

## Description of the final stadium larvae of African *Gomphidia* (Odonata: Gomphidae)

Ole Müller<sup>1</sup>, Viola Clausnitzer<sup>2</sup>, Karsten Grabow<sup>3</sup>, Graham Vick<sup>4</sup> & Frank Suhling<sup>5</sup>

<sup>1</sup> Birkenweg 6d, D-15306 Libbenichen, Germany. <olemueller@bioscience-art.de>

<sup>2</sup> Graefestraße 17, D-06110 Halle/Saale, Germany. <violacl@gmx.de>

<sup>3</sup> Pädagogische Hochschule Karlsruhe, Bismarckstraße 10, D-76133 Karlsruhe.  
<grabow@ph-karlsruhe.de>

<sup>4</sup> Crossfields, New Road, Little London, Tadley, Hants RG26 5ET, UK.  
<camdragonfly@aol.com>

<sup>5</sup> Institut für Geoökologie, Technische Universität Braunschweig, Langer Kamp 19c,  
D-38106 Braunschweig, Germany. <f.suhling@tu-bs.de>

Key words: Odonata, dragonfly, *Gomphidia bredoi*, *G. gamblesi*, *G. quarrei*, larval description.

### ABSTRACT

Descriptions and illustrations of the final stadium larvae of *Gomphidia bredoi*, *G. gamblesi* and *G. quarrei* are presented, based on exuviae collected in Ivory Coast, Cameroon, Kenya and Namibia. The three species can be separated by the presence/absence and shape of an abdominal dorsal spine on segment 9, by the numbers of abdominal lateral spines and by several characteristic processes on the head.

### INTRODUCTION

The genus *Gomphidia* is composed of 22 species, most of which occur in Asia (Davies & Tobin 1985). From sub-Saharan continental Africa five species have been recognised based upon males, but there are only three types of appendages. According to K.-D.B. Dijkstra (pers. comm.) adults of *G. madi* Pinhey are structurally identical to those of *G. bredoi* (Schouteden), and those of *G. balii* Fraser to *G. quarrei* (Schouteden). Hence, we consider the names *balii* and *madi* as junior synonyms. The three remaining valid African species are: *G. bredoi*, *G. gamblesi* Gauthier, and *G. quarrei*. Whereas *G. bredoi* occurs in a belt from West Africa to Uganda, *G. gamblesi* is confined to western African rain forests (K.-D.B. Dijkstra pers. comm.). *G. quarrei* has been encountered from Kenya and Tanzania to the northern parts of South Africa and Namibia (Samways 1999; Clausnitzer 2003; Martens et al. 2003; K.-D.B. Dijkstra & V. Clausnitzer unpubl. manuscript). *G. bredoi* and *G. quarrei* are sympatric in the Democratic Republic of Congo from where they have been described. It has, however, not been established whether both species co-occur in the same habitat or region.

The general appearance of larvae of the genus *Gomphidia* is known, e.g. of the Asian *G. confluens* Selys (Seidenbusch 1999) and *G. kelloggi* Needham (Wilson 1995). The larvae of the African species of *Gomphidia*, however, have never been formally described. Fraser (1956) described an unidentified larva of *Gomphidia* from the French Cameroons, which may be *G. gamblesi*. Using material from the Ivory Coast *G. bredoi* has been figured as *G. madi* (Suhling & Müller 1996) and as *G. sp.* (Seidenbusch 1999). Another *Gomphidia* larva based on material from Kenya has been illustrated in a photograph by Seidenbusch (1999) and attributed to *G. madi*. Based on its morphological features, however, the latter should be *G. quarrei* (see below). Here we describe and compare the final stadium larvae of the three African species based on exuviae from Ivory Coast, Cameroon, Kenya and Namibia.

## DESCRIPTION

### Exuviae studied

Exuviae of *Gomphidia bredoi* were collected in the Comoé National Park, Ivory Coast (8.45°N, 3.49°W) on 12 March 1991 (attributed to *G. madi*,  $n = 20$ , leg. K. Grabow). Some of these were collected during emergence and therefore the identification was certain.

Two exuviae of *Gomphidia* sp. were obtained from the Marere River (4.2°S, 39.4°E) and from the Pemba River (4.18°S, 39.4°E) in Kenya on 10 October 2002 (leg. V. Clausnitzer). Additional exuviae of *Gomphidia* sp. were collected at the Okavango River, Namibia W of Rundu (17.85°S, 19.67°E;  $n = 2$ ) on 3 December 2004 and at Popa Falls (18.12°S, 21.58°E;  $n = 2$ ) on 16 December 2004 (leg. F. Suhling). Because only *G. quarrei* is known from both Kenya and Namibia and because adults were observed at the localities, the exuviae from both regions were assigned to that species.

Another exuvia was collected from Limbe Botanical Gardens (4.02°N, 9.2°E) in Cameroon (leg. G. Vick), which differs from the two other forms. Because *G. gamblesi* was the only *Gomphidia* encountered in the region we tentatively assigned that exuvia to *G. gamblesi*.

### Shared characters of the *Gomphidia* larvae

The general appearance of the larvae of *Gomphidia* spp. (Fig. 1) is similar to that of the genus *Ictinogomphus*. However, the total length is smaller and the abdomen and some morphological features of the head differ in shape. The body colour of the *Gomphidia* larvae is brown with inconspicuous markings. The whole body is poorly setosed. Legs are long, the hind-legs exceeding the length of the abdomen. **Head:** Wider than long, covered with short setae except for eyes, ocelli and several spots on occiput. Antennae 4-segmented, the third largest and distinctly longer than wide, the fourth smallest. All segments nearly cylindrical, not flattened, all antennomeres covered with a furry layer of short setae. Anterior margin of head with comb-like projections between eyes and antennae, also long lateral tusk-like projections in ventral direction reaching the level of mentum (Fig. 2a, 2b). Prementum-postmentum articulation reaches posterior margin of procoxae. Prementum slightly longer than wide, rectangular (Fig. 2c).

**Thorax:** Wing cases parallel, reaching over the posterior margin of S6 (Fig. 1). Legs relatively long in comparison to other gomphid larvae, particularly the femora with rows of short setae. Tarsi of all legs two-segmented.

**Abdomen:** Nearly circular in ventral view with widest part between S5 and S6, convex dorsally and flattened ventrally (Fig. 3). Anterior margin of S9 laterally projecting over S10, ventral surface of the whole abdomen very flat, only slightly convex in the middle, tergites of S8+9 are inflexible connected without visible intersegmental skins, dorsal surface strongly convex, mid-dorsal spines are prominent on S3-8(9) forming a keel along S5-8, conspicuous lateral spines at S7-9. Short anal pyramid, cerci conical, reaching 1/2 length of paraprocts. Eiproct as long as paraprocts.

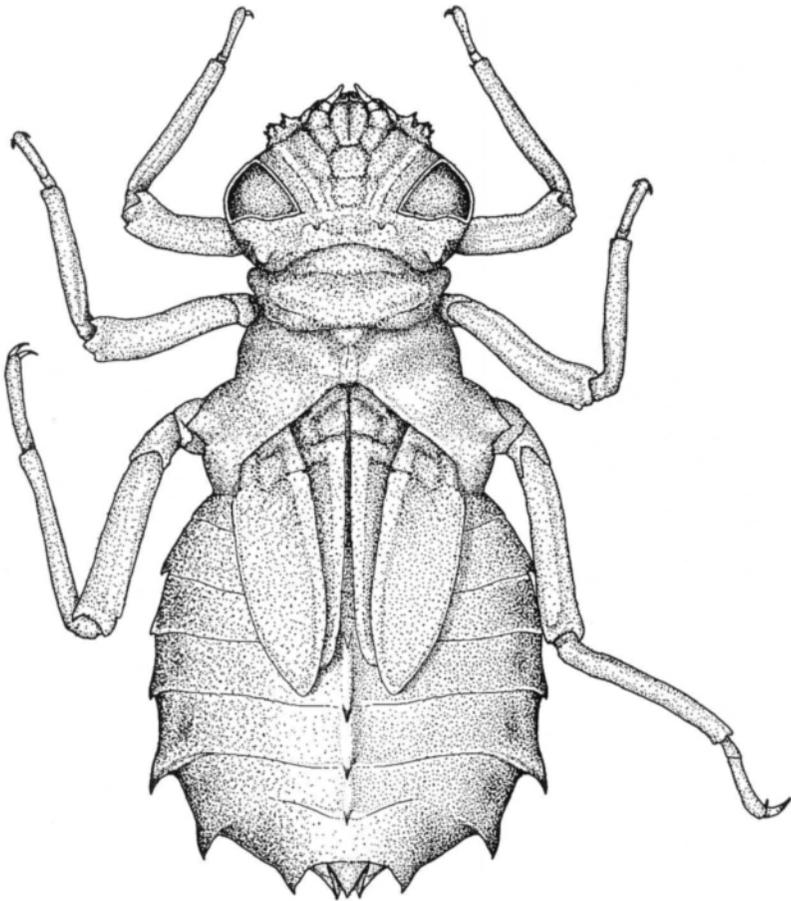


Figure 1: Exuvia of *Gomphidia bredoi* (dorsal view) — depicting the general habitus of a *Gomphidia* larva. *G. gamblesi* and *G. quarrei* resemble *G. bredoi* in shape of head, legs and abdomen.

## Discriminating characters

The larvae of the three *Gomphidia* species differ in a set of characters shown in Table 1 and Figures 2-4. Major differences are the number of abdominal segments with dorsal spines, the number of abdominal segments with lateral spines and the shape of these spines, and the number and shape of distinct projections at the post-ocular region and between the eyes.

## NOTES ON BIOLOGY AND ECOLOGY

*Gomphidia bredoi* was recorded from the Comoé National Park, Ivory Coast, at an elevation of ca 250 m. The habitat, the Comoé River, is fringed by gallery forests in the bush-tree savanna zone. Larvae were found under and between stones in rocky river sections. They were absent from sandy habitats. They were also recorded in drift-nets in the Kongo River, a temporary tributary of the Comoé River; larval drift took place in January 1992, just before the total cessation the river flow due to the dry season. Exuviae were found in March, April and May at the Comoé River, hence, at the end of the dry season, which ranges from January to April, and at the beginning of the rainy season, which starts in April or May. Most exuviae were recorded at river sections with predominantly rocky bottom and high current speed.

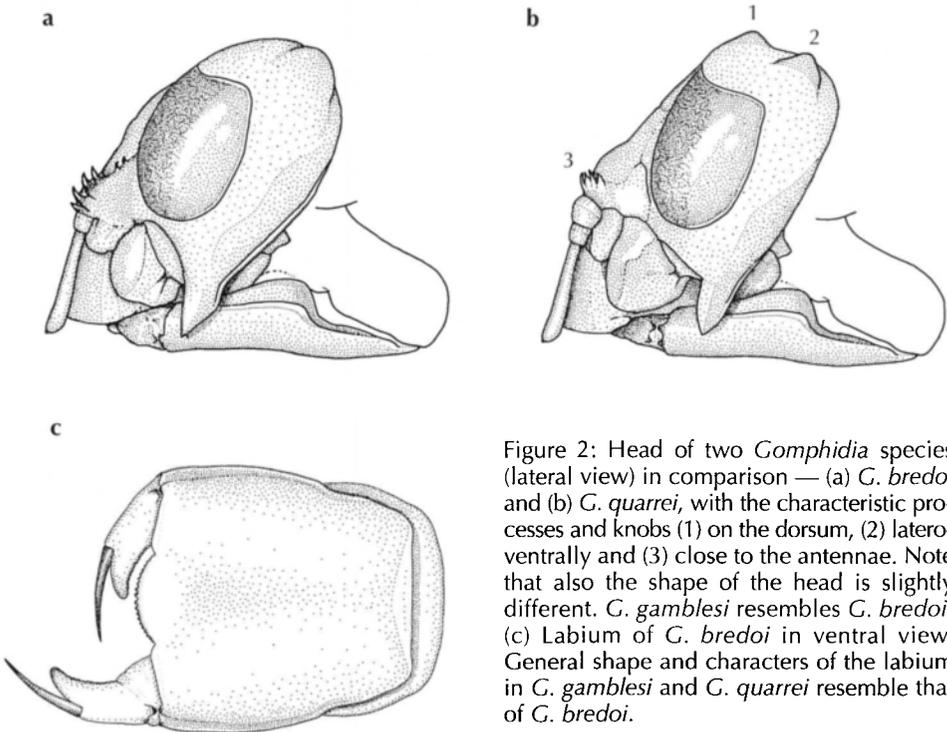


Figure 2: Head of two *Gomphidia* species (lateral view) in comparison — (a) *G. bredoi* and (b) *G. quarrei*, with the characteristic processes and knobs (1) on the dorsum, (2) latero-ventrally and (3) close to the antennae. Note that also the shape of the head is slightly different. *G. gamblesi* resembles *G. bredoi*. (c) Labium of *G. bredoi* in ventral view. General shape and characters of the labium in *G. gamblesi* and *G. quarrei* resemble that of *G. bredoi*.

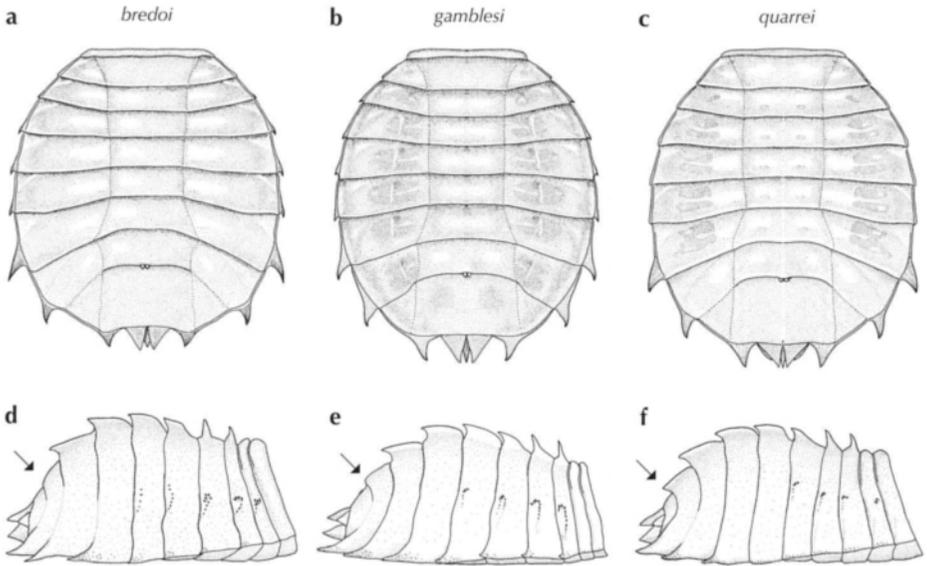


Figure 3: Shape of female abdomen in three *Gomphidia* species — ventral view (a, b, c), and lateral view (d, e, f).

*G. gamblesi* was recorded in Cameroon in the lowlands usually below 500 m. It was mainly encountered at fairly slow silty or sandy streams, but also occurred in faster gravel-bedded streams where there were slower stretches with accumulated silt. The habitats were in and adjacent to mature forest. The adults were seen flying in sunny clearings. Several sites also were found in secondary forest. The species appeared to tolerate farmbrush where this provided enough shade. Its distribution was local. There are Cameroon records of adults from the following sites: lowlands near Kumba and Tombel (South-West Province): Ebonji, Blackbush Water, River Ekom and Sandwater Falls (4.74°N, 9.52°E; 300 m) on 24 February 1996, 10 July 1996 and 3 February 1997; Etam, streams west of Mungo River and Camp Water (4.73°N, 9.56°E; 300 m) on 5/6 April 1997, 19 June 1997 and 6 April 2003; Lake Kotto (south-west of Kumba) and Tung Nuria, Tung Nsuria inlet streams (4.47°N, 9.25°E; 110 m) on 11 April 1970; lowlands N of Mamfe (South-West Province): Takamanda, Matene (6.28°N, 9.37°E; 500 m) on 27 January 1998; Takamanda, Assam (6.01°N, 9.18°E; 140 m) on 20 February 1998; lowlands to east of Mt Kupe (Littoral Province): Lala, River Ndibe (4.78°N, 9.76°E; 340 m) on 1 April 1997.

Adults of *G. quarrei* have been recorded from several rivers in Kenya, viz. the Pemba River (4.18°S, 39.4°E; Shimba Hills), Marere River (4.2°S, 39.4°E; Shimba Hills), Rongo Mwagandi River (4.3°S, 39.4°E; Shimba Hills), Mzima Springs (3.0°S, 38.0°E; Tsavo West NP), Kiboko River (2.3°S, 37.5°E; Athi Plateau), Ura River (0.0°N; 38.2°E; Meru NP), and Morun River (1.5°N, 35.5°E; Cherangani Hills), and in Tanzania from the Msingo River (5.1°S, 38.7°E; East Usambara Mts). The altitude of all the Kenyan and Tanzanian records for *G. quarrei* ranged between 150 and 930 m a.s.l., being situated largely in the coastal plains. The common habitat features were fast and clear streams or rivers with a largely sandy

Table 1. Larval characters of *Gomphidia bredoi*, *G. gamblesi* and *G. quarrei* in comparison.

<b>Character</b>	<b><i>bredoi</i></b>	<b><i>gamblesi</i></b> (by presumption)	<b><i>quarrei</i></b> (by presumption)
Head (Fig. 2)			
Postocular projections	One pair	One pair	Two pairs
Projections between eyes and antennae (# spines)	4 - 6	2 - 4	≥ 10
Abdomen (Fig. 3, 4)			
Dorsal spines	S3-8	S3-9 <sup>1</sup>	S3-9
Distinct lateral spines	S4-9	S4-9	S7-9 <sup>2</sup>
Abdomen ratio height : width	1.90	1.82	1.79
Measurements <sup>3</sup> [mm]			
Total length	19.4 / 17.7	19.4 / -	19.9 / 18.6
Abdomen length	11.1 / 10.2	11.4 / -	10.12 / 10.06
Abdomen maximum width (except lateral spines)	9.7 / 9.3	9.3 / -	10.02 / 10.01
Caudal appendages length (in ventral view)	1.0 / 0.9	1.1 / -	1.2 / 1.0
Wing case length of Fw	6.75 / 6.5	7.2 / -	6.7 / 6.5
Wing case length of Hw	6.2 / 6.1	6.7 / -	6.3 / 6.2
Head width	5.6 / 5.6	5.9 / -	5.9 / 5.7
Mentum length	3.3 / 3.2	3.4 / -	3.4 / 3.3
Mentum width	3.3 / 3.2	3.3 / -	3.1 / 3.1

<sup>1</sup> at S9 only a small dorsal hook<sup>2</sup> at S4-6 knob-like projections<sup>3</sup> female first, male second dimension

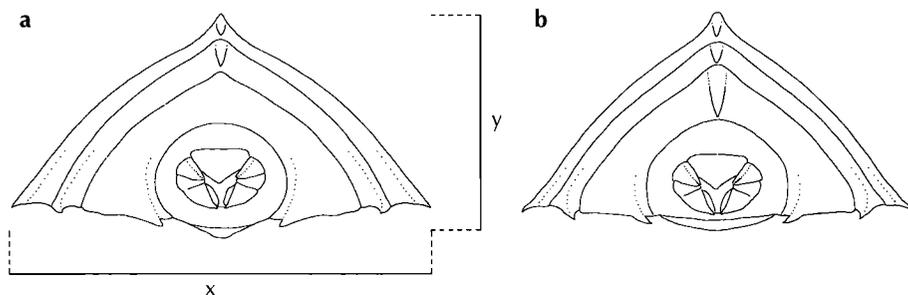


Figure 4: Abdomen of two *Gomphidia* species in caudal view — (a) *G. bredoi* with a more flattened appearance; and (b) *G. quarrei*. *G. gamblesi* resembles the latter.

riverbed in lush forest or in thornbush with at least some gallery forest along the watercourse. Adults were recorded in January, February, March, April, May, October and December in several years between 2000 and 2003. Exuviae and recently hatched adults were only found in April and May. Especially in April 2002 many exuviae were found along the Kiboko River. Since this river was quite often examined during several seasons, but exuviae were only found once, *G. quarrei* is assumed to emerge seasonally shortly before, and with the beginning of, the long rains, usually starting in April in that region.

In Namibia *G. quarrei* was recorded at several sites along the Okavango River and at one locality at the Kwando River between December and March. The habitats ranged from slow flowing, swampy river sections (at the Kwando River) to rapids (at Popa Falls, Okavango River). The exuviae were however collected at more rapidly flowing sections of the river and even directly in the rapids of Popa Falls. The altitudes of the localities ranged between 970 and 1,100m a.s.l., being situated in the Kalahari basin of southern Africa.

## DISCUSSION

The larva of *Gomphidia* resembles others of the subfamily Lindeniinae (cf. Carle 1986) regarding the general body shape and the tarsi of all legs having only two segments. From the other Afrotropical genera of the subfamily, *Ictinogomphus* and *Diastatomma*, the African *Gomphidia* particularly differ in their smaller size in the final stadium. However, specimens of *G. kelloggi* and *G. confluens* from Asia are much larger compared with *G. bredoi*, *G. gamblesi* and *G. quarrei*, thus resembling *Ictinogomphus* in size (Wilson 1995; Seidenbusch 1999; own specimens, Suhling collection). *I. ferox* (Rambur) and *I. fraseri* Kimmins may also be separated from the African *Gomphidia* species by the abdomen having a more tapered profile, with the widest part occurring more posteriorly, anterior margin of S9 not projecting

over S10 and anterior margin of head with knob like projections between eyes and antennae instead of spiny projections (Corbet 1956, 1977). The larva of *Diastatomma gamblesi* Legrand as depicted by Karsch (1893) may be distinguished by its elongated thorax and spineless dorsum of the abdomen. However, because not all species of these genera are known these separation characters are preliminary.

The exuviae of *G. gamblesi* and *G. quarrei* could not be identified with total certainty because we did not observe emerging adults at the same time. However, we here describe three forms, which can be clearly distinguished, one of them being *G. bredoi*. *G. quarrei* has been identified due to the distribution pattern of this species (see above). The only previous record of any *Gomphidia* from Kenya and Tanzania was made by Miller & Miller (1991), who reported *G. madi* from Kiboko River. Since *G. quarrei* has been found to be abundant and reproductively active from the same locality (by V. Clausnitzer) the reported *G. madi* is assumed to be a misidentification. Also the exuviae collected in Kenya resemble those of Namibia, where only *G. quarrei* occurs, in all characters. Hence, we believe the identification of *G. quarrei* is also correct. For *G. gamblesi*, although the presumed exuvia differs from that of the two other species, we have least evidence, because still unknown species may be hidden in Cameroon. Although this is unlikely at the well-worked site where the exuvia was collected, the identification should be corroborated with unequivocally assigned material.

The larvae of the African *Gomphidia* described here are to be distinguished by the numbers of lateral and dorsal abdominal spines and by the shape and arrangement of projections on the head (Table 1). A key should therefore be as follows:

1. Dorsal spine or hook at S9..... 2
- 1'. No dorsal spine or hook at S9, distinct lateral spines at S4-9; projections between eyes and antennae consist of 4-6 spine-like elements; one pair of postocular projections ..... *G. bredoi*
2. Dorsal hook on S9; distinct lateral spines at S4-9; projections between eyes and antennae consist of 2-4 spines and groups of club-shaped setae; one pair of postocular projections ..... *G. gamblesi* (by presumption)
- 2'. Prominent dorsal spine on S9; distinct lateral spines only at S7-9; extremely short lateral projections at S4-6 particularly consists of or covered by short setae; projections between eyes and antennae consist of several long setae (> 10); two pairs of postocular projections ..... *G. quarrei* (by presumption)

The head processes of *G. kelloggi* from Hong Kong (Wilson 1995) appear to differ in shape from those observed in the African *Gomphidia*. Therefore we suggest that these processes may be useful general characters for the species identification of *Gomphidia*, although they are often hidden under mud.

The tergites of S8 and S9 of the *Gomphidia* species which we have considered are directly connected without intersegmental membranes. Due to this, these segments are not movable against each other, which contrasts with normal inter-segmental connections in odonate larvae. This unusual morphological feature has also been recorded in the libellulids *Olpogastra fraseri* Pinhey, *O. fuelleborni* Grünberg

and *O. lugubris* (Karsch) (F. Suhling and O. Müller unpubl.), which all share a generally similar shape of abdomen with *Gomphidia*. This feature may increase the rigidity of the abdomen and may be attributed to the running water habitat of the species.

## ACKNOWLEDGEMENTS

We thank Klaas-Douwe Dijkstra for allowing us to cite an unpublished manuscript on Afrotropical lindeniine Gomphidae. We thank Roger Cammaerts and Bernd Kunz for comments on the final draft of this paper. The studies of Viola Clausnitzer and Frank Suhling were supported by the BMBF, German Ministry for Science and Education: BIOLOG Programme 01LC0025 and 01LC0404 (VC) as well as 01LC0024 (FS).

## REFERENCES

- Carle, F.L., 1986. The classification, phylogeny and biogeography of the Gomphidae (Anisoptera). I. Classification. *Odonatologica* 15: 275-326.
- Clausnitzer, V., 2003. Dragonfly communities in coastal habitats of Kenya: indication of biotope quality and the need of conservation measures. *Biodiversity and Conservation* 12: 333-356.
- Corbet, P.S., 1956. Larvae of East African Odonata. Introduction and 1. *Ictinogomphus ferox* Rambur. *The Entomologist* 89: 97-100.
- Corbet, S.A., 1977. Gomphids from Cameroon, West Africa (Anisoptera: Gomphidae). *Odonatologica* 6: 55-68.
- Davies, D.A.L. & P. Tobin, 1985. The dragonflies of the world: a synopsis of the extant species of Odonata. Vol. 2: Anisoptera. *Societas Internationalis Odonatologica Rapid Communications (Supplements)* 5: i-ix, 1-151.
- Fraser, F.C., 1956. Results from the Danish expedition to French Cameroons 1949-50. XIV. Odonata: Nymphs. *Bulletin de l'Institut Français d'Afrique Noire (A)* 18: 949-959.
- Karsch, F., 1893. Libellen – Odonata – von Adeli. *Berliner Entomologische Zeitschrift* 38: 2-48, pls I-V.
- Martens, A., R. Jödicke & F. Suhling, 2003. Annotated checklist of the Odonata of Namibia. *Cimbebasia* 18: 139-160.
- Miller, P.L. & A.K. Miller, 1991. The dragonflies of Hunter's Lodge, Kenya, 1981-1991. *Notulae Odonatologicae* 3: 113-136.
- Samways, M.J., 1999. Diversity and conservation status of South African dragonflies (Odonata). *Odonatologica* 28: 13-62.
- Seidenbusch, R., 1999. Description of two last instar larvae out of the genus *Gomphidia* (Odonata, Anisoptera, Gomphidae). *Sulzbach-Rosenberger Libellenrundbriefe* 11: 7 pp.
- Suhling, F. & O. Müller, 1996. Die Flußjungfern Europas. Gomphidae. *Die Neue Brehm-Bücherei* 628. Westarp & Spektrum, Magdeburg.
- Wilson, K.D.F., 1995. The gomphid dragonflies of Hong Kong, with descriptions of two new species (Anisoptera: Gomphidae). *Odonatologica* 24: 319-340.