíge Province, 13 km N of Negage, Lucunga river near Hinda, gravel river in open swamp and forest gallery, 1 200 m a.s.l. (7.6462°S 15.2598°E), 24-xi-2012, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** ANGOLA (Uíge Province): 3 ♂ (RMNH.INS.508376), as holotype, RMNH. 4 larvae (RMNH.INS.559575, RMNH.INS.559576, RMNH.INS.559577, RMNH.INS.559578), locality as holotype, 04-x-2013, leg. K.-D.B. Dijkstra, RMNH. ZAMBIA (Northwestern Province): 1 ♂ (RMNH.INS.507955), Luakera River, 20 km N of Mwinilunga, fast flowing rocky and sandy river with several cascades in gallery forest, 1 380 m a.s.l. (11.5271°S 24.4110°E), 25-ii-2010, leg. J. Kipping, CJKL.

### Genetics

Four unique haplotypes ( $n=7$ ) are the most distinct within the genus (Tree 7).

### Male morphological diagnosis

Superficially similar to *E. buettikoferi* by the abdomen being (a) entirely whitish pruinose on the upperside with maturity; and (b) largely orange on the underside. Differs from other *Eleuthemis* species by (1) the pale labrum with at most a hint of a black border; (2) the pale frons darkened basally at least anteriorly to the lateral ocelli; (3) the uniformly brown occipital triangle; (4) the dark metapleural stripe expanded markedly onto the metepisternum between the metastigma and wing bases, rather than being of fairly even width throughout; (5) the Fw discoidal field with 2 to 5 single cells, rather than entirely of two or more rows of cells, although rarely up to 4 are



**Type Photo 45.** Holotype of *Eleuthemis libera* sp. nov., RMNH. Pale abdominal pruinosity has been discolored in preservation.

single in others; (6) the largely pale brown rather than blackish secondary genitalia; (7) the relatively large and less divergent posterior branch of the genital lobe; and (8) the hook of the hamule with a right-angled rather than acute tip. Also notable are (9) the modest size, Hw 23.0–24.0 mm (n = 4) rather than 23.5–26.5 mm (n = 10); and (10) the dark tips of Fw that extend almost halfway along Pt, rather than just touching its distal end.

### Etymology

Latin “free” refers to the separate position in the genus and its Greek equivalent *eleutho* used in the genus name (feminine adjective). The name *Elethemis* was presumably derived from Liberia, the nation of freed slaves, from which the type species *E. buettikoferi* was described.

### Range and ecology

Like all *Elethemis* favours rather swift streams and rivers with overhanging trees, recorded between 1 200 and 1 400 m a.s.l. Near Negage in Angola larvae were found in an especially gravelly and fast-flowing section, while the site in north-western Zambia was also notably rapid, including waterfalls.

### ***Elethemis umbrina* Dijkstra & Lempert sp. nov. – Shadow Firebelly**

(Type Photo 46, Photos 59–60, Fig. 28)

### Taxonomy

First recognised in Liberia as a distinctly coloured ecological form of *E. buettikoferi* or possibly a good species (LEMPERT 1988). Genetic data show it is among the most distinct taxa within this formerly monotypic genus, particularly relative to the topotypical and sympatric *E. buettikoferi* (Tree 7). The characters described for *E. b. monardi* Schmidt, 1951 from nearby Guinea-Bissau agree with the latter.

### Material studied

**Holotype** ♂. RMNH.INS.501604, Liberia, Grand Gedeh County, Putu Iron Ore Mining concession, Jebeh River at Johnsonville, sandy forested river (Photo 60), 216 m a.s.l. (5.6329°N 8.1413°W), 10-ii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH.

**Further material.** GHANA (Eastern Region): 3♂, Asikam Gold Mine and Wankobi stream, 291 m a.s.l. (6.2017°N 0.5365°W), 19-vi-2016, leg. K.-D.B. Dijkstra, RMNH. 2♂, Asiakwa, rocky stream SW of Asiakwa, 264 m a.s.l. (6.2533°N, 0.5130°W), 09-v-2000, leg. K.-D.B. Dijkstra, RMNH. GHANA (Western Region): 4♂, bridge over Ankasa River near tourist camp, 60 m a.s.l. (5.215°N 2.650°W), 09-iv-2000, leg. K.-D.B. Dijkstra, RMNH. GHANA (Volta Region): 3♂ 1♀, Agumatsa River between Wli Waterfalls and village, 261 m a.s.l. (7.1167°N 0.5833°E), 26-iv-2000, leg. K.-D.B. Dijkstra, RMNH. LIBERIA (Grand Gedeh County): 2♂ (RMNH.INS.501603), as holotype, RMNH. 1♂, several larvae (RMNH.INS.501503), Putu Iron Ore Mining concession, Sawleh river (main stream of central valley between Mts Ghi and Jideh) between Jackson's and Biodiversity Camps, small sandy and gravelly river in somewhat disturbed rainforest, 266 m a.s.l. (5.6592°N 8.1979°W), 21-i-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. 2 larvae (RMNH.INS.501622), W of Jawordee, muddy, sandy and gravelly stream, part forested, part open with aquatic vegetation, 208 m a.s.l. (5.6167°N 8.3260°W), 12-ii-2011, leg. K.-D.B. Dijkstra, RMNH. LIBERIA (Nimba County): 3♂, northern bank Yah (Dayea) River near Gbapa, Gbaleh Creek, calm sandy river in cocoa plantations, 470 m a.s.l. (7.507°N 8.638°W), 07-x-2010, leg. K.-D.B. Dijkstra, RMNH. 1♂, Lugbeyee-Bonlah Road, stream on eastern side of Bonlah, large, gravelly and sandy stream in farmbush, 437 m a.s.l. (7.507°N 8.638°W), 13-x-2010, leg. K.-D.B. Dijkstra, RMNH. 2♂ (RMNH.INS.501416), same locality, 04-i-2010, leg. K.-D.B. Dijkstra, RMNH. LIBERIA (Grand Gedeh County): 2♂, Cavalla River, 33 km E of Zwedru, 206 m a.s.l. (6.083°N 7.83°W), 03-05-iii-1982, leg. & coll. J. Lempert. 1♂, Dugbi River, 24 km E of Zwedru, 224 m a.s.l. (6.083°N 7.83°W), 19-xi-1983, leg. & coll. J. Lempert. SIERRA LEONE (Eastern Province): 1♂, 1 larva, Gola Forest, Gagbe stream, 1 km W of Mogbaima, parts in forest, parts in disturbed area with diamond pits, 136 m a.s.l. (7.6574°N 10.7788°W), 02-iii-2011, leg. K.-D.B. Dijkstra, RMNH. 1♂, Gola Forest, Mogbai River upstream from Mogbaima, mostly gravelly and rocky river in forest, 139 m a.s.l. (7.6596°N 10.7676°W), 03-iii-2011, leg. K.-D.B. Dijkstra, RMNH. 2♂ (RMNH.INS.503110), Gola Forest, Wibwa (Wegbua) stream at Mayengema, 152 m a.s.l. (7.6426°N 10.7898°W), 01-iii-2011, leg. K.-D.B. Dijkstra, RMNH.

### Genetics

Four unique haplotypes ( $n = 6$ ) form the sister-group of all other *Eleuthemis* species except *E. libera* sp. nov. (Tree 7).

### Male morphological diagnosis

Morphologically like *E. buettikoferi* with (a) moderate size, Hw 24.5–26.0 mm ( $n = 3$ ); (b) the distinct black border to labrum; (c) the vertex and occipital triangle blackened at least basally; (d) the Fw discoidal field entirely of two or more rows of cells; (e) the abdomen being entirely whitish pruinose on the upperside with maturity; (f) the largely blackish secondary genitalia; and (g) the acute tip to the hook of the hamule (like Fig. 28). However, (1) the ventral portions of the sternites of S1–9 are yellow marked with black on the ventral carinae up to the (largely) black S9, rather than orange with black carinae at most up to S5, with S9 largely orange (Photo 59). While both species vary strongly, the new species also tends to have



**Type Photo 46.** Holotype of *Eleuthemis umbrina* sp. nov., RMNH (horizontally mirrored from original).



**Photo 59.** Abdomen undersides of (a) *Eleuthemis umbrina* sp. nov. and (b) *E. buettikoferi* from Liberia. Photo: KDBD (10-ii-2011)



**Photo 60.** Jebeh River at Johnsonville, Liberia. Type locality of *Eleuthemis umbrina* that perches in the shade, while *E. buettikoferi* was found in the sunny parts in the background. Photo: KDBD (16-ii-2011)

(2) the frons darkened at the base of its central furrow, anterior to the median ocellus, and not entirely pale brown; (3) more contrasting black and yellow thoracic markings with usually a black line along the humeral suture's full length, thus not absent on its ventral section, and the black stripe on the metepimeron dead-ended dorsally, i.e., not curving forward to (almost) join the metapleural black line; and (4) the dark tips of Fw are less sharply defined and extend below Pt, rather than just touching its distal end, while Hw tips are often more darkened too.

### Etymology

Latin "of shade" refers to the darker habitat and abdominal underside of the species (feminine adjective).

### Range and ecology

Largely sympatric with *E. buettikoferi* between 100 and 500 m a.s.l. from Sierra Leone to Ghana, inhabiting shady rather than sunny sections of often the same forested streams and rivers.

### ***Malgassophlebia andzaba* Dijkstra & Mézière sp. nov. – Redwater Leaftipper**

(Type Photo 47, Photos 26, 61–62, Fig. 29)

### Taxonomy

DIJKSTRA (2007) reduced the genus *Malgassophlebia* Fraser, 1956 to two Madagascan and two African species, the widespread *M. bispina* Fraser, 1958 and Gabonese *M. westfalli* Legrand, 1986. The current taxon is sympatric with both and seems nearest to *M. westfalli*, but its genetics and morphology are clearly distinct.

### Material studied

**Holotype** ♂. RMNH.INS.508883, Gabon, Haut-Ogooué Province, Batéké Plateau, Léconi Valley, Eaux Claires, Camps des Pygmés, sandy streams (1 m and 4–5 m wide) at forest edge, 434 m a.s.l. (1.4549°S 14.1785°E), 30-ix-2013, leg. N. Mézière, J. Kipping & H. Krahnstöver, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♂ (RMNH.INS.508878), 3♀ (RMNH.INS.508867), as holotype, RMNH. 1♀, same

locality, 26-x-2013, leg. N. Mézière, RMNH. 1♀ (RMNH.INS.508141), same locality, 29-ix-2013, leg. J. Kipping, CJKL. 1♂ 1♀, Bongoville-Léconi road, 5 km after Bongoville toward Léconi, Andzaba River, Ekala, sandy and swampy stream, 389 m a.s.l. (1.6319°S 13.8888°E), 28-iii-2010, leg. N. Mézière & J. Renoult, RMNH. 1♂ 1♀, Bongoville-Léconi road after Ekala, old village of Boubou, stream (2 m wide) with gravel bottom, 393 m a.s.l. (1.6114°S 13.9105°E), 07-ii-2010, leg. N. Mézière, RMNH. 1♀, Franceville-Akieni road, near Oyou, sandy forest stream, 452 m a.s.l. (1.3539°S 13.7766°E), 22-ix-2014, leg. J. Kipping, CJKL. GABON (Ogooué-Ivindo Province): 1♀, Okondja-Makokou road, 5 km SE of Bakouaka, sandy forest stream, 531 m a.s.l. (0.1298°N 13.6772°E), 23-ix-2014, leg. J. Kipping, CJKL.



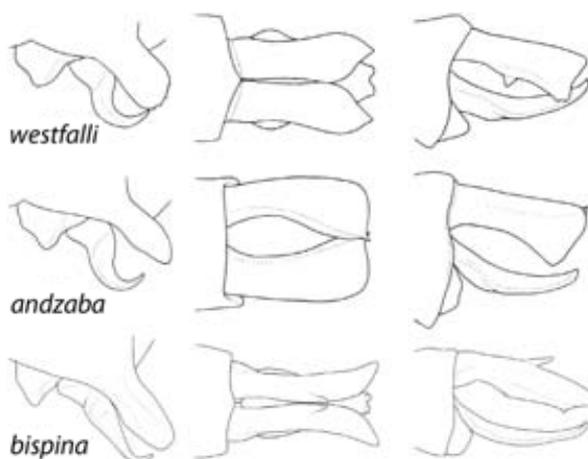
**Type Photo 47.** Holotype of *Malgassophlebia andzaba* sp. nov., RMNH (horizontally mirrored from original).

### Genetics

Three unique haplotypes ( $n = 4$ ) are very distinct but nearest to *M. westfalli* and *M. bispina*.

### Male morphological diagnosis

Nearest sympatric *M. westfalli* by (a) the dark brown to black rather than yellow pronotal hindlobe; (b) the triangular rather than quadrangular Fw discoidal cell, i.e., the sector of the arculus joins it at its distal corner rather than about halfway along the anterior vein; (c) at least partly two rows of cells in the Fw discoidal field proximal to the node, rather than entirely one row from base to beyond node; (d) 6–10 cells in the anal loop, rather than only 3–4; (e) the gradually curved rather than abruptly subapically bent hamule; and (f) the terminally expanded and truncated cerci in lateral view (Fig. 29). However, has (1) slightly smaller size, Hw 25.0–26.0 mm ( $n = 3$ ) rather than 27.0–29.0 mm ( $n = 5$ ); (2) the black on the labium not expanded laterally of the central lobe; (3) a pale brown rather than black occipital triangle, base of vertex and base of frons; (4) 6–7 cells in the anal loop, not 9–10; (5) the apical border of the genital lobe pointed and smooth, instead of broadly rounded bearing 3–6 denticles (Fig. 29); (6) the dorsal carina of S4–8 yellowish brown rather than black; (7) the abdomen barely expanded and widest on S7, with S8 longer than wide, instead of distinctly clubbed and widest on S8, which is wider than long; (8) the cerci lacking a small



**Figure 29.** Secondary genitalia in lateral view (left) and male appendages in dorsal (middle) and lateral view (right) of the continental African *Malgassophlebia* species.

ventral process at mid-length, well-separated rather than closely apposed in middle, truncated rather than pointed in dorsal view, and bearing an internal spine at their apex; and (9) a narrower epiproct whose base is eclipsed by the cerci in dorsal view and whose apical cleft and tips are triangular rather than rounded (Fig. 29).



**Photo 61.** *Malgassophlebia andzaba*, male; near Akieni, Gabon. Photo: NM (20-ix-2014)



**Photo 62.** Andzaba Stream near Bongo-ville at the foot of the Batéké Plateau, Gabon. Habitat of *Malgassophlebia andzaba*, *Elattoneura aurifex*, *Pseudagrion aureolum*, and *Lestinogomphus venustus*. Photo: NM (28-iii-2010)

### Etymology

The name means 'red water' to the Batéké people of Gabon, alluding to the colour of the streams that flow off the sandy plateau they and the new species inhabit (noun in apposition).

### Range and ecology

Only known from streams in gallery forest between 350 and 450 m a.s.l. on and at the foot of the Batéké Plateau in south-eastern Gabon, where perches high on leaves or twigs. Found more easily while resting in shady spots on the forest edge. By contrast, *M. westfalli* is found flying rapidly along the stream banks in rainforest.

### ***Neodythemis infra* Dijkstra, Diedericks & Mézière sp. nov. – Blackwater Junglewatcher**

(Type Photo 48, Photos 52, 70, Fig. 30)

### Taxonomy

This rather nondescript species is easily overlooked, but the combination of morphological features that superficially recalls the related genus *Micro-macromia* Karsch, 1890 is unique in *Neodythemis* Karsch, 1889, as are the COI sequences.

### Material studied

**Holotype** ♂. RMNH.INS.508825, Gabon, Haut-Ogooué Province, Bongo-ville-Léconi road, Ekala, herbaceous swamp close to Boubou River (Photo 70), 421 m a.s.l. (1.6116°S 13.9116°E), 19-v-2013, leg. N. Mézière, J. Renoult & J. Lekogo, RMNH.

**Further material.** CONGO-BRAZZAVILE (Sangha Region): 1♂, 61 km NE of Queso, blackwater swamp on sand in half open forest, 353 m a.s.l. (1.9501°N 16.4899°E), 19-ix-2014, leg. & coll. G. Diedericks. 1♂, 59 km NE of Queso, forest road with stagnant blackwater on sand, 373 m a.s.l. (1.9441°N 16.4699°E), 25-ix-2014, leg. & coll. G. Diedericks. CONGO-KINSHASA (Province Orientale): 1♀ (RMNH.INS.502275), Lilanda & Baombo streams at and upstream of Lilanda & Yafake villages, sandy clear and blackwater streams and river, 390–450 m a.s.l. (0.83°S 24.34°E), 04-v-2010, leg. K.-D.B. Dijkstra, RMNH.

### Genetics

Two unique haplotypes ( $n=2$ ) are very distinct but nearest to *N. klingi* (Karsch, 1890).

### Male morphological diagnosis

Combines characters of three sympatric *Neodythemis* species. Recalls *N. preussi* (Karsch, 1891) by (a) the broad and complete pale ante-humeral stripes; and (b) the absence of black interpleural stripes, although there is a small dark smudge at the dorsal border of the metastigma (Fig. 30). Similarly to that species and *N. klingi* has (c) Fw discoidal field of 1 cell-row at and distal of node, and 2 cells wide on wing border; (d) 4 cells in Hw anal loop; (e) 1 Cux in Fw and 2 in Hw; (f) 0 cross-veins in Fw triangle and 1 in Hw; (g) 12–14 Ax in Fw. Similarly to the latter and *N. afra* (Ris, 1909) has (h) black central lobe and inner borders of the lateral lobes of the labium; (i) the hook of hamule lying in a horizontal plane, not erect, and thus invis-

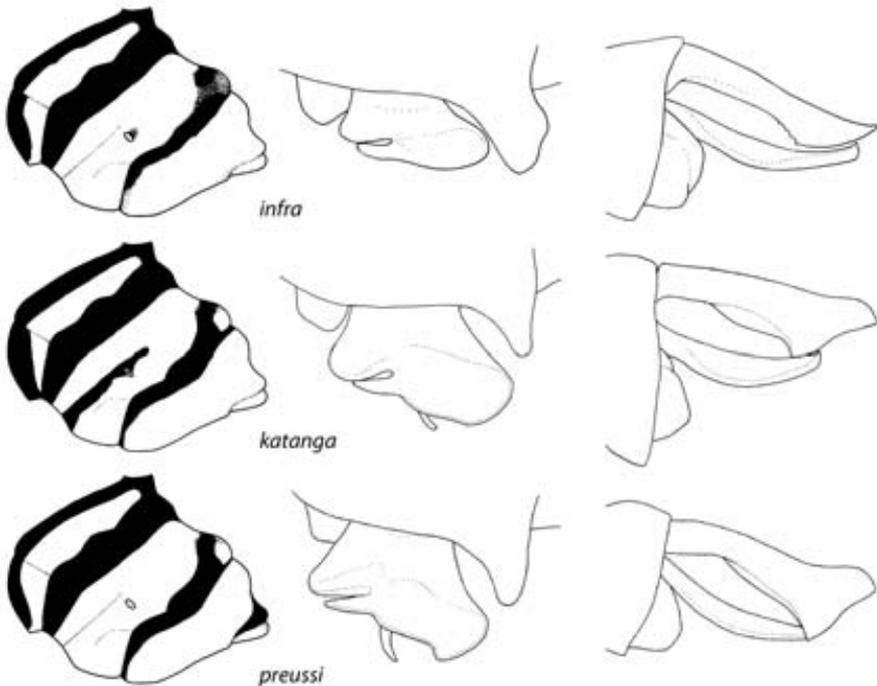


**Type Photo 48.** Holotype of *Neodythemis infra* sp. nov., RMNH.

ible in lateral view; and (j) slender apices of the cerci (Fig. 30). Also notably small, Hw 22.2–24.3 mm ( $n = 3$ ) at low end of 22.0–31.0 mm range of genus, and has brown rather than blackish Pt as is usual in the genus. Also recalls *Micromacromia*, especially *M. camerunica* Karsch, 1890 and *M. zygoptera* (Ris, 1909), but differs by the presence of an anterior cleft on the hamule (the most reliable character for *Neodythemis*) and in details of the markings and venation, as well as the wholly black labrum (see DIJKSTRA & VICK 2005).

### Etymology

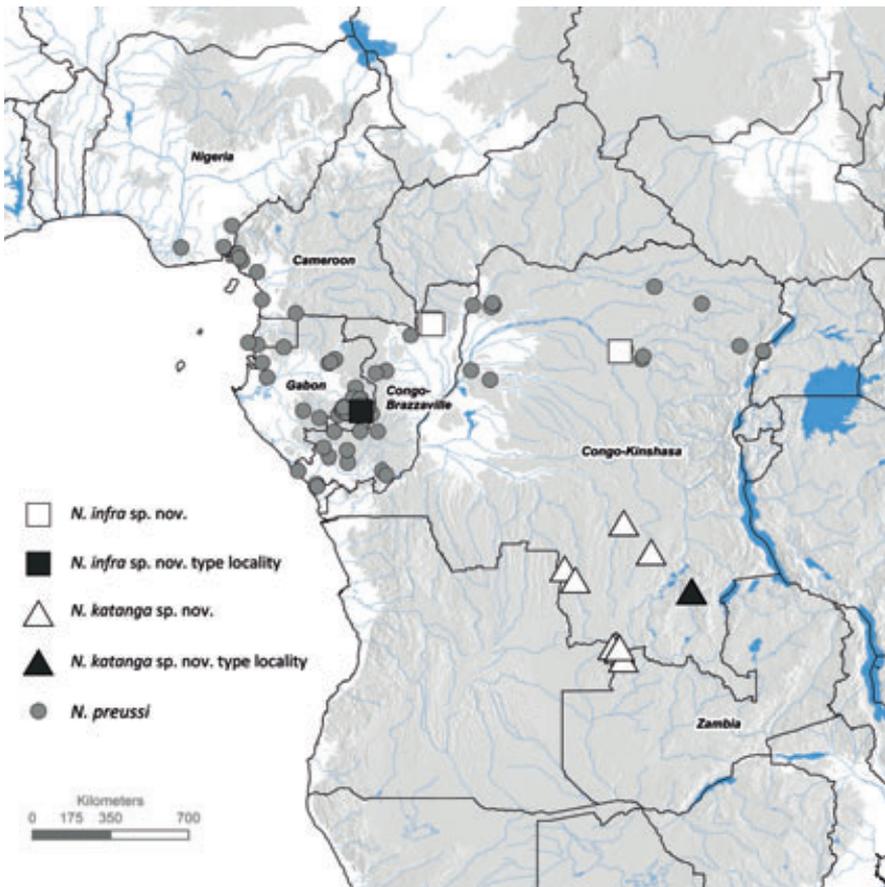
As the new species is small and easily overlooked, its name is a pun based on the species name of *N. afra* and the Latin word for “below”, which is to be treated as a noun in apposition.



**Figure 30.** Thorax (left), secondary genitalia (middle) and male appendages (right) in lateral view of three *Neodythemis* species.

### Range and ecology

The holotype perched two metres above a swamp in gallery forest on the Batéké Plateau in Gabon (Photo 70). The Congo-Kinshasa female was caught at a sandy blackwater forest stream and is genetically nearer to the holotype, but lacks the metapleural black stripe. The Congo-Brazzaville males confirm that this species favours blackwater swamps on sandy soils between 350 and 450 m a.s.l (Map 10).



**Map 10.** Distribution of *Neodythemis infra* sp. nov., *N. katanga* sp. nov. and *N. preussi*.

***Neodythemis katanga* Dijkstra & Kipping sp. nov. –  
Katanga Junglewatcher**

(Type Photo 49, Photos 63–64, Fig. 30)

**Taxonomy**

DIJKSTRA & VICK (2006) illustrated this as »*N. preussi* Katanga«. Genetically and morphologically very close to *N. preussi*, the taxon is probably its southern counterpart, but differs in sufficient detail to be described as a new species, and treated as such by DIJKSTRA & CLAUSNITZER (2014).

**Material studied**

**Holotype** ♂. RMNH.INS.505522, Congo-Kinshasa, Katanga, Upemba National Park, Lusinga valley 3 km E of park headquarters (Photo 64), stream with patches of gallery and swamp forest, open swamp and arable fields, 1 570–1 590 m a.s.l. (8.93°S 27.23°E), 13-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** CONGO-KINSHASA (Katanga): 5♂ (RMNH.INS.505456), 1♀ (RMNH.INS.505459), Upemba National Park, source area of Lusinga near park headquarters, spring streams in gallery forest and adjacent bog, dam and channel, 1 760–1 800 m a.s.l. (8.93°S 27.23°E), 11–15-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 1♂, Kapanga, v-1933, leg. G.F. Overlaet, MRAC. 2♀, Kabinda, xii-1952, leg. Ch. Seydel, MRAC. 2♂ 2♀, Kabongo, xii-1952, Ch. Seydel, MRAC. 1♂, Lulua, Kapelekese Riv., 1933, leg. G.F. Overlaet, MRAC. ZAMBIA (Northwestern Province): 1♂ 1♀, Sakeji Mission School, E of Ikelenge, seepages and spring brook in dense gallery forest, 1 390 m a.s.l. (11.2320°S 24.3093°E), 24-xi-2014, leg. J. Kipping, CJKL.

**Genetics**

One unique haplotype (n = 3) nearest to six of *N. preussi* (n = 10).

**Male morphological diagnosis**

Similar to *N. preussi* by (a) fairly small size, Hw 26.0–28.0 mm (n = 8); (b) the largely yellow labium; (c) the broad and complete pale ante-humeral stripes; (d) 14–15 Ax in Fw; (e) Fw discoidal field of 1 cell-row both at and distal to the node, 2–3 cells wide on wing border; (f) 0 cross-veins in Fw triangle and 0–1 in Hw; (g) 1 Cux in Fw and 2 in Hw; (h) 3–4 cells in Hw anal loop; (i) the hook of hamule raised and thus visible in lateral view; and (j) the thick-

ened apex of cerci (Fig. 30). However, has (1) a narrow black stripe running through the metastigma towards the middle leg; (2) the metepimeron posteriorly only rarely black (Fig. 30); (3) the pale spots of S7 merged across the dorsal carina; and (4) cerci with a more slender apex and less pronounced ventral angle, which the tip of the epiproct surpasses clearly (Fig. 30).

### Etymology

Named after Katanga province where the species was discovered (noun in apposition).

### Range and ecology

Confused with *N. preussi* that it seems to replace south of the central African rainforests, occurring at greater elevation between about 900 and 1 800 m



**Type Photo 49.** Holotype of *Neodythemis katanga* sp. nov., RMNH.

a.s.l. at forested spring areas surrounded by grass- or woodland in Katanga and northern Zambia (Map 10).



**Photo 63.** *Neodythemis katanga*, male; Lusinga, Upemba National Park, Katanga, Congo-Kinshasa. Photo: KDBD (15-xi-2011)

**Photo 64.** Lusinga Valley in Upemba National Park, Katanga, Congo-Kinshasa. Habitat of *Notogomphus intermedius* and *Neodythemis katanga*. Photo: KDBD (10-xi-2011)



***Orthetrum agaricum* Dijkstra sp. nov. – Western Mushroom Skimmer**

(Type Photo 50, Photos 65–66, Fig. 31)

**Taxonomy**

Although their morphology did not initially suggest it, three new *Orthetrum* species first recognised in the field were found to be genetically close to each other and *O. saegeri* Pinhey, 1966 (Tree 8). The latter species itself comprised of two geographically distinct groups, which differ in details of the hamule and markings. All species in this *saegeri*-group are rather small and slender, occurring locally in cooler (shaded or elevated) habitats with much organic material (e.g., peat moss, leaf litter) and little open water.

**Material studied**

**Holotype** ♂. RMNH.INS.501573, Liberia, Grand Gedeh County, Putu Iron Ore Mining concession, 3 km south of Slabbertsville camp, sandy stream in rainforest, 233 m a.s.l. (5.6366°N 8.1674°W), 03-ii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH.

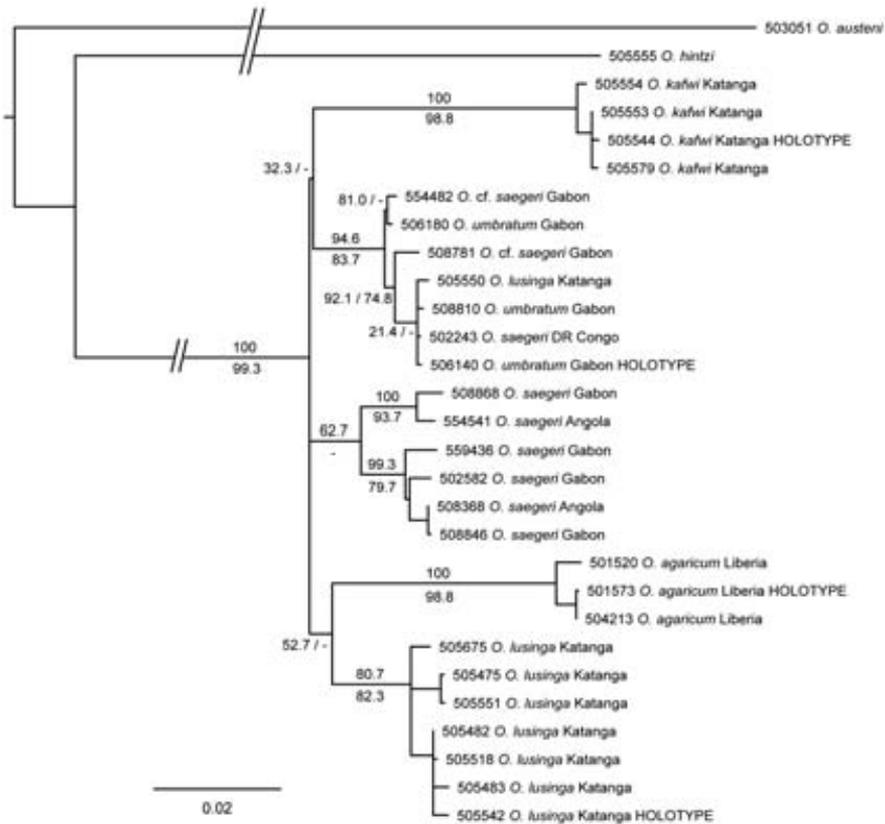
**Further material.** GHANA (Eastern Region): 1♂, N of Kibi, Atewa Range Forest Reserve, Obeng-ne-obeng stream, 637 m a.s.l. (6.2342°N 0.5675°W), 20-vi-2006, leg. K.-D.B. Dijkstra, RMNH. LIBERIA (Grand Gedeh County): 4♂, as holotype, RMNH. 1♂, as holotype, CJKL. 1♂ (RMNH.INS.501520), Putu Iron Ore Mining concession, Biodiversity Camp, sandy and gravelly streams and muddy seepage in rainforest, 299 m a.s.l. (5.6592°N 8.2041°W), 22-i-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. 1♂, Putu Iron Ore Mining concession, swamp south of Mt Montroh, dammed swamp and feeder stream and springs in rainforest, 215 m a.s.l. (5.6845°N 8.1392°W), 14-ii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH. LIBERIA (Nimba County): 1♀ (RMNH.INS.504213), Mt Tokadeh, north of corner swamp, road edge in rainforest, 676 m a.s.l. (7.4661°N 8.6650°W), 20-iii-2011, leg. K.-D.B. Dijkstra, RMNH.

**Genetics**

Three unique haplotypes ( $n = 3$ ) with no evidence that this species is nearer to *O. saegeri* than to other species in the group (Tree 8).

### Male morphological diagnosis

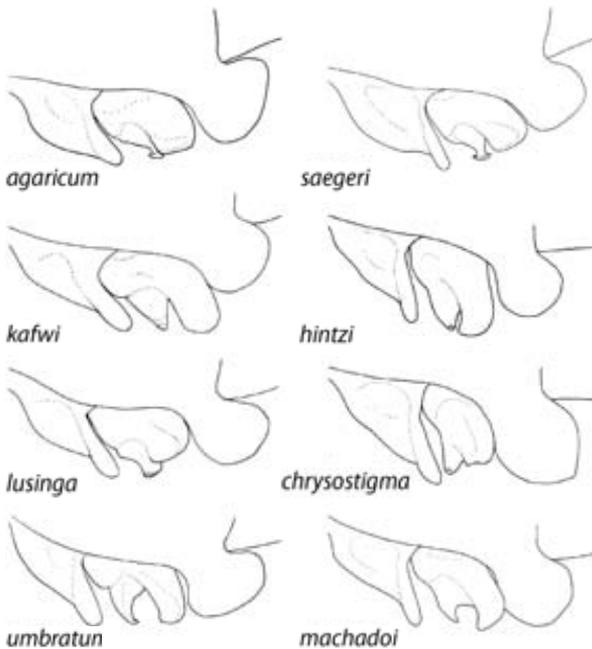
Nearest to its eastern counterpart *O. saegeri* by (a) moderate size, Hw 29.5–30.5 mm (n = 7); (b) the absence of cell-doublings in the radial planate and thus a single row of cells there; (c) all subcostal Ax dark; (d) the medium-sized dark brown Pt that are 10–11 % of Hw length, 3.0–3.3 mm; (e) Hw base faintly yellow, but never with a dark brown patch; (f) the slender abdomen, though shorter than Hw; and (g) the hamule excised anteriorly, with expanded hood- or mushroom-like hook that is turned outward, hugging and



**Tree 8.** COI gene tree from Bayesian inference analysis for the *saegeri*-group of *Orthetrum* and two outgroup taxa. For relevant branches posterior probabilities are shown first, as is bootstrap support from a 50 % majority rule consensus of 1 000 trees from Maximum Likelihood analysis (both as percentages).



**Type Photo 50.** Holotype of *Orthetrum agaricum* sp. nov., RMNH.



**Figure 31.** Secondary genitalia in lateral view of the *saegeri*-group of *Orthetrum* and three similar species.

often partly concealed by the lobe (Fig. 31). When not pruinose also similar by (h) the dorsa of S4–6 bearing pairs of pale subapical spots that lie closer to the dorsal than lateral carinae, while the appendages often remain pale. However, (1) the anterior excision at the base of the hood-like hamule hook has a straight rather than sigmoid profile; and (2) the out-turned part of the



**Photo 65.** *Orthetrum agaricum*, immature male without pruinosity on abdomen; Putu, Liberia. Photo: KDBD (14-ii-2011)



**Photo 66.** Forest swamp below Putu Range, Liberia. Habitat of *Orthetrum agaricum*. Photo: KDBD (14-ii-2011)

hamular hook is less than twice as long as wide in ventral view, rather than well over (Fig. 31). When not pruinose also (3) only S4–6 have distinct pale subapical spots and S7 is black at most with hint of a spot, while *O. saegeri* typically has a similar spot there as on S4–6.

### Etymology

Latinised form of the Greek *agarikon* (“mushroom”) refers to the distinctive shape of the hamule’s hook (noun in apposition).

### Range and ecology

Replaces *O. saegeri* from Liberia to Ghana and possibly also Nigeria, recorded at similar rainforest habitat between 200 and 700 m a.s.l. (Map 11). Males were either found flying rapidly over streams or perching by shaded swamps with much detritus.

### *Orthetrum kafwi* Dijkstra sp. nov. – Bog Skimmer

(Type Photo 51, Photo 67, Fig. 31)

### Taxonomy

Morphologically similar to *O. hintzi* Schmidt, 1951 among which it was discovered, but genetically closer to the *saegeri*-group (see *O. agaricum* sp. nov.), which includes the also syntopic *O. lusinga* sp. nov. (Tree 8). Treated as a distinct species by DIJKSTRA & CLAUSNITZER (2014).

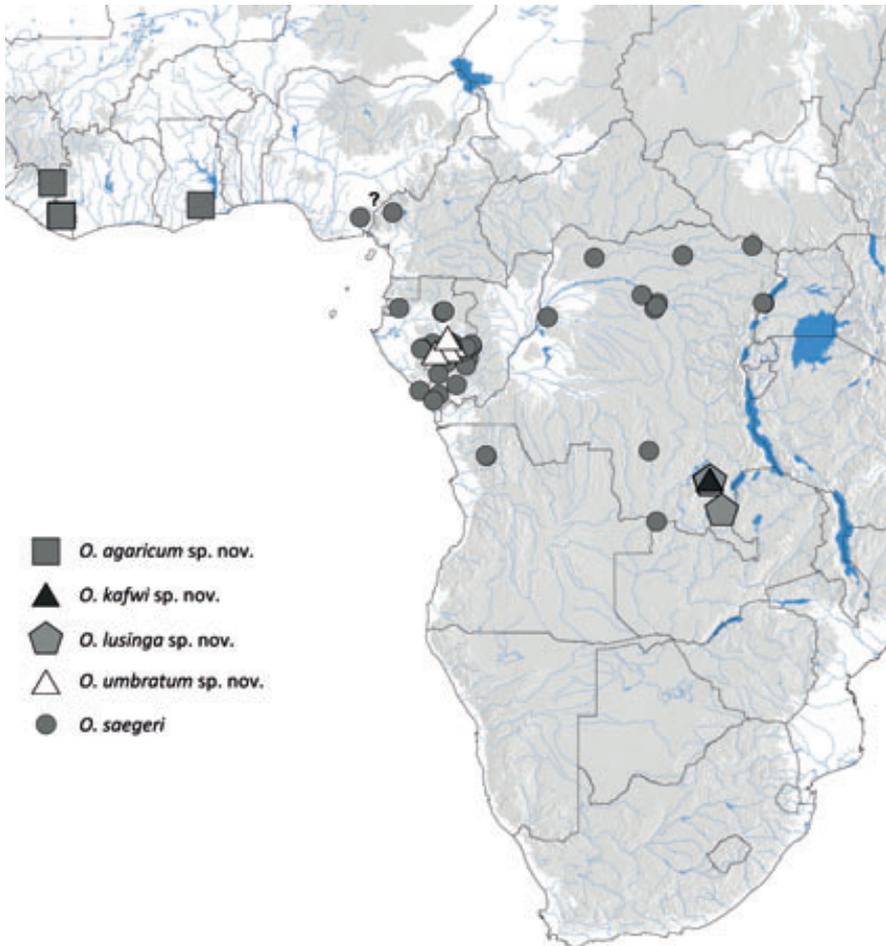
### Material studied

**Holotype** ♂. RMNH.INS.505544, Congo-Kinshasa, Katanga, Upemba National Park, Kabwekanono, source area of Kafwi, stream through gallery forest and bogs in open grassy plains (Photo 67), 1 770–1 820 m. a.s.l. (8.937°S 27.166°E), 15-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** CONGO-KINSHASA (Katanga): 4♂ (RMNH.INS.505554, RMNH.INS.505579), 2♀ (RMNH.INS.505553), 2♂♀, as holotype, RMNH. 1♂ 1♀, Upemba National Park, source area of Lusinga near park headquarters, spring streams in gallery forest and adjacent bog, dam and channel, 1 760–1 800 m a.s.l. (8.933°S 27.199°E), 11-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

### Genetics

One unique haplotype (n=4) is perhaps the most distinct within *saegeri*-group (Tree 8).



**Map 11.** Distribution of the *saegeri*-group of *Orthetrum* (*O. agaricum* sp. nov., *O. kafwi* sp. nov., *O. lusinga*, *O. umbratum* sp. nov. and *O. saegeri*).

### Male morphological diagnosis

Recalls the widespread and syntopic *O. hintzi* by (a) small size, Hw 23.7–26.0 mm (n = 6); (b) the absence of cell-doublings in the radial planate and



**Type Photo 51.** Holotype of *Orthetrum kafwi* sp. nov., RMNH. Pale abdominal pruinosity has been partly discolored in preservation.

**Photo 67.** Bog at the source of the Kafwi River on the Kibara Plateau in Upemba National Park, Katanga, Congo-Kinshasa. Both *Orthetrum kafwi* and *O. lusinga* were found here. Photo: KDBD (15-ii-2011)



thus a single row of cells there; (c) the pale subcostal Ax; (d) the large pale Pt that are about 13–14 % of Hw length, 3.2–3.5 mm; and (e) the narrow space between the triangular and out-turned hook and prominent lobe of the hamule (Fig. 31). When not pruinose also similar by (f) the absence of a black line on the metepimeral carina; (g) the dorsa of S4–10 yellow with black lateral halves; and (h) the cerci always dark. However, (1) the frons anterior to the vertex, as well as the labium, is always pale and never marked with black; and (2) the hamule has a straight rather than convex anterior border, ending in a slender hook that is distinctly longer rather than shorter than it is wide at the point where it turns outward when seen in ventral view (Fig. 31). Also, when not yet pruinose (3) the dorsal carina of S3–9 is always marked with a thin black line.

### Etymology

Named after the Kafwi River, of which the type locality is the source (noun in apposition). The name also mimics the genitive suffix of most related species.

### Range and ecology

Found between 1 760 and 1 820 m a.s.l. at boggy areas bordering forest patches on the otherwise grassy Kibara Plateau in Upemba National Park, Katanga (Map 11).

### *Orthetrum lusinga* Dijkstra sp. nov. – Spring Skimmer

(Type Photo 52, Photo 67, Fig. 31)

### Taxonomy

Genetically nearest to the *saegeri*-group (see *O. agaricum* sp. nov.), which includes the syntopic *O. kafwi* sp. nov. (Tree 8), but has a distinctive hamule shape and is coloured very differently with limited black markings. Treated as a distinct species by DIJKSTRA & CLAUSNITZER (2014).

### Material studied

**Holotype** ♂. RMNH.INS.505542, Congo-Kinshasa, Katanga, Upemba National Park, source area of Lusinga near park headquarters, spring streams

in gallery forest and adjacent bog, dam and channel, 1 760–1 800 m a.s.l. (8.933°S 27.199°E), 15-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** CONGO-KINSHASA (Katanga): 4♂ (RMNH.INS.505475, RMNH.INS.505483, RMNH.INS.505518), 1♀ (RMNH.INS.505482), as holotype, RMNH. 1♂ (RMNH.INS.505550), 2♀ (RMNH.INS.505551), Upemba National Park, Kabwekanono, source area of Kafwi, stream through gallery forest and bogs in open grassy plains, 1 770–1 820 m a.s.l. (8.937°S 27.166°E), 15–16-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 2♂ (RMNH.INS.505675), Kundelungu National Park, source area of Lutshipuka, grassy plateau with pools, bog, wet meadows and gallery forest patches, 1 680–1 705 m a.s.l. (10.58°S 27.83°E), 23–24-xi-2011, leg K.-D.B. Dijkstra, RMNH.

### Genetics

Four unique haplotypes (n = 7) are distinct from other *saegeri*-group species, but one unique haplotype (n = 1) is similar to *O. umbratum* sp. nov. (Tree 8).



**Type Photo 52.** Holotype of *Orthetrum lusinga* sp. nov., RMNH (horizontally mirrored from original).

**Male morphological diagnosis**

Recalls the widespread *O. guineense* Ris, 1910 and sympatric *O. machadoi* Longfield, 1955 by (a) moderate size, Hw 28.0–30.8 mm (n=7); (b) the absence of cell-doublings in the radial planate and thus a single row of cells there; (c) the pale subcostal Ax at least proximally, although they can be notably dark; and (d) the medium-sized pale brown Pt that are 10–11 % of Hw length, 2.8–3.3 mm. When not pruinose also similar by (e) the thorax lacking whitish stripes; (f) all abdominal segments being brown and variably but generally quite narrowly black on the dorsal carina of S3–9 and lateral carinae of S3–8; and (g) the always dark cerci. However, (1) the hook of the hamule has a concave anterior border and a broad and outward-turned tip lying closely against the rather low lobe, i.e., similar to *O. chrysostigma* (Burmeister, 1839) but with the sigmoid anterior profile of *O. saegeri* (Fig. 31). When not yet pruinose also (2) unlike *O. guineense* lacks a black line on the ventral carina of the metepimeron; and (3) unlike *O. machadoi* S6–8 are only narrowly black on the lateral carinae and S9–10 are largely brown rather than black.

**Etymology**

Named after the headquarters of Upemba National Park at the source of the Lusinga stream, the species' type locality (noun in apposition).

**Range and ecology**

Found between 1 680 and 1 820 m a.s.l. at boggy spring areas bordering or enclosed by forest on the otherwise grassy Kibara and Kundelungu Plateaus of Katanga (Map 11).

***Orthetrum umbratum* Dijkstra & Mézière sp. nov. – Shadow Skimmer**

(Type Photo 53, Photo 68, Fig. 31)

**Taxonomy**

Morphologically and ecologically similar to *O. saegeri* (see *O. agaricum* sp. nov.), but differs clearly in the shape of the hamule. May genetically be distinct from sympatric *O. saegeri*, but this is not entirely resolved (see below).

### Material studied

**Holotype** ♂. RMNH.INS.506140, Gabon, Haut-Ogooué Province, Moanda-Lastoursville road about 4 km after Moukoumbi, roadside stream, swamp, forest and spring, 532 m a.s.l. (1.0836°S 12.8923°E), 10-iii-2012, leg. N. Mézière, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 5♂ (RMNH.INS.506180), as holotype, RMNH. 1♂ (RMNH.INS.508810), Bakoumba, Parc de la Lékédi, Module 3, sandy forest stream (1–2 m wide, 20 cm deep) with bordering seep, sources and ponds, 577 m a.s.l. (1.7437°S 12.9354°E), 08-v-2013, leg. N. Mézière & J. Renoult, RMNH.

### Genetics

Five unique haplotypes (n=7) are quite distinct from five of *O. saegeri* (n=6), but aside from three samples of *O. umbratum* this group includes one of *O. lusinga* sp. nov., one of *O. saegeri* from central Congo-Kinshasa, and two unverified samples of *O. saegeri* from Gabon (Tree 8).



**Type Photo 53.** Holotype of *Orthetrum umbratum* sp. nov., RMNH.

**Male morphological diagnosis**

Recalls the sympatric *O. saegeri* by (a) moderate size, Hw 27.5–31.0 mm ( $n=7$ ); (b) the absence of cell-doublings in the radial planate and thus a single row of cells there; (c) all subcostal Ax dark; (d) medium-sized dark brown Pt that are about 11 % of Hw length, 3.0–3.4 mm; (e) Hw base faintly yellow, but never with a dark brown patch; and (f) abdomen slender, although shorter than Hw. When not pruinose also similar by (g) the dorsa of S4–7 with pairs of pale subapical spots that lie closer to the dorsal than lateral carinae, while S8–10 are all dark. However, (1) the hook of the hamule tapers and curves gradually toward a sharp tip that is turned back- and outward, appearing like a claw or talon beside a rather narrow and distinctly higher lobe, with a wide space between the hook and lobe, and thus the overall shape is somewhat intermediate between *O. hintzi* and *O. machadoi* (Fig. 31); and (2) the appendages are always wholly black and never (partly) pale in young specimens, although sympatric *O. saegeri* can be similarly dark.



**Photo 68.** *Orthetrum umbratum*, male; Moukoubi, Gabon. Photo: NM (10-iv-2012)

### Etymology

Latin “shaded” refers to the species’ deep forest habitat, which is unusual for the genus (neuter adjective).

### Range and ecology

Replaces *O. saegeri* in south-eastern Gabon at the darkest and least disturbed rainforest pools with very much detritus, recorded at relatively higher elevation between 530 and 580 m a.s.l (Map 11). While *O. saegeri* often basks at the forest edge, *O. umbratum* only comes down to the ponds during bright sun in the two hours around noon.

### *Porpax mezierei* Dijkstra & Kipping sp. nov. – Blue-spotted Pricklyleg

(Type Photo 54, Photos 52, 62, 69–70, Fig. 31)

### Taxonomy

DIJKSTRA (2006) revised the genus *Porpax* Karsch, 1896, separating five species principally on the basis of male markings and hind femur ornamentation. *Porpax garambensis* Pinhey, 1966 was the only species to differ also in the structure of male and female genitalia. The current taxon is morphologically and genetically close to that species but overlaps geographically, differs genetically, and has unique abdominal markings: while other *Porpax* species are marked with greenish blue, it and the closely related *Cyanothemis simpsoni* Ris, 1915 seem exceptional among nearly 1 500 libelluloid species for attaining deep blue coloration without pruinosity.

### Material studied

**Holotype** ♂. RMNH.INS.508827, Gabon, Haut-Ogooué Province, Bongoville-Léconi road after Ekala, old village of Boubou, ponds and humid forest near stream (Photo 70), 393 m a.s.l. (1.6068°S 13.9137°E), 19-v-2013, leg. N. Mézière, J. Renoult & J. Lekogo, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♂ (RMNH.INS.508823), as holotype, RMNH. 3♂, same locality, 28-xii-2010, leg. N. Mézière, RMNH. 3♂, Bongoville-Léconi road, Boubou River, Ekala, swamp close to the river, 421 m a.s.l. (1.6116°S 13.9116°E), 30-xii-2010, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.508160), same locality, 27-i-2012, leg. N.

Mézière, RMNH. 4♂ 1♀ (RMNH.INS.506221), same locality, 20-xi-2011, leg. N. Mézière, RMNH. 2♂, same locality, 27-i-2012, leg. N. Mézière, A. Günther, J. Kipping & H. Krahnstöver, RMNH. 1♂ (RMNH.INS.508803), Bongoville-Léconi road, Boubou River, Ekala, sandy forest stream (1–2 m wide, 5–10 cm deep), muddy edges, 427 m a.s.l. (1.6133°S 13.9124°E), 05-iv-2013, leg. N. Mézière, RMNH. 1♂, Bakoumba road, village 3 km before Kounda, Mikouangna (Mouyeugue), large standing water in forest clearing and cassava fields, 520 m a.s.l. (1.6001°S 13.1584°E), 05-ii-2009, leg. N. Mézière, RMNH. 1♂, same locality, 05-iv-2009, leg. N. Mézière, RMNH.

### Genetics

Three unique haplotypes (n = 5) distinct from but close to five of *P. garambensis* (n = 6).



**Type Photo 54.** Holotype of *Porpax mezierei* sp. nov., RMNH.

**Male morphological diagnosis**

Structurally like its sympatric sister-species *P. garambensis* by (a) the dorsally converging pale postdorsal stripes; (b) the densely hairy anterior side of the hind femur and trochanter; and (c) the pointed rather than rounded lobe of the hamule. However, many details are closer to the norm in this genus, such as (1) the larger size, Hw 23.5–25.5 mm (n = 8) rather than 21.5–23.0 mm; (2) the large central pale spot on the spiracular dorsum; (3) the black area between the pale postdorsal stripes that is at least as wide as the stripes themselves; (4) the venter of the thorax with the largely pale post-sternum and metepimera enclosed by black; (5) normally 2 rather than 1 Cux in Hw, although both species vary between 1 and 3; (6)  $11\frac{1}{2}$ – $12\frac{1}{2}$  rather than  $8\frac{1}{2}$ – $10\frac{1}{2}$  Ax in Fw; and (7) the absence of abdominal pruinosity. Unique in the genus by (8) the pale band on the frons being severed by black



**Photo 69.** *Porpax mezierei*, male; Ekala, Gabon. Photo: NM (06-xi-2010)

medially, as well as at the level of each antenna; (9) the black vertex with at most a weak dorsal spot, rather than a large and contrasting pale patch; (10) S4–7 with lateral blue spots that extend onto the ventral part of the tergites, but without a ring-like pale marking on S6; and (11) the blue dorsa of the cerci and epiproct.

### Etymology

Named in honour of our co-author Nicolas Mézière who, living in south-eastern Gabon, has made many discoveries in this odonatologically unexplored part of Africa within a short time (masculine singular genitive noun).

### Range and ecology

Recorded between 350 and 550 m a.s.l. in south-eastern Gabon. Males are found on sunny vegetation by swamps and pools that have much detritus, probably never dry out completely and lie on the forest edge. Not found with *P. garambensis* as that species prefers similar but deeply shaded habitat with only small sun spots.



**Photo 70.** Forest swamp at Ekala near Bongoville, Gabon. Type locality of *Neodythemis infra*, *Porpax mezierei*, and *Trithemis hinnula* with their discoverer Nicolas Mézière. Photo: JK (27-i-2012)

***Trithemis hinnula* Dijkstra, Mézière & Kipping sp. nov. – Mule Dropwing**

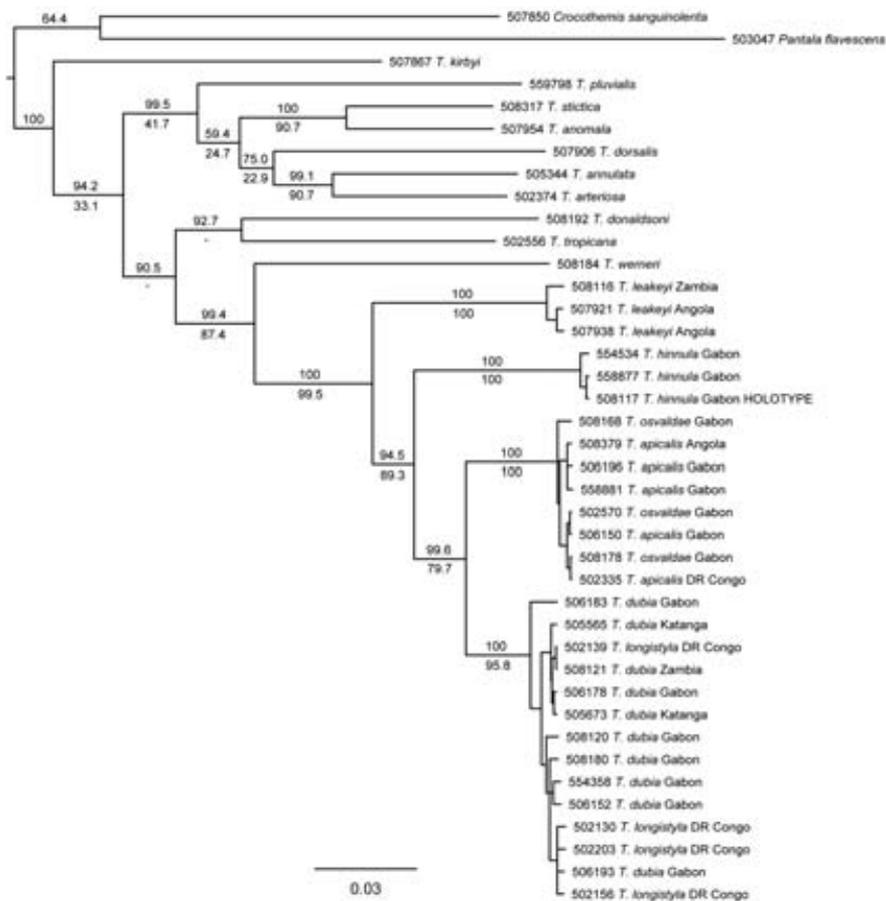
(Type Photo 55, Photos 52, 70–71, Fig. 32)

**Taxonomy**

DAMM et al. (2010) recovered *Porpacithemis trithemoides* Fraser, 1958 within their molecular phylogeny of *Trithemis* Brauer, 1868. Morphology (see DIJKSTRA & CLAUSNITZER 2014) and COI data indicate that the genera/species *Congothemis longistyla* Fraser, 1953, *Anectothemis apicalis* Fraser, 1954, *Porpacithemis dubia* Fraser, 1954 and *Lokithemis leakeyi* Pinhey, 1956 are also related closely to each other and *Trithemis osvaldae* D'Andrea & Carfi, 1997 (Tree 9). These genera were recognised for their open venation, but “*Congothemis*” *longistyla* and “*Porpacithemis*” *dubia* cannot even be separated using COI, nor can “*Anectothemis*” *apicalis* and *T. osvaldae*. “*Lokithemis*” *leakeyi* is

**Type Photo 55.** Holotype of *Trithemis hinnula* sp. nov., RMNH.

more distinct, but all fall within the variation of *Trithemis* (Tree 9). They also share typical generic characters of *Trithemis* such as the (a) small prothoracic hindlobe; (b) terminally narrowed Fw discoidal field; (c) high anterior lamina; and (d) large and prominently apical hook of the hamule. Furthermore, the female holotype of “*A.*” *apicalis* agrees in markings and venation with females



**Tree 9.** COI gene tree from Bayesian inference analysis for the *longistyla*-group, a selection of other *Trithemis* species and two outgroup taxa. For relevant branches posterior probabilities are shown first, as is bootstrap support from a 50% majority rule consensus of 1 000 trees from Maximum Likelihood analysis (both as percentages).

collected with the male holotype of “*P.*” *trithemoides* also held in MRAC. All species are best considered as the *longistyla*-group within *Trithemis* (see diagnosis below) and we treat the listed genera as junior synonyms of *Trithemis* and the species *T. trithemoides* of *T. apicalis* [new synonymies]. An unnamed taxon with intermediate features but distinct COI sequences occurs with *T. apicalis*, *T. dubia* and *T. osvaldae* in Gabon, which is described here.

### Material studied

**Holotype** ♂. RMNH.INS.508117, Gabon, Haut-Ogooué Province, Ekala, Boubou stream at road Franceville-Bongoville, forest stream (Photo 52), 421 m a.s.l. (1.6115°S 13.9115°E), 27-i-2012, leg. J. Kipping, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♂ (RMNH.INS.554534), Bongoville-Léconi road after Ekala, old village of Boubou, Boubou River, sandy and gravelly (2 m wide, 60 cm deep), open on roadside, bushy near river, 393 m a.s.l. (1.6113°S 13.9105°E), 09-xii-2012, leg.



**Photo 71.** *Trithemis hinnula*, male; Ekala, Gabon. With maturity the male develops more pruinosity on the abdomen. Photo: NM (25-x-2013)

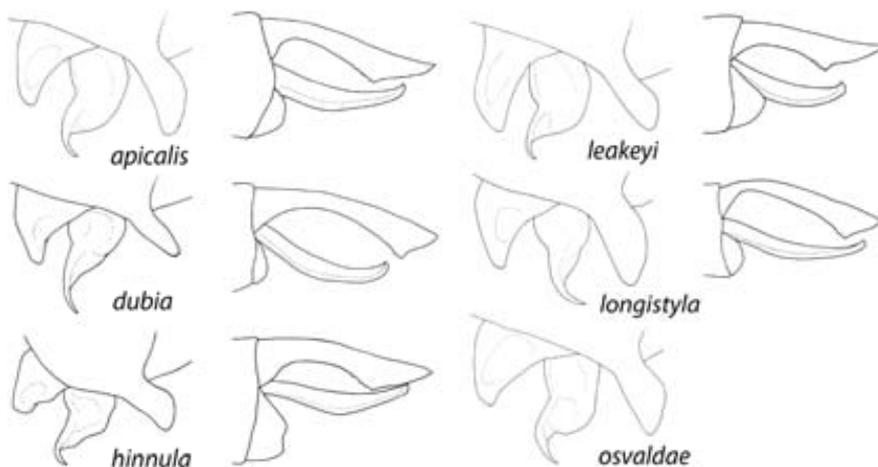
N. Mézière & J. Lekogo, RMNH. 1♂ (RMNH.INS.558877), Plateau Batéké, Léconi Valley, Eaux Claires to Camps des Pygmés, clearing near river, 434 m a.s.l. (1.4548°S 14.1784°E), 26-x-2013, leg. N. Mézière, RMNH.

### Genetics

Two unique haplotypes (n=3) form the well-supported sister-group of *T. dubia/longistyla* and *T. apicalis/osvaldae* combined (Tree 9).

### Male morphological diagnosis

Typical of the *longistyla*-group by (a) small size, Hw 26.5–27.5 mm (n=3); (b) the glossy black dorsum of the frons; (c) Fw discoidal field being partly of 2 cell-rows; and (d) the absence of cell-doublings in the radial plane and thus a single row of cells there. However, (1) the pale thoracic markings are more reduced, i.e., when the mesepimeron and metepimeron still bear distinct pale bands the mesepisternum, as well as the metepisternum between the metastigma and metapleural suture, is unmarked; (2) Hw base has a weakly defined dark patch to about Cux, most like *T. apicalis*, which is not distinctly darker in the subcostal and cubital spaces as in *T. dubia* and *T. longistyla*; (3) the hamule does not have a slender and sickle-like hook



**Figure 32.** Secondary genitalia (left) and male appendages (right) in lateral view of the *longistyla*-group of *Trithemis*; the appendages of *T. osvaldae* are similar to those of *T. apicalis*.

like *T. dubia* and *T. longistyla*, but also lacks the distinctly humped lobe of *T. apicalis*, *T. leakeyi* and *T. osvaldae*, instead having a rather short hook and a ridge-like lobe (Fig. 32); (4) S4–7 have distinct pale markings ventrally when their dorsum is wholly black, S5–6 developing some pale grey pruinosity, rather like *T. dubia* but unlike *T. apicalis* where pruinosity is more blue and concentrated on the thorax and S1–3; and (5) the cerci are of normal proportions, with their ventral angle at a third of their length from the apex, rather than a sixth as in *T. dubia* and *T. longistyla* (Fig. 32).

### Etymology

Latin “little female mule” refers to the intermediate morphology within the *longistyla*-group (noun in apposition).

### Range and ecology

Swamps in gallery forest at 390 to 440 m a.s.l. on the sandy Batéké Plateau of south-eastern Gabon, where it occurs with *T. dubia* but is much scarcer. Males were mostly found on bare branches at the forest edge.

## ***Trithemis legrandi* Dijkstra, Kipping & Mézière sp. nov. – Robust Dropwing**

(Type Photo 56, Photos 2, 72, Fig. 33)

### Taxonomy

DIJKSTRA (2007) diagnosed the *basitincta*-group of *Trithemis* (see below) and its similar species *T. basitincta* Ris, 1912 and *T. bifida* Pinhey, 1970. However, males from Makokou in north-eastern Gabon identified as *T. bifida* by Jean Legrand in MNHN pertain to neither species, and similar individuals occur with both in south-eastern Gabon. Although available COI evidence is limited, the morphological distinction is sufficient to describe this species, based also on material from extreme south-western Cameroon. Damm et al. (2010) found a small difference with *T. bifida* in ND1, 16S and ITS; the two species together forming the sister-group of *T. basitincta*.

### Material studied

**Holotype** ♂. Cameroon, South Province, 26 km E of Campo, Campo-Ma'an National Park (buffer zone), Bitandé River 1 km E of Nkoélon, rocky rain-

forest river (Photo 72) and adjacent roadsides, 70–100 m a.s.l. (2.3940°N 10.0540°E), 15-vi-2008, leg. K.-D.B. Dijkstra, J. Kipping & K. Schütte, RMNH. **Further material.** CAMEROON (South Province): 2♀, as holotype, CJKL. 1♀, locality as holotype, 13-vi-2008, leg. K.-D.B. Dijkstra, J. Kipping & K. Schütte, RMNH. GABON (Haut-Ogooué Province): 1♂ (RMNH. INS.508171), 1♀ (RMNH.INS.508175), 38 km SE of Franceville, Franceville-Kessala Road, 3rd stream E of Onkoua, gravelly stream in rainforest, 411 m a.s.l. (1.8551°S 13.8620°E), 09-i-2010, leg. K.-D.B. Dijkstra, N. Mézière & C. Vanappelghem, RMNH. 1♂ 4♀, Concession Rougier, plot L21A on road to Franceville, 10 km after Moanda, Moyabi, sandy stream (1 m wide, 20–50 cm deep), 377–398 m a.s.l. (1.7390°S 13.2977°E), 14–28-x-2010, leg. N. Mézière, RMNH. 2♂ 1♀, Concession Rougier, Moanda, sandy stream (Photo 2) (3–4 m, 50 cm deep), 411 m a.s.l. (1.7051°S 13.3560°E), 26-iv-2009,



**Type Photo 56.** Holotype of *Trithemis legrandi* sp. nov., RMNH.

leg. C. Vanappelghem & N. Mézière, RMNH. 1♂ 1♀, Moanda-Mounana road, Mbéréssé bridge, Nguiaassono, sandy stream (2 m wide, 30 cm deep) with rapids and rocks, 420 m a.s.l. (1.4953°S 13.1800°E), 08-i-2011, leg. N. Mézière, RMNH. 1♀, Franceville-Okondja road, 2 km before Okila, muddy and gravelly stream in forest (4 m wide, <50 cm deep), 364 m a.s.l. (1.0790°S 13.5669°E), 23-ix-2010, leg. N. Mézière, RMNH. 1♀ (RMNH.INS.508897), same locality, 14-x-2013, leg. N. Mézière, RMNH. 1♂, Franceville-Okondja road, 1 km after Ondzei, muddy river (silted from laterite of road) bordered by dammed ponds, 351 m a.s.l. (0.7317°S 13.5970°E), 13-iii-2011, leg. N. Mézière, RMNH. 1♂, Bongoville-Léconi road, swamp close to Boubou River, 421 m a.s.l. (1.6116°S 13.9116°E), 30-x-2010, leg. N. Mézière, RMNH. GABON (Ogooué-Ivindo Province): 1♂, Okondja-Makokou road, 5 km SE of Bakouaka, sandy forest stream, 531 m a.s.l. (0.1298°N 13.6772°E), 23-ix-2014, leg. J. Kipping, CJKL. GABON (Estuaire Province): 1♂ (RMNH.INS.508734), Kougouleu-Medouneu road, Monts de Cristal, Assegone-Es-sala, mountain stream with rapids and small falls, 2–4 m wide, 50 cm deep (0.5596°N 10.2362°E), 28-xii-2012, leg. N. Mézière & J. Lekogo, RMNH.

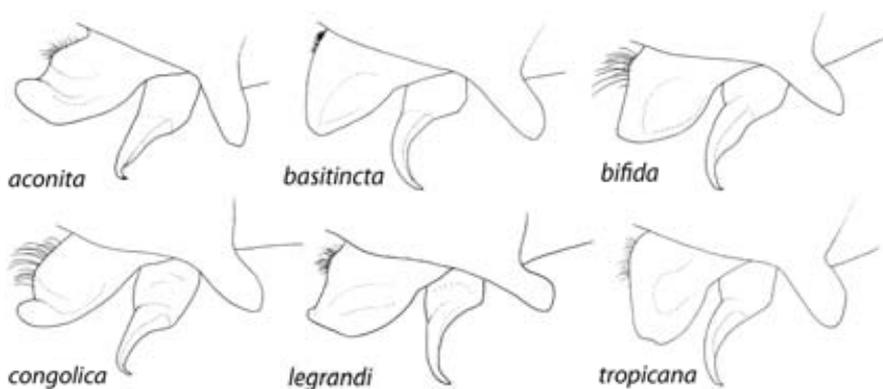
### Genetics

Two unique haplotypes (n = 4) are very similar to six of *T. bifida* (n = 11) and the two species are potentially inseparable.

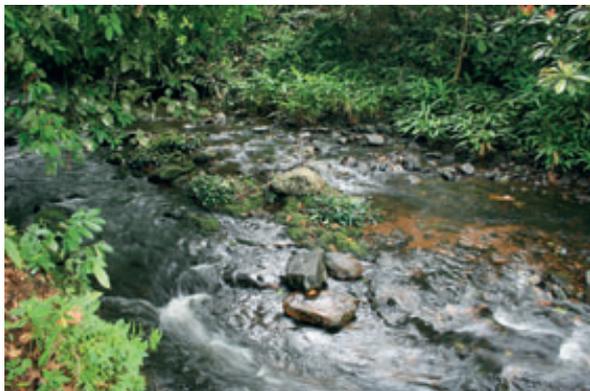
### Male morphological diagnosis

Belongs to the *basitincta*-group by the combination of (a) Fw discoidal field of 3 rows at base; (b) 4–6 cell-doublings in radial planate and thus two rows of cells there; (c) hamule with long sickle-shaped hook; and (d) the genital lobe directed away from the hamule (Fig. 33). Nearest to the sympatric *T. basitincta* and *T. bifida* by (e) the fairly large size, Hw 31.8–33.5 mm (n = 4); (f) 13½–16½ Ax in Fw; (g) the large and dark patch at Hw base that fills the cubital space to beyond Cux and extends into the anal field, thus appearing triangular and nearest to *T. basitincta* as Fig. 6s in DIJKSTRA (2007), although sometimes also present in the subcostal space proximal to Ax1; (h) the parallel-sided anterior lamina with a broad and deeply-notched apex; and (i) the notably slender and sabre-like hamules (Fig. 33). Only separated reliably by (1) the apical peaks of the anterior lamina that in lateral

view are not dark and pointedly rounded, but have pale flat-topped swellings, which in caudal or rostral view may appear to close the top of the cleft between them. The swelling is greater and the cleft completely closed in the sympatric *T. aconita* Lieftinck, 1969 and *T. congolica* Pinhey, 1970, while *T. tropicana* Fraser, 1953 has a fairly flat but neither swollen nor cleft anterior lamina (Fig. 33). Also is (2) shorter-bodied, Hw being 79–82 % of full length rather than 73–78 %; and (3) as males darken with age, the pale markings remain visible last ventrally on S4–7, while any visible dorsal markings lie on the lateral carina and are shorter than half the segments' length. The dorsal markings that are visible last in *T. bifida* lie closer to the dorsal than lat-



**Figure 33.** Secondary genitalia in lateral view of the *basitincta*-group species of *Trithemis* that occur together in central Africa.



**Photo 72.** Bitandé River near Nkoélon, Cameroon. Type locality of *Trithemis legrandi*. Photo: JK (06-vi-2008)

eral carinae and extend over almost the full segment length. The markings are intermediate in *T. basitincta*, with the rather short final markings lying about halfway the dorsal and lateral carinae. That species, however, can be separated by the presence of short bristles rather than long hairs at the base of the anterior lamina (Fig. 33). *Trithemis legrandi* also often has large and distinct lateral yellow spots on the labium, postclypeus and frons even in very dark specimens, e.g., those virtually lacking pale abdominal markings.

### Etymology

Named in honour of Dr Jean Legrand, collector of the first material of this species, and successor to Elliot Pinhey as the leading specialist of African Odonata of his time (masculine genitive noun).

### Range and ecology

Sandy, gravelly and rocky streams and small rivers in rainforest between 50 and 500 m a.s.l. in Gabon and southern Cameroon. Males fly rapidly over water but rarely perch by the streams.

### ***Urothemis venata* Dijkstra, Mézière & Kipping sp. nov. – Red-veined Basker**

(Type Photo 57, Photos 26, 73–74, Fig. 34)

### Taxonomy

Combines the blue pruinose body of *U. edwardsii* (Selys, 1849) with the red venation of the other African *Urothemis* Brauer, 1868 species. This combination is unique, as are genetic and morphological details, and thus treated as a distinct species by DIJKSTRA & CLAUSNITZER (2014).

### Material studied

**Holotype** ♂. RMNH.INS.503166, Sierra Leone, Eastern Province, Gola Forest, 500 m NE of Vaama, abandoned diamond pits with swampy vegetation enclosed by forest, 208–235 m a.s.l. (7.7756°N 10.7148°W), 08-iii-2011, leg. K.-D.B. Dijkstra & A. Dayeker, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 8♂ 2♂♀, “Africa No1” radio station, Moyabi, swamp and treed savanna, 456 m a.s.l. (1.7029°S 13.3198°E), 18-x-2009, leg. N. Mézière, RMNH. 2♂ 2♂♀, Moanda-Mounana

road, Moanda, forest edge pond, 362 m a.s.l. (1.5057°S 13.1989°E), 11-12-xi-2009, leg. N. Mézière, RMNH. 2♂, Massango, Chinese forestry road at entrance of Mounana, pond in treed savanna, 468 m a.s.l. (1.4556°S 13.1302°E), 18-iv-2010, leg. N. Mézière, RMNH. 2♂ (RMNH.INS.502561), 18 km SE of Moanda, “Africa No1” radio station, Moyabi, swamp near Moyabi, flooded area in rainforest, 520 m a.s.l. (1.7030°S 13.3199°E), 04-i-2010, leg. K.-D.B. Dijkstra, N. Mézière & C. Vanappelghem, RMNH. 3♂, Plateau d’Okouma, Mounana, lake in grassland, 583 m a.s.l. (1.4638°S 13.1987°E), 31-x-2010, leg. N. Mézière, RMNH. 1♂, Bongoville-Léconi road after Ekala, old village of Boubou, vegetated pond on road side (abandoned sand pit), 393 m a.s.l. (1.6114°S 13.910°E), 07-ii-2010, leg. N. Mézière, RMNH. 1♂, road to the station, Moanda, road side swamp, 405 m a.s.l. (1.0105°S 13.2594°E), 23-i-2010, leg. N. Mézière, RMNH. 1♂, road to Akieni, entrance to Omoï, open swamp



**Type Photo 57.** Holotype of *Urothemis venata* sp. nov., RMNH.

and temporary ponds, 413 m a.s.l. (1.3424°S 13.7755°E), 26-xii-2010, leg. N. Mézière, RMNH. 1♂, Lac aux Caïmans, Léconi, large lake with swamps and pools, 460 m a.s.l. (1.6533°S 14.2763°E), 04-iv-2010, leg. N. Mézière, RMNH. 1♂, Batéké Plateau, Eaux Claires, small sandy river (4–6 m wide) with gallery forest in savanna, and associated swamp and pools, 446 m a.s.l. (1.5753°S 14.2014°E), 31-xii-2009, leg. N. Mézière & C. Vanappelghem, RMNH. 1♂, Batéké Plateau, Eaux Claires, lake in grassland, 445 m a.s.l. (1.4961°S 14.9748°E), 16-iv-2011, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.502504), 8 km NW of Bakoumba, Bakoumba, Parc de la Lékédi, Sentier Botanique, small swampy stream in rainforest, 627 m a.s.l. (1.7786°S 12.9748°E), 01-i-2010, leg. K.-D.B. Dijkstra, N. Mézière & C. Vanappelghem, RMNH. 1♂ (RMNH.INS.508093), Batéké Plateau, 18 km NW of Léconi, shallow, muddy lake in open savanna, surrounded by gallery forest, 425 m a.s.l. (1.4530°S 14.1704°E), 29-i-2012, leg. J. Kipping, CJKL. 4♂ (RMNH.INS.508094), same locality, 28-ix-2013, leg. J. Kipping, CJKL. 3♂ same locality, same dates, CJKL. 1♂, Botoso, road Moanda-Bakoumba, artificial lake in forest, 676 m a.s.l. (1.6581°S 12.8981°E), 04-ii-2012, leg. J. Kipping, CJKL. GABON (Ngounie Province): 2♂ 1♀, Mimongo-Mouila road, open roadside swamp and stream, 584 m a.s.l. (1.6972°S 11.4479°E), 29-iii-2011, leg. N. Mézière, RMNH. 1♂, Lastoursville-Koulamoutou road, Koulamoutou, roadside swamp, 290 m a.s.l. (1.0012°S 12.5535°E), 17-ix-2010, leg. N. Mézière, RMNH. 1♂, Vuku road, Mboundou-Mbadouma, swampy standing water, 295 m a.s.l. (1.2494°S 13.2797°E), 14-iii-2010, leg. N. Mézière, RMNH. LIBERIA (Nimba County): 2♂, Mt Tokadeh, corner swamp, swampy lake in degraded forest (Photo 74), 605 m a.s.l. (7.4579°N 8.6664°W), 19-iii-2011, leg. K.-D.B. Dijkstra, RMNH. 3♂, same locality, 03-iii-2012, leg. K.-D.B. Dijkstra & M. Darpay, RMNH. 2♂, Mt Tokadeh, north of corner swamp, road edge in rainforest, 676 m a.s.l. (7.4661°N 8.6650°W), 20-iii-2011, leg. K.-D.B. Dijkstra, RMNH. 1♂ (RMNH.INS.504478), East Nimba Nature Reserve, Blue Lake, swampy lake borders in abandoned mining pit and outflow stream, 857 m a.s.l. (7.5400°N 8.5005°W), 22-ii-2012, leg. K.-D.B. Dijkstra & M. Darpay, RMNH. SIERRA LEONE (Eastern Province): 4♂ 2♂♀ (♀ RMNH.INS.503167), as holotype, RMNH. 2♂, Gola Forest, NE of Dukor, abandoned diamond pits with swampy vegetation, 251 m a.s.l. (7.7884°N 10.7071°W), 09-iii-2011, leg. K.-D.B. Dijkstra & A. Dayaker, RMNH.

### Genetics

Three unique haplotypes ( $n = 7$ ) nearest to single sample of *U. thomasi* Longfield, 1932 from Oman and further from African species *U. assignata* (Selys, 1872) and *U. edwardsii*, although *U. luciana* Balinsky, 1961 was not sampled.

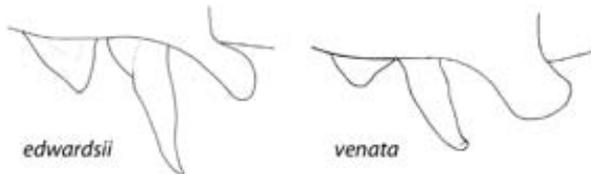
### Male morphological diagnosis

Fairly large dragonfly (Hw 31.0–34.0 mm;  $n = 10$ ) that recalls *U. edwardsii* in (a) abdomen being blue pruinose with maturity, rather than bright red. However, (1) the labium is uniformly warm brown and only rarely darkened; (2) the pruinosity is pale and uniform, rather than dark and sparing a broad black middorsal line from the abdomen base to tip; (3) the costa, subcosta and radial vein are bright red with maturity, contrasting with the



**Photo 73.** *Urothemis venata*, male; Batéké Plateau, Gabon. Photo: JK (28-ix-2013)

**Figure 34.** Secondary genitalia in lateral view of two *Urothemis* species.



blackish other veins; and (4) the hamule is only about as long as the genital lobe and distinctly less wide than it (Fig. 34). While the extent of the dark Hw basal patch is often used for identification in the genus, this species is extremely variable: the blackish markings may not even reach halfway the wing base and Ax1, and thus not enter the anal loop, but can also surpass Ax2 and even cover most of the triangle.

### Etymology

Latin “veined” for the artery-like red wing veins (feminine adjective).

### Range and ecology

First recognised from a photograph taken by Jack Windig north-east of Kin-du in Congo-Kinshasa in 1983. Subsequently found commonly in south-eastern Gabon, 1 500 km west, and locally in Liberia and Sierra Leone, another 3 000 km west. Probably widespread and overlooked, despite being conspicuous, occurring at richly vegetated still water near or enclosed by forest between 200 and 900 m a.s.l. Such habitats include abandoned diamond pits (Sierra Leone) and areas flooded by streams blocked by road construction (Liberia, Gabon). Records of adults are concentrated in the rainy months.



**Photo 74.** Open swamp enclosed by rainforest, Mt Tokadeh, Liberia. Habitat of *Urothemis venata*. Photo: KDBD (20-iii-2011)

***Zygonyx annika* Dijkstra sp. nov. – Annika's Cascader**

(Type Photo 58, Photo 75, Fig. 35)

**Taxonomy**

Variation in markings and male genitalia suggests that a complex exists of species similar to *Z. flavicosta* (Sjöstedt, 1900), but thus far only *Z. geminuncus* Legrand, 1997 has been separated. Morphology and COI data suggest that at least six species are involved, with two or even three occurring in close proximity. Variation among specimens nearest to the true *Z. flavicosta* is so great that we only name three species that can be separated from sympatric relatives by both genetics and morphology (Tree 10). The present taxon is known only from a pair caught in copula, which overlaps geographically with morphologically and genetically distinct populations that were identified as *Z. flavicosta*.

**Material studied**

**Holotype** ♂. RMNH.INS.503187, Sierra Leone, Eastern Province, 40 km SW of Kenema, Moa River at Tiwai Island, forested island in large river with rocky rapids (Photo 75), 122 m a.s.l. (7.551°N 11.3549°W), 14-iii-2011, leg. K.-D.B. Dijkstra, RMNH. The right Hw and leg are aberrant in shape, which is probably a developmental defect.

**Further material.** SIERRA LEONE (Eastern Province): 1♀ (RMNH.INS.503188), in copula with holotype, RMNH.

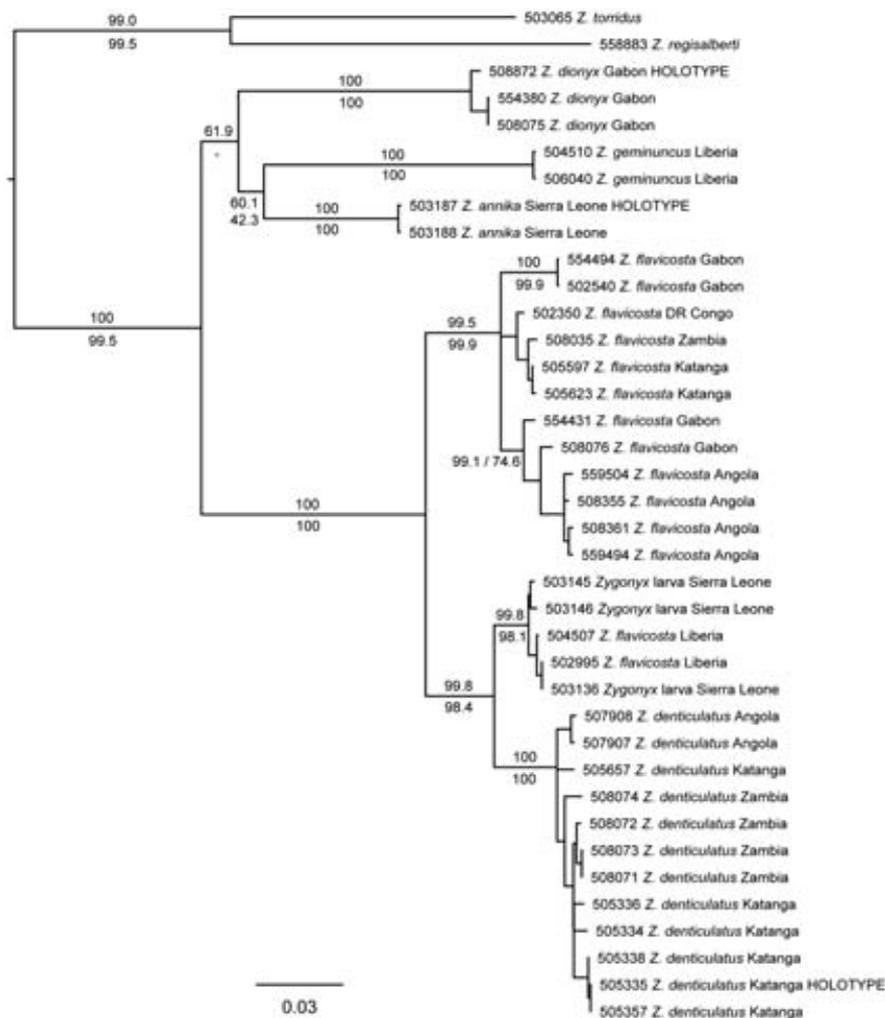
**Genetics**

One unique haplotype (n = 2) is distinct and nearer to *Z. dionyx* sp. nov. and *Z. geminuncus* than the morphologically similar *Z. flavicosta* (Tree 10).

**Male morphological diagnosis**

Belongs to the *flavicosta*-complex by (a) the modest size, Hw 36.5 mm (n = 1); (b) the moderately dense venation, with 13½–14 Ax in Fw; (c) the largely black hind legs; (d) the pointed and forward-curved apex of the anterior lamina (Fig. 35); and (e) the pale dorsal band on S7 that stands out against the largely dark S5–6. Differs from the sympatric *Z. flavicosta* by (1) the dorsum of the eyes being deep reddish brown, contrasting with their

greyish underside, rather than uniformly grey-blue; and (2) the shorter hook of hamule, which is less than a third as long as the hamule is wide (Fig. 35). Also differs from *Z. flavicosta* from Sierra Leone, Liberia and Gha-



**Tree 10.** COI gene tree from Bayesian inference analysis for the *flavicosta*-complex of *Zygonyx* and two outgroup taxa. For relevant branches posterior probabilities are shown first, as is bootstrap support from a 50% majority rule consensus of 1 000 trees from Maximum Likelihood analysis (both as percentages).



**Type Photo 58.** Holotype of *Zygonyx annika* sp. nov., RMNH (horizontally mirrored from original).

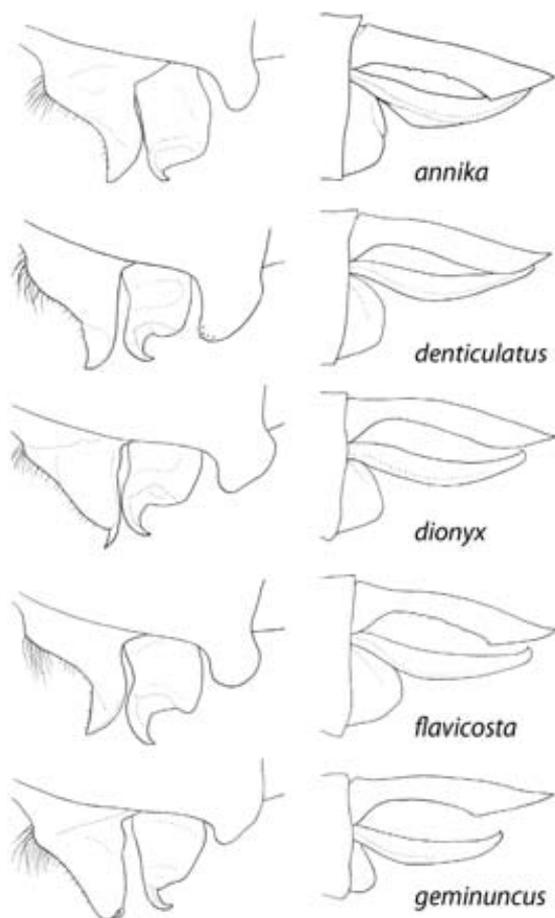
**Photo 75.** Rocky stretch of the Moa River at Tiwai Island, Sierra Leone. Type locality of *Zygonyx annika* and habitat of *Pseudagrion pacale*. Photo: KDBD (14-iii-2011)



na by (3) the Hw membrane being darkly stained and not clear beside the membranule; (4) the more continuous pale thoracic markings, the stripe on the metepisternum not being broken between the metastigma and wing base, while that on the metepimeron is not invaded by black posteriorly to appear T-shaped; and (5) the straighter cerci (Fig. 35).

### Etymology

Named in honour of Dr Annika Hillers, who advanced research on the Gola rainforest ecosystem and enabled the author to make his contribution (noun in apposition).



**Figure 35.** Secondary genitalia (left) and male appendages (right) in lateral view of the *flavicosta*-complex of *Zygonyx*; illustrations of *Z. flavicosta* are based on a specimen from Sierra Leone.

### Range and ecology

Rocky fast-flowing section of the large Moa River in Sierra Leone, flanked by gallery forest and about 120 m a.s.l. Similar adults and possible exuviae were seen near Kenema 35 km upstream, but *Z. flavicosta* is sympatric and possibly syntopic.

### *Zygonyx denticulatus* Dijkstra & Kipping sp. nov. – Pale Cascader

(Type Photo 59, Photos 47, 76–77, Fig. 35)

### Taxonomy

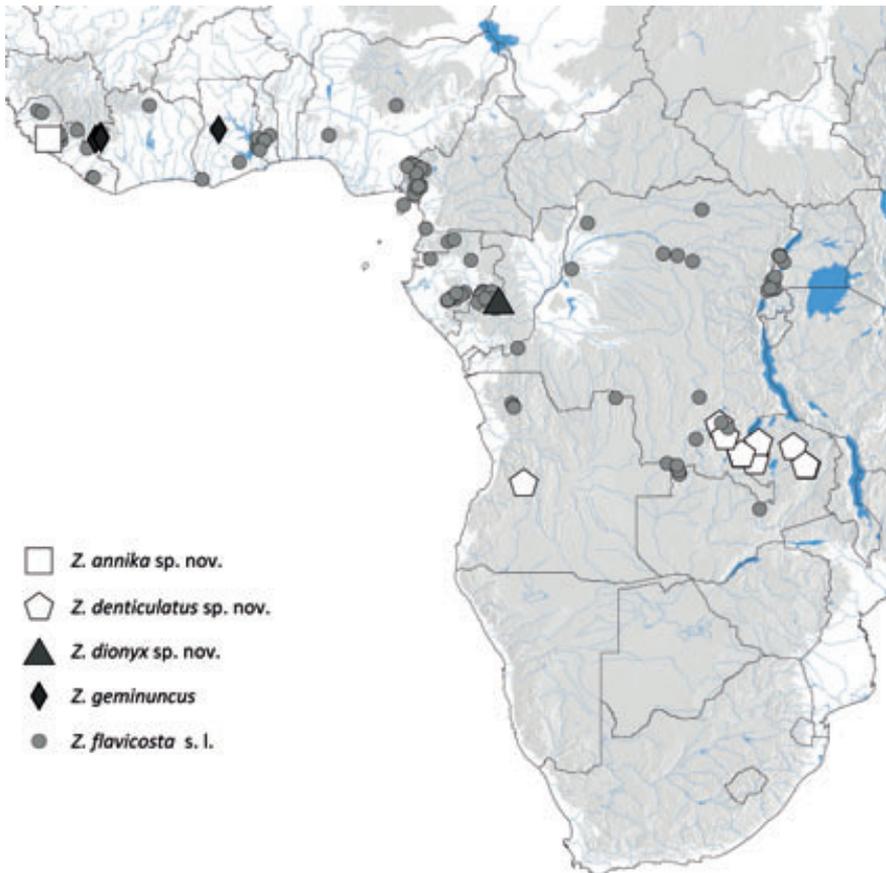
Morphologically distinct from *Z. flavicosta* (see *Z. annika* sp. nov.) and genetically closer to western African specimens of that species than those found within 40 km of it around Upemba National Park, Katanga (Tree 10). Treated as a distinct species by DIJKSTRA & CLAUSNITZER (2014), but the photograph on page 218 shows this species, and not *Z. flavicosta* (Map 12).

### Material studied

**Holotype** ♂. RMNH.INS.505335, Congo-Kinshasa, Katanga, Kiubo, Lufira (large, Kiubo Falls) and Luvilombo (small, rocky) rivers, and adjacent flooded areas, gallery forest and degraded miombo woodland, 840–880 m a.s.l. (9.52°S 27.05°E), 05-xi-2011, leg. K.-D.B. Dijkstra, RMNH.

**Further material.** ANGOLA (Huambo Province): 2♂ (RMNH.INS.507908), Keve (Cuvo) River near Alto Hama, 1 415 m a.s.l. (12.2031°S 15.5952°E), 14-v-2012, leg. J. Kipping, CJKL. 1♂ (RMNH.INS.507907), same locality and date, RMNH. CONGO-KINSHASA (Katanga): 6♂ (RMNH.INS.505334, RMNH.INS.505338, RMNH.INS.505357), 1♀ (RMNH.INS.505336), as holotype, RMNH. 2♂ 1♀ (RMNH.INS.505657), Kundelungu National Park, Masansa, small river with some gallery forest and falls in miombo woodland, 1 440–1 480 m a.s.l. (10.532°S 27.978°E), 22-xi-2011, leg. K.-D.B. Dijkstra, RMNH. 1♂, Kundelungu National Park, Lutshipuka, small river with some gallery forest and falls in miombo woodland (Photo 47), 1 500–1 530 m a.s.l. (10.557°S 27.958°E), 26-xi-2011, leg. K.-D.B. Dijkstra, RMNH. ZAMBIA (Luapula Province): 1♂ (RMNH.INS.508074), 1♂♀, Mumbuluma Falls, 35 km NW of Mansa, large waterfall, 1 195 m a.s.l. (10.9301°S 28.7354°E), 05-iv-2011, leg. J. Kipping, CJKL. 1♂, Ntumbachushi Falls, 21 km SE of

Mbereshi, large waterfall of Ngoni River (Photo 77), 1 154 m a.s.l. (9.8537°S 28.9448°E), 07-iv-2011, leg. J. Kipping, RMNH. 2♂, same locality, same dates, BMNH. 5♂ 1♀, same locality, same dates, CJKL. ZAMBIA (Northern Province): 1♂ (RMNH.INS.508071), Shiwa N'gandu, Kapishya Hot Springs, Mansha River, fast flowing rapids, 1 434 m a.s.l. (11.1702°S 31.6053°E), 06-xii-2014, leg. J. Kipping, RMNH. 1♂, same locality, same dates, CJKL. 1♂♀ (♂ RMNH.INS.508072, ♀ RMNH.INS.508073), Chishimba Falls W of



**Map 12.** Distribution of selected species of the *flavicosta*-complex of *Zygonyx* (*Z. annika* sp. nov., *Z. denticulatus* sp. nov., *Z. dionyx* sp. nov., *Z. flavicosta* s.l. and *Z. geminuncus*).

Kasama, Kaela Fall, large waterfall, 1 315 m a.s.l. (10.1089°S 30.9167°E), 07-xii-2014, leg. J. Kipping, RMNH.

### Genetics

Nine unique haplotypes (n = 12) nearest to *Z. flavicosta* from western Africa, but more distant to the sympatric clade of *Z. flavicosta* (Tree 10).

### Male morphological diagnosis

Belongs to *flavicosta*-complex by (a) the modest size, Hw 35.0–39.0 mm (n = 24); (b) the moderately dense venation, with  $10\frac{1}{2}$ – $12\frac{1}{2}$  Ax in Fw; (c) the largely black hind legs; (d) the pointed and forward-curved apex of the anterior lamina (Fig. 35); and (e) the pale subapical band on the dor-



**Type Photo 59.** Holotype of *Zygonyx denticulatus* sp. nov., RMNH (horizontally mirrored from original).

sum of S7 that stands out against largely dark S5–6. Differs from sympatric *Z. flavicosta* by (1) the dorsal dark metallic area that does not extend to the anterior side of the frons; (2) the pale brown and not blackish Pt (Photo 76); and (3) the presence of denticles on the apical border of the genital lobe



**Photo 76.** *Zygonyx denticulatus*, male resting in the morning sun; Ntumbachushi Falls, Zambia. Note the brown pterostigmas. Photo: JK (07-iv-2011)



**Photo 77.** Cascades of the Ngona River above Ntumbachushi Falls near Mbereshi, Zambia. Males of *Zygonyx denticulatus* frequently hovered over the river. Photo: JK (07-iv-2011)

(Fig. 35). Also, (4) the labrum is often pale brown at least at its base, although it can be wholly black as in *Z. flavicosta*; (5) the background colour of the thorax is browner and the pale stripes are often more fragmented and reduced, e.g., the stripe on the metepisternum is typically broken between the metastigma and wing base, or may be reduced to a single spot in that position, while the metepimeron may bear only one to three spots rather than a T-shaped stripe; and (6) the hook of the hamule often seems longer and more strongly curved, about as long as the width of its base, rather than about half (Fig. 35).

### Etymology

Latin “with small teeth” for the denticles on the genital lobe (masculine adjective).

### Range and ecology

Fast-flowing sections and waterfalls of large streams and small rivers in gallery forest and open miombo woodland in Katanga, eastern Angola and north-eastern Zambia, recorded between 840 and 1 530 m a.s.l.

## ***Zygonyx dionyx* Dijkstra & Mézière sp. nov. – Eastern Double-hooked Cascader**

(Type Photo 60, Photo 26, 56, Fig. 35)

### Taxonomy

Part of the *flavicosta*-complex of *Zygonyx* Hagen, 1867 (see *Z. annika* sp. nov.). Genetics and the distinct morphology of its secondary genitalia suggest it is the eastern counterpart of the Upper Guinea endemic *Z. geminuncus* (Tree 10).

### Material studied

**Holotype** ♂. RMNH.INS.508872, Gabon, Haut-Ogooué Province, Batéké Plateau, Léconi Valley, Eaux Claires, Camps des Pygmés, sandy river (4 m wide, 20–200 cm deep) in gallery forest bordered by swamp, 434 m a.s.l. (1.4549°S 14.1785°E), 29-ix-2013, leg. N. Mézière, J. Kipping & H. Krahnstöver, RMNH.

**Further material.** GABON (Haut-Ogooué Province): 1♂, locality as holotype, 16-ix-2012, leg. N. Mézière, RMNH. 1♂, Bongoville-Léconi road after Ekala, old village of Boubou, stream (2 m wide) with gravel bottom, 393 m a.s.l. (1.6114°S 13.9105°E), 17-iv-2011, leg. N. Mézière, RMNH. 1♂ (RMNH.INS.508075), Batéké Plateau, 18 km NW of Léconi, sandy stream in dense gallery forest, tributary to Léconi River, 425 m a.s.l. (1.447218°S 14.166175°E), 29-ix-2013, leg. J. Kipping, CJKL. 1♂, same locality, 30-ix-2013, leg. J. Kipping, CJKL.

### Genetics

Two unique haplotypes (n = 3) that are nearest to *Z. annika* and *Z. geminuncus* (Tree 10).



**Type Photo 60.** Holotype of *Zygonyx dionyx* sp. nov., RMNH (horizontally mirrored from original).

### Male morphological diagnosis

Belongs to the *flavicosta*-complex by (a) the modest size, Hw 36.0–38.5 mm ( $n = 3$ ); (b) the moderately dense venation, with  $11\frac{1}{2}$ – $12\frac{1}{2}$  Ax in Fw; (c) the largely black hind legs; and (d) the pale subapical band on the dorsum of S7 that stands out against largely dark S5–6. Most similar to the probable sister-species *Z. geminuncus* with (e) the apex of the anterior lamina being constricted and incised to form a pair of triangular forward-curved hooks; and (f) the hamule with a low lobe and narrow base making its hook appear longer (Fig. 35). However, (1) the anterior lamina is not swollen and raised laterally of the apical hooks to eclipse them in lateral view; (2) the apical hooks of the the anterior lamina are relatively large; (3) the hamule has a less tapering base; and (4) the epiproct is longer with a narrower tip (Fig. 35).

### Etymology

Greek “two claws” in parallel to Latin “twin claw” of western counterpart *Z. geminuncus* and matching the generic name (noun in apposition).

### Range and ecology

Sandy and very clear tributaries of the Léconi River at about 400 to 435 m a.s.l. on the Batéké Plateau in south-eastern Gabon, which meander through dense gallery forest surrounded by open grasslands (Photos 26, 56). As for *Z. geminuncus*, these sites are much shadier than preferred by other *Zygonyx* species, including *Z. flavicosta*, and males hover very low over rapid sections at the few sun spots present.

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**Map 13.** Map of the African continent with political borders, country names as used in the text, and major rivers and lakes.

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