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Two new species of *Triaenodes* MCLACHLAN 1865 from streams in the Lake Kivu basin, South Kivu, Democratic Republic of the Congo (Trichoptera, Leptoceridae)¹

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Abstract: We describe two new species of *Triaenodes* MCLACHLAN 1865: *Triaenodes (Triaenodes) hansii*, nov.sp. and *Triaenodes (Triaenodella) malickyi*, nov.sp., from the Kabindi and Kalengo Rivers near Lwiro, South Kivu, Democratic Republic of the Congo (DRC). This study represents the first results of ongoing research into the aquatic insect fauna of the eastern DRC, and increases the number of known *Triaenodes* species in the DRC from 15 to 17.

Key words: *Triaenodes*, *Triaenodella*, new species, caddisfly, Democratic Republic of the Congo, Africa, Afrotropical region, taxonomy, systematics.

Introduction

The cosmopolitan long-horned caddisfly genus *Triaenodes* MCLACHLAN 1865 contains 229 extant and 2 fossil species (MORSE 2010). In Africa, the genus is represented by 53 species (TOBIAS & TOBIAS 2007). While the taxonomy of the genus is well known for West Africa (ANDERSEN & HOLZENTHAL 2001, 2002), little is known of the East African *Triaenodes* fauna. In his checklist of eastern African caddisflies, JOHANSON (1992) listed 12 species in the genus, but his list did not cover the Democratic Republic of the Congo (DRC, formerly Zaïre), where 15 species of *Triaenodes* have been recorded to date (TOBIAS & TOBIAS 2007).

The Centre de Recherche en Sciences Naturelles (CRSN), Lwiro has been a hub of scientific activity in the eastern DRC since its founding in the late 1940s. The diversity of the region's rivers was studied extensively by MARLIER (1943, 1953, 1954a, 1954b, 1956, 1960, 1961) and later by STATZNER (1975, 1976, 1977) and JAQUEMART & STATZNER (1981). In 2005, SUP and FNM participated in a biological survey of the aquatic invertebrates, birds, small mammals, and plants of Kahuzi-Biega National Park and surroundings as part of the Programme Biodiversité des Écosystèmes Aquatiques et Terrestres dans le Rift Albertin (P-BEATRA), a basic training program in conservation biology and the monitoring of biological diversity jointly sponsored by the Field Museum of Natural History and the John D. and Catherine T. MacArthur Foundation. Following this initial survey, NMF and his colleagues at CRSN (Kitambala wa Kayugi, Mulumba Kazamwali, and Kajagi Mizinzi †) conducted a monthly survey of five sites on the Kalengo and Kabindi Rivers from July 2005 through May 2008. The new species described here were collected as part of that survey. This study represents the

¹ This paper is dedicated to Prof. Dr. Hans Malicky on the occasion of his 75th birthday.

first in what we hope will be a series of studies on the aquatic insect fauna of the eastern DRC, including taxonomic studies on caddisflies and ecological studies of stream invertebrates.

Materials and methods

Specimens were attracted to a 15W fluorescent UV light powered by a 12V car battery and placed in front of a 200 x 140 cm white bed sheet suspended between 2 trees or poles following the description and procedures outlined by BLAHNIK & HOLZENTHAL (2004). Specimens attracted to the light were captured and killed in 70-95 % EtOH. Light trapping generally occurred for two hours after sunset (18:00-20:00). After return to the laboratory, specimens were labelled, sorted to morphospecies, and stored in vials of 80 or 95 % EtOH. Male genitalia were cleared for species determination following the methods of BLAHNIK et al. (2007) with a minor modification. Instead of macerating the abdomen directly in 10 % lactic acid, the genitalia were placed in 2 ml reaction vials and macerated in 180 µl ATL lysis buffer and 20 µl Proteinase K (both Qiagen, Hilden, Germany) for 12 hours at 56 °C in a heated shaker. After initial lysis of tissue, 200 µl AL buffer (also Qiagen, Hilden, Germany) was added and the solution was incubated an additional 10 minutes at 70 °C. After lysis was completed, the genitalia were removed using a sterile, disposable pipette tip and placed in a glass vial with 10 % lactic acid for final maceration. The lysed tissue in the 2 ml reaction tube was used for downstream DNA extraction using the Qiap Micro Kits (Qiagen, Hilden, Germany) following the manufacturer's protocol. DNA was stored at -20 °C for future use.

Specimens were determined using the online resource "Trichoptera Africana" (TOBIAS & TOBIAS 2007), primary literature (e.g., ANDERSEN & HOLZENTHAL 2001, 2002, STATZNER 1976, JAQUEMART & STATZNER 1981), and by comparison with material housed at the University of Minnesota Insect Collection, St. Paul, Minnesota, USA (UMSP). Morphological terminology follows ANDERSEN & HOLZENTHAL (2001, 2002). Types are deposited at UMSP. Specimens were assigned a unique 9-digit accession number beginning with the prefix UMSP and taxonomic, collection, and locality data were entered in the University of Minnesota Biota (COLWELL 2003) database (<http://www.entomology.umn.edu/museum/databases/BIOTAdatabase.html>).

Descriptions of new species

Triaenodes hansii nov.sp., ♂ (Fig. 1a-e)

H o l o t y p e : Male, Democratic Republic of the Congo, South Kivu, CRSN Lwiro, Kabindi River at chimpanzee orphanage ("Animalien"), 2°14.289'S/28°42.672'E, 1695m asl, 28.09.2005, 19°C, Ngera M.F., UMSP000210981, (UMSP), in 70 % alcohol.

P a r a t y p e s : Democratic Republic of the Congo, South Kivu, CRSN Lwiro, Kalengo River, Scientific Director's Field, 2°14.293'S/28°48.094'E, 1757m asl, 23.08.2006, 17°C, Ngera M.F., UMSP000211065, (UMSP), 2♂♂ in 95 % alcohol.

D i a g n o s i s : Following the definition of YANG & MORSE (1993) and the key provided by ANDERSEN & HOLZENTHAL (2001), we place *Triaenodes hansii* nov.sp. in the subgenus *Triaenodes*. The phallus has distinct lateral ridges in the basal region that guide it on the recurved process of the inferior appendage, which is fused to the basal plate of the inferior appendage. The recurved process is only slightly recurved caudally similar to the condition in

T. (Triaenodes) africanus ULMER 1907, *T. (Triaenodes) contartus* JAQUEMART & STATZNER 1981, and *T. (Triaenodes) kwasi* ANDERSEN & HOLZENTHAL 2002. In contrast to these species, the mesal basodorsal process of the new species is not directly fused to the inferior appendage, but rather to the base of the recurved process as in *T. (Triaenodes) darfuricus* MOSELY 1936 or *T. (Triaenodes) kwaku* ANDERSEN & HOLZENTHAL 2002. In *T. hansii*, however, the mesal basodorsal process sits much higher on the recurved process (Fig. 1a).

Triaenodes hansii is easily distinguishable from all other described species of *Triaenodes*. Its genitalia most closely resemble those of *T. africanus*. ANDERSEN & HOLZENTHAL (2002) considered *T. africanus* morphologically most similar to *T. contartus*. *Triaenodes contartus* was described from the Kalengo River and bears some similarity to *T. hansii* in the general shape of its preanal and inferior appendages. However, *T. hansii* can easily be distinguished from both species by the shape of the lower part of tergum X, the shape of the mesal basodorsal process of the inferior appendage, and the apex of the recurved process of the inferior appendage. In *T. africanus* the lower part of tergum X is much longer (almost 2x as long as the preanal appendage in dorsal view) and curved ventrad; in *T. contartus* it is shorter but distinctly curved ventrad with a distinct caudal triangular process, while it is much shorter (only slightly longer than the preanal appendage in dorsal view) and apically curved dorsad in *T. hansii*. The mesal basodorsal processes of *T. hansii* and *T. contartus* are slender basally, but its apex is triangular in *T. contartus* while it is more irregular in shape and with several very long setae in *T. hansii*. In *T. africanus* the process is more club-shaped with short spines on the apex. The apex of the recurved process is bifurcate in *T. hansii* and bulbous in *T. africanus* and *T. contartus*.

Description: Male. Forewing length 7.5 mm. Antennae $2\frac{1}{2}$ times as long as forewing. Color stramineous (specimen in alcohol). Genitalia (Fig. 1a-e): Abdominal segment IX with anterior margin slightly rounded; tergum IX short, rounded; pleural region broadly rounded, posterior margin semimembranous, with few long setae; sternum IX subtriangular, heavily setose, in ventral view posterior margin with truncate corners, shallow excavation mesally. Preanal appendage long, narrow, setose. Upper part of tergum X short, rounded. Lower part of tergum X long, narrow, apex slightly curved dorsad; in dorsal view almost divided to base, apex slightly curved mesad. Inferior appendage subquadrangular, in ventral view triangular; apicomeral lobe subquadrate with numerous strong, spine-like setae mesally, in ventral view setae directed mesad; mesal basodorsal process emerging from base of recurved process, slender basally, slightly curved ventrad, enlarged apically with 3 blunt ventral projections and long, apically curved setae; abbreviated basal plate weak; recurved process thick, strongly sclerotized, strongly curved ventrad and anterad, with short, stout, lateral setose projection at midlength, subapically with long, slender spine projecting caudad, apex of recurved process curving mesad, with 2-3 apical setae. Phallus curved ventrad, with thin triangular lateral flanges near base, with paired subapicodorsal membranes and membranous apex; phallosomal sclerite U-shaped in dorsal view.

Distribution and Habitat: The species was collected from the Kalengo and Kabindi Rivers at the CRSN station in Lwiro. The Kalengo river is a first order stream that runs through agricultural fields, where land use extends right up to the waters' edge, leaving only a small strip of grasses and herbaceous plants as riparian vegetation. The substrate at the sampling site was largely boulders and cobbles interspersed by finer sediment. The Kabindi River is a remnant stretch of the largely diverted Lwiro River. It was deeply entrenched (~2 m) at the collection site, where the river bed was composed primarily of coarse gravel and cobble, with a few larger boulders. The riparian vegetation at the collection site consisted of woody and herbaceous plants, providing some shading to the stream.

E t y m o l o g y : We name this species *Triaenodes hansi* to honor Prof. Dr. Hans Malicky for his accomplishments and contributions to caddisfly taxonomy and stream ecology.

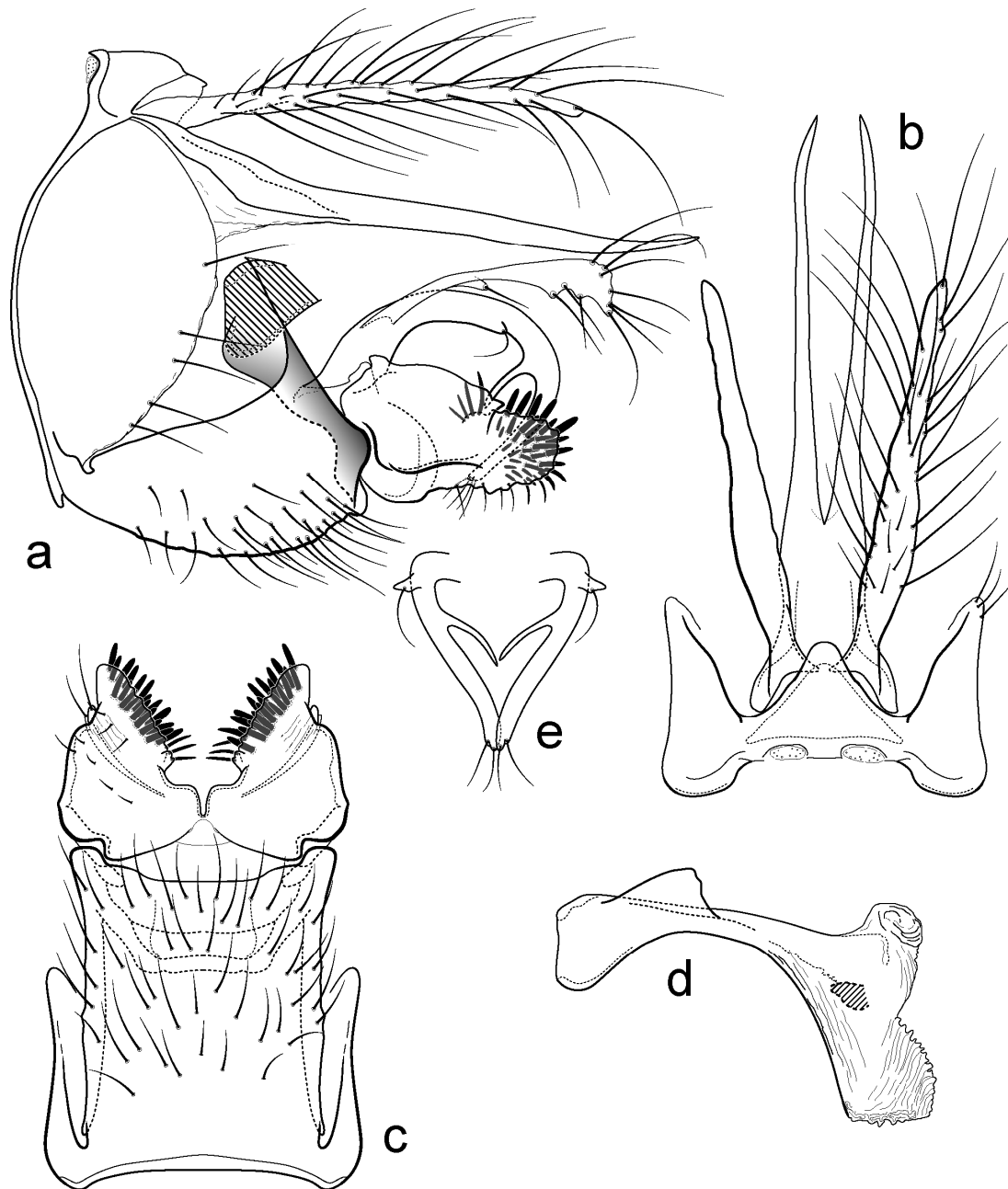


Fig. 1: *Triaenodes (Triaenodes) hansi*, nov.sp., male genitalia. (a) Segments IX and X, inferior appendages, lateral view. (b) Segments IX, X, dorsal view. (c) Segment IX, inferior appendages, ventral view. (d) Phallus, lateral view. (e) Recurved processes of inferior appendages, apices, caudal view. Illustrated was the holotype (UMSP000210981).

***Triaenodes malickyi* nov.sp., ♂ (Fig. 2a-e)**

H o l o t y p e : Male, Democratic Republic of the Congo, South Kivu, CRSN Lwiro, Kabindi River below the CRSN Guest House, 2°14.270'S/28°42.907'S; 1668m asl, 24.08.2005, Ngera M.F., UMSP000210982 [MN320], (UMSP), in 95 % alcohol.

A d d i t i o n a l s p e c i m e n : Democratic Republic of the Congo, South Kivu, CRSN Lwiro, Kabindi River at chimpanzee orphanage ("Animalien"), 2°14.289'S/28°42.672'E, 1695m asl, 21.02.2006, 19-20°C, Ngera M.F., UMSP000211066, (UMSP), 1 ♂ in 70 % alcohol, genitalia lost.

D i a g n o s i s : The species is very different from all known *Triaenodes* species and is here placed in the subgenus *Triaenodella* MOSELY 1932 as defined by YANG & MORSE (1993) because 1) the mesal basodorsal process of the inferior appendage is curved caudad and ventrad and subdivided into 2 processes, and 2) the basal plate with its associated recurved process is lacking. The new species can be distinguished from all other Afrotropical *Triaenodes* by the structures of tergum X and the inferior appendage. While the inferior appendage of *T. malickyi* is similar in shape to that of *T. (Triaenodella) legonus* MOSELY 1936, it differs in the shape of the clavate mesal basodorsal process, of which the basal projection is longer and more strongly curved ventrad in *T. malickyi*, while it is shorter and more triangular in *T. legonus*. The two species also differ in the lower part of tergum X, which has two more or less straight spines that are about equal in length to the preanal appendage in *T. legonus*. In *T. malickyi* the lower part of tergum X is divided into a pair of very long, thin, curved processes that are much longer than the preanal appendage and strongly curved ventrad (Fig. 2a).

D e s c r i p t i o n : Male. Forewing length 6.5 mm. Antennae 3 times as long as forewing. Color stramineous (specimen in alcohol). Genitalia (Fig. 2a-e): Abdominal segment IX with anterior margin rounded; tergum IX short, apex slightly bilobed; pleural region broadly rounded, posterior margin semimembranous, with few long setae; sternum IX triangular, heavily setose, in ventral view posterior margin with rounded corners, shallowly excavate with nearly straight apical margin. Preanal appendage long, narrow, widest subbasally, setose. Upper part of tergum X not apparent. Lower part of tergum X divided almost from base into pair of very long, narrow, processes, their distal halves strongly curved ventrad, sharply pointed; ventrally tergum X with single long, very thin, semi-membranous, stylet-like process. Inferior appendage subquadrangular, in ventral view triangular; apicolaterally with flangelike process; apicomeral lobe digitate with numerous strong, spine-like setae mesally; mesal basodorsal process projecting caudad, clavate, with ventral process curved ventrad, pointed apically, apex setose, with dorsal process subtriangular to bilobed apex with slightly concave caudal margin, apex setose. Phallus curved ventrad, with slightly asymmetrical, sclerotized lateral flanges dorsally; subapicoventrally with bulbous projection; apex bilobed, troughlike, connected by thin membrane, with dense, highly convoluted apical membranes; phallotremal sclerite U-shaped in dorsal view.

D i s t r i b u t i o n a n d H a b i t a t : For general descriptions of the rivers and the site where the additional specimen was collected see *T. hansii*. At the type locality on the Kabindi River, the stream passes in a small cascade under a bridge. The substrate was primarily large rocks and the river was deeply entrenched (~1.5-2m) and encroached by a deep embankment. The riparian vegetation consisted of shrubs and grasses.

E t y m o l o g y : We name this species *Triaenodes malickyi* to honor Prof. Dr. Hans Malicky for his accomplishments and contributions to caddisfly taxonomy and stream ecology.

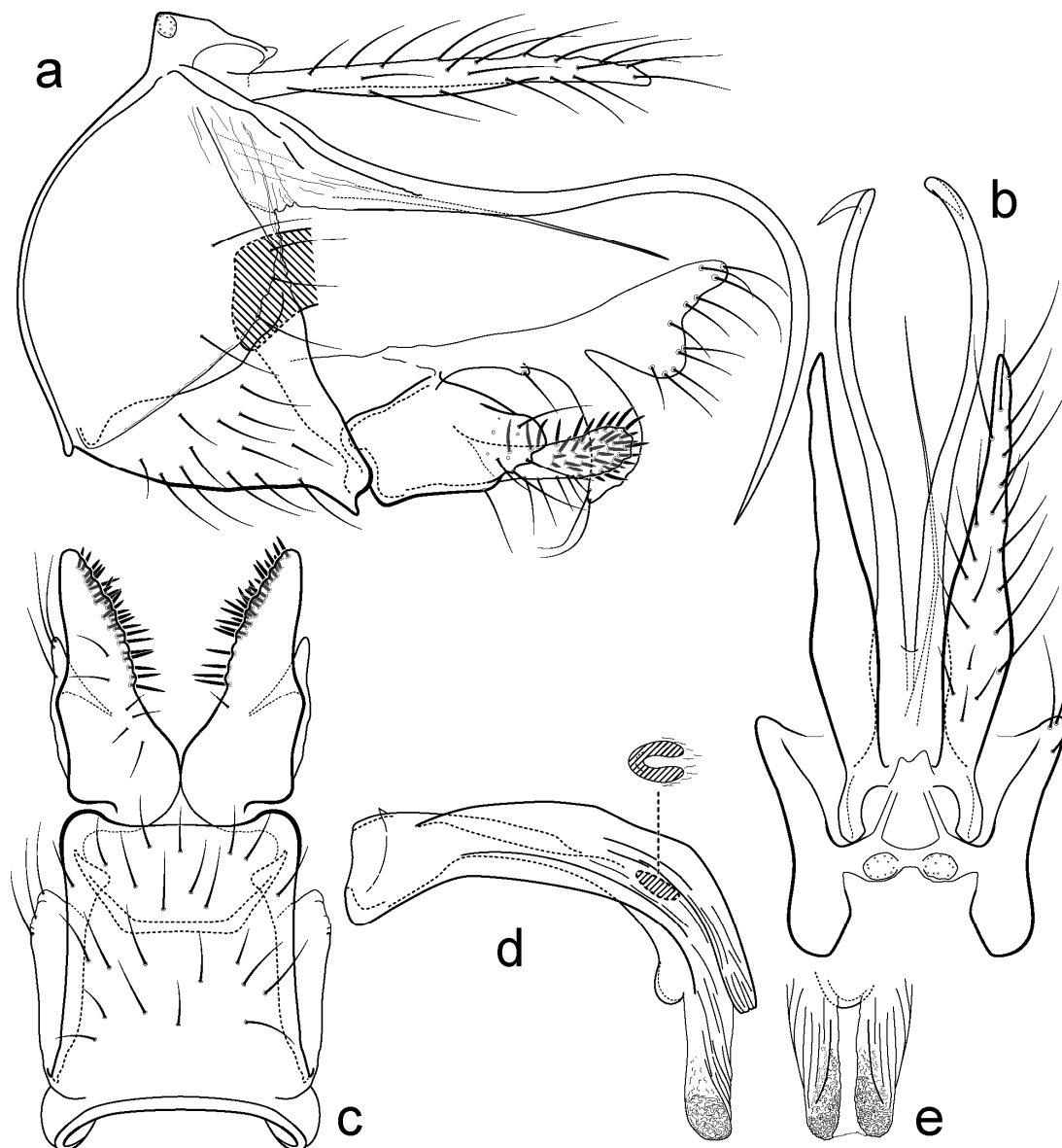


Fig. 2: *Triaenodes (Triaenodella) malickyi*, nov.sp., male genitalia: (a) Segments IX and X, inferior appendages, lateral view. (b) Segments IX, X, dorsal view. (c) Segment IX, inferior appendages, ventral view. (d) Phallus, lateral view, inset: phallotremal sclerite, dorsal. (e) Phallus, apex caudal view. Illustrated was the holotype (UMSP000210982).

Discussion

This study is the first in what we hope will be a series of contributions on the aquatic insect fauna of the eastern DRC. The country has been ravaged by civil unrest for most of the time since the end of Rwandan Genocide. The insecurity is increasing the pressure through subsistence farming on the regions' water resources. The rivers we studied here drain one of the last remnants of the intact highland rainforest in central Africa, Kahuzi-Biega National Park, and present an important resource of biodiversity and more importantly clean water.

While we begin with descriptive studies of the region's biodiversity, we hope to rapidly expand our work to more ecological questions with direct resource management implications.

In our first three-year survey of five sites on two rivers that had been previously intensely studied (e.g. STATZNER 1976, KOPPELKE 1981), we identified a number of caddisfly species that were new to the region or to science. Several of these await in depth taxonomic treatment and formal description. What our results already show is that the region, although greatly impacted by anthropogenic pressure on the aquatic resources, remains much more diverse than previously thought. Some taxa require particular taxonomic attention in the eastern DRC and the eastern Afrotropical region in general. These include the diverse caddisfly taxa *Hydropsyche*, *Lepidostoma* and Leptoceridae. Leptoceridae and the Afrotropical representatives of the *Hyropsyche propinqua* group lend themselves very well to morphological study and diagnosis, and ANDERSEN & HOLZENTHAL (2001, 2002) have given an excellent example of how revisionary work in a largely unknown and hyper-diverse fauna can be approached. A similar study for East African *Triaenodes* is needed, while *Hydropsyche* is being addressed (MEY, personal communication). In other groups, we may need to additionally apply molecular data to help sort out the taxonomy, as has been done in several other caddisfly studies recently (e.g. PAULS et al. in press, GRAF et al. 2009). One group, where this approach seems particularly necessary are Afrotropical *Lepidostoma*, where the differences in male genitalia and secondary sexual characters used to define species are highly variable and seem to intergrade in much of the material we collected.

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Zusammenfassung

Wir beschreiben zwei neue Köcherfliegenarten der Gattung *Triaenodes* MCLACHLAN 1865, *Triaenodes (Triaenodes) hansii* nov.sp. and *Triaenodes (Triaenodella) malickyi* nov.sp. aus der Umgebung von Lwiro, Süd-Kivu Provinz in der Demokratischen Republik Kongo. Diese Studie ist die erste in einer Reihe von Arbeiten zu den Wasserinsekten im Osten der DRC, und hebt die Anzahl bekannter *Triaenodes*-Arten im Land von 15 auf 17.

Sommaire

Nous décrivons deux nouvelles espèces de Trichoptères du genre *Triaenodes* MCLACHLAN 1865, *Triaenodes (Triaenodes) hansii* nov.sp. et *Triaenodes (Triaenodella) malickyi* nov.sp. des environs de Lwiro, Province du Sud-Kivu dans la République Démocratique du Congo. Ce travail est le premier dans une série d'études sur les insectes aquatiques dans l'Est du Congo, et augmente le numéro d'espèces du genre *Triaenodes* connue dans le pays de 15 à 17.

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