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Namibian Dragonflies: Larval Key and Distribution

Supplement 13

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Larvae of *Diplacodes levebvrii*, *Mastinogomphus dissimilis*, and *Pseudagrion massaicum*
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The dragonfly larvae of Namibia (Odonata)

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Drawings by Ole Müller, unless noted otherwise

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Abstract

We present an illustrated key to the exuviae and final stadium larvae of the dragonflies of Namibia. We have also included some taxa from neighbouring areas, which have not been recorded in Namibia yet. The key is therefore applicable also in southern Angola, most of Botswana and the Northern Cape province of South Africa. It includes identification characters of taxa hitherto undescribed, viz. *Lestes pallidus*, *Pseudagrion deningi*, *P. rufostigma*, *Ictinogomphus dundoensis*, *Crenigomphus cornutus*, *C. kavangoensis*, *C. hartmanni*, *Paragomphus cataractae*, *P. elpidius*, *P. sabicus*, *Mastigogomphus dissimilis*, *Anax bangweuluensis*, and *Phyllomacromia overlaeti*, and for the first time keys for some widespread African species pairs, such as *Tramea basilaris* and *T. limbata*, and *Zygonyx torridus* and *Z. natalensis*. However, the larvae of many species and even four out of 50 genera occurring in Namibia are still unknown. Therefore, this key remains preliminary.

Zusammenfassung

Die Larven der Libellen Namibias (Odonata). – Ein Bestimmungsschlüssel für die Exuvien und die letzten Larvenstadien der Libellen Namibias wird vorgestellt. Er enthält darüber hinaus einige Taxa, die in benachbarten Gebieten vorkommen und bisher noch nicht in Namibia gefunden wurden. Der Schlüssel ist auch in Süd-Angola, Botswana und der nördlichen Kapprovinz der Republik Südafrika verwendbar. Von bisher unbeschriebenen Larven wie denen von *Lestes pallidus*, *Pseudagrion deningi*, *P. rufostigma*, *Ictinogomphus dundoensis*, *Crenigomphus cornutus*, *C. kavangoensis*, *C. hartmanni*, *Paragomphus cataractae*, *P. elpidius*, *P. sabicus*, *Mastigogomphus dissimilis*, *Anax bangweuluensis* und *Phyllomacromia overlaeti* werden erstmals Bestimmungsmerkmale vorgestellt, zudem für die in Afrika weit verbreiteten Artenpaare *Tramea basilaris* und *T. limbata* sowie *Zygonyx torridus* und *Z. natalensis*. Die Larven vieler Arten und selbst vier von 50 der in Namibia vorkommenden Gattungen sind derzeit noch unbekannt. Damit bildet dieser Bestimmungsschlüssel die Arten nach unserem derzeitigen Kenntnisstand ab und hat deshalb vorläufigen Charakter.

Introduction

As dragonflies are useful indicators of freshwater ecosystem health (cf. Clausnitzer & Jödicke 2004), keys are essential to permit their identification. During the last decade a number of keys have been published that allow the identification of adults of African dragonfly species, for instance for South Africa (Tarboton & Tarboton 2002, 2005; Samways 2008), Namibia (Suhling & Martens 2007), and East Africa (Dijkstra & Clausnitzer in press). As a consequence of the existence of such keys the pattern of dragonfly biodiversity on the African continent is fairly well known (Clausnitzer et al. 2012) and indicator systems for the environmental health of freshwater habitats based mainly on dragonfly adults (e.g. Simaika & Samways 2010) can therefore be applied.

However, assessment systems based on freshwater macroinvertebrates in most cases use larvae and the species level should be the default taxonomic level (Jones 2008). For instance, the European AQEM system acts mainly on the species level, even if coarser identifications are partly accepted (Hering et al. 2004). But, species level keys are often non-existent for the African continent. Therefore, for practical reasons assessment systems often act at the family level. This is even the case in the South African Scoring System (SASS) (Dickens & Graham 2002), where guides to the freshwater invertebrates are available which in many taxa allow identification at least to the genus level (e.g. Samways & Wilmot 2003 for Odonata).

For African Odonata, a larval key to the family level was published by Pinhey (1985). A key to dragonfly larvae of Cameroon by D.G. Chelmick remains unpublished, but is available on request from the author. The most recent and most comprehensive regional key available so far allows the identification of most genera and many species occurring in South Africa (Samways & Wilmot 2003). Besides this, mainly descriptions of the larvae of single species have been published, for instance by Corbet (1956a-c, 1957a-c) and a South African-Italian consortium (e.g. Carchini et al. 1992a, b; Di Domenico et al. 1994, 2001; Samways et al. 1992, 1993a, b, 1997). For an overview of published descriptions see the Appendices 1 and 2 to this publication. Keys that compare all, or even most, African species of a genus are rare. Chelmick (1999, 2001) published keys to the African species of the aeshnid genera *Aeshna* and *Anax*. Müller et al. (2005) keyed the African species of *Gomphidia* and Dijkstra et al. (2006) the species of *Zygonoides*.

The work presented here is our contribution to capacity building in the framework of the BIOTA project. As a first step we published a handbook to the dragonflies of Namibia (Suhling & Martens 2007), which included keys to the adults as well as some simple identification charts to the larvae. The illustrated identification key to the final stadium larvae and exuviae presented here completes our engagement, although the key is not yet finalized since several species cannot yet

be identified. However, we aimed to make our knowledge available and hope that future researchers may be able to fill the gaps.

During our studies of Namibian Odonata we initially focused on the desert-dwelling dragonflies and only later became involved in studying the dragonflies in the more humid parts of the country, i.e. along the Okavango River and in the Caprivi. The key is therefore most comprehensive for the arid parts of the country. Most of the species occurring there can be identified to species level. The key is also applicable in the humid parts of Namibia and, by including some additional species, in the neighbouring provinces of the surrounding countries (Fig. 1). It allows the identification of almost all genera, and in most families the key also allows the identification to species level or summarises the identification characters of the known species.

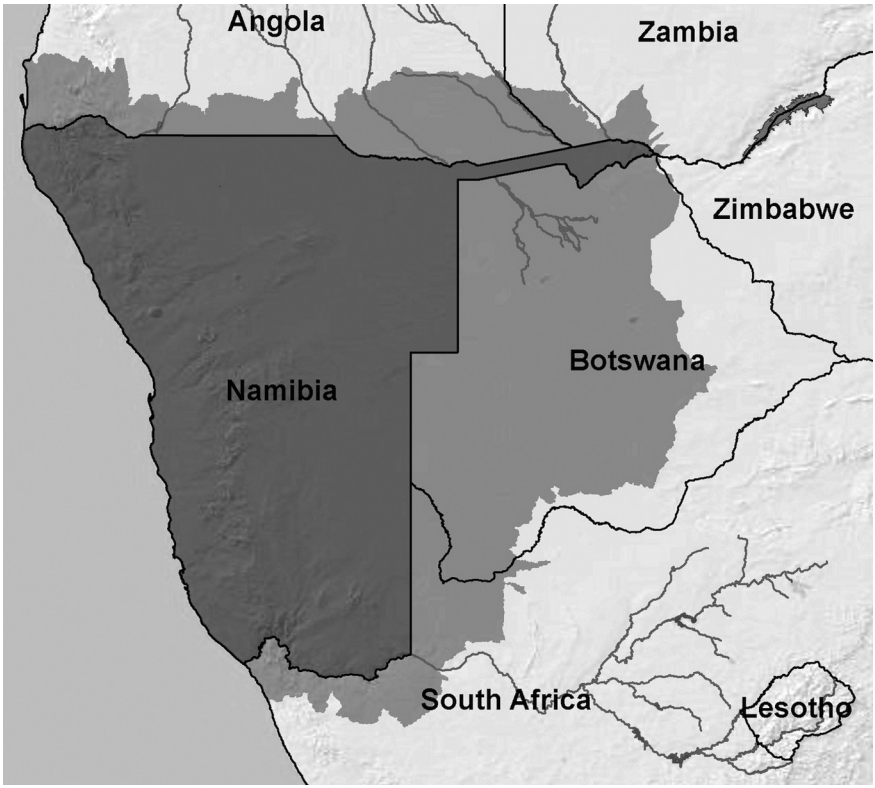


Figure 1. Geographical scope of this key.

So far 50 Odonata genera are encountered in Namibia (cf. Martens & Suhling 2014) of which we could key all except for four genera, for which no material is available (Appendix 1). We include nine more genera which have not yet been recorded in Namibia, but occur in the neighbouring countries. The knowledge at the species level is much poorer: for 44 out of the 130 species (33%) recorded as adults no collected specimens or descriptions of larvae or exuviae were available to us. We take 20 more species from the adjacent area into consideration (cf. Appendix 2). Particularly in the species-rich genera, i.e. *Pseudagrion*, *Orthetrum* and *Trithemis*, the larvae of many species remain unknown. In these genera we did not produce identification keys, as the unknown characters of the remaining species might confuse or mislead users. In contrast to other families the larvae of most gomphids of the region can be distinguished. The major reason is that gomphid larvae often are very distinct in their body shape, which is linked to their larval habitat. In addition, the exuviae are usually easy to find and often abundant at river margins, so that the material for a higher proportion of species is available than for other families.

Material and methods

The identification key presented here is based on published larval descriptions as well as on specimens collected in several parts of Africa. The sources of the material and the references are summarised in the Appendices 1 and 2. We tried to only use specimens that have been clearly identified; in most cases by having adults emerged from collected larvae. In some cases we lack clear confirmation of the species identity, e.g. because rearing failed or only exuviae were found. However, in a number of such cases we were able to infer the species' identity as most other species of a given genus were already known or several freshly emerged specimens of a species were observed in the vicinity. In those cases we tentatively assigned the larvae or exuviae to the supposed species. Most illustrations are drawn from exuviae or preserved material by OM. However, in some cases illustrations of other authors were redrawn (also by OM); see overview of Figures in Appendix 3.

How to find and handle dragonfly larvae and exuviae

Collection and handling of exuviae

The key presented here is mainly based on exuviae, i.e. the skins of the final stadium larvae, which remain on supports near the water after the adult hatched. Generally, exuviae are relatively easy to find along all kinds of freshwater habitats. In most cases the final stadium larva crawls onto stems of plants emerging from the water, such as reeds, or into the vegetation along the shore. Exuviae of Gomphidae can also be found on the ground near the shoreline or even on float-

ing algal mats. Places that are of particular interest are trunks and roots of overhanging trees, which are quite often used as supports by larvae leaving the water. These trunks may protect the exuviae from being washed away after heavy rains. For emergence the larvae may climb up to 3 m into the tree or crawl as far as 20 m away from the shoreline. However, these are maximum distances and usually the exuviae are much closer to the water.

For collecting one should carry a number of small containers, for instance film tubes, in which the exuviae can be stored. Do not forget to note collection date and locality on a label, allowing a clear localisation of your record. Sometimes exuviae are wet, e.g. if it has been raining. In such cases they should be dried to prevent them from decay. Small spiders often use the interior of exuviae as dens, which should be removed to prevent them spinning silk over the exuviae.

For identification it will often be necessary to clean the exuviae. In particular the skins of those species that live on or buried in the sediment, e.g. exuviae of the genus *Orthetrum*, have mud stuck between the setae which densely cover the body. For cleaning, the exuviae should be soaked in a small amount of water with a drop of washing-up liquid until the mud can easily be removed with a fine brush. After the cleaning process the exuviae should be dried again for storage or preserved in 70% alcohol. Generally, it is useful to wet exuviae for handling, which reduces damage and allows the flexible parts to be moved, e.g. for opening of the labium, which may be necessary to count setae.

Collection and rearing of larvae

Because the larvae of many species of dragonflies are still unknown, it is useful to capture dragonfly larvae in order to rear them to the adult stage. Exuviae with associated adults can be identified by using keys for imagines (Tarboton & Tarboton 2003, 2005; Samways 2008; Suhling & Martens 2007). If the reared adult cannot be identified it may be preserved together with its exuviae in ≥ 70% alcohol for later identification.

Dragonfly larvae are readily sampled in most kinds of freshwater, e.g. ponds and rivers. The best tool for sampling is a hand net with a long and robust handle. The frame of the net should have a straight edge allowing sampling of bottom substrates. A solid frame allows collecting between vegetation, e.g. reeds and rushes, while the net gauze needs to be finer than normal fishing nets, e.g. a mesh size of 0.5 mm to 2 mm. Two sampling methods may be applied. The first is 'shovelling' the net back and forth among water weed, along rushes and along the bank (Samways & Wilmot 2003). The second is the so-called 'kick-sampling' method during which a current is produced by foot ('kicking') or a broom, thus shovelling water and substrate into the net. You should avoid collecting too much mud or debris, which would hamper finding the larvae. The net is lifted out of the water and the content emptied into a larger pan, preferably with white bottom, which allows

you to detect larvae more easily. Dragonfly larvae usually start to move after a while when removed from the water. Collect only large, preferably final stadium larvae, which are likely to emerge within a short period after collection. Final stadium larvae are easily recognised by the prominent wing sheaths extending over at least half of the abdomen.

If larvae cannot be reared for some reason but need to be preserved it should be taken into account that the cuticle of dragonfly larvae is quite thick. If they have just been put in alcohol the preservative will usually not penetrate to the stomach and therefore the larva will partly decay. Larvae preserved in this way usually have a swollen appearance and not all relevant characters can be studied easily. To avoid this, one should make one or more holes into the larval cuticle (from the ventral side) that perforates the stomach so that the alcohol can penetrate and preserve the inner organs.

If transport is required, the larvae should be kept individually if possible. Dragonfly larvae are predators and cannibalistic, thus will feed on smaller larvae in the same container. Hence, often only the largest larva survives transport. The containers should not be filled with too much water as the oxygen in the water may otherwise be used up, particularly if longer transport is needed. For longer-lasting transport dragonfly larvae are best transported on well-wetted filter paper or textile (e.g. flannel) with very little water. The dragonfly larvae are able to breathe oxygen in the air as long as their breathing organs, i.e. the caudal lamellae or the rectal gills, stay wet. This method of transport also minimises predation among larvae, thus more than one larva may be transported in a single container.

For rearing it is necessary to keep a single larva in each rearing container to ensure the right association of larvae and adults and to prevent cannibalism. The containers should be provided with some substrate onto which the larva may climb (in the case of Zygoptera, Aeshnidae or many Libellulidae) or with some sand that is useful particularly for burrowing larvae like Gomphidae. An emergence support also has to be provided. A lid, e.g. gauze, must enclose the container.

The water in the rearing containers should be de-chlorinated and replaced by fresh water every now and then. Aeration of the water is not needed in most cases, with the exception of some running water species. The larvae should be fed with mosquito or chironomid larvae or with water fleas (*Daphnia*) or other small crustaceans. Other freshwater organism can also be used as prey, including mayflies, smaller dragonfly larvae, small tadpoles, and small fish (the latter particularly for Aeshnidae). Larvae should be fed daily and uneaten remains have to be removed from the containers on a regular basis to reduce the growth of fungi or bacteria. Gardner (1952) and Samways & Wilmot (2003) summarise rearing methods. After emergence the exuviae and emerged adults should be handled as described above.

Figure 2. Ole Müller is sampling dragonfly larvae in ponds at our field station at Tsaobis Leopard Nature Park (08-iv-2003). Photo: AM

Figure 3. Set up for rearing, photographing, and measuring of dragonfly larvae in our field station, here by Frank Suhling. The containers in the rack are used for rearing of larvae from the egg (07-iv-2003). Photo: OM

Terminology

Most of the characters used are illustrated in the key. Some of the more frequently used terms are briefly described and illustrated here. For convenience, we have simplified some terms. For example, we call all separate parts of the antennae or legs segments, although anatomically some may only be subunits of single segments.

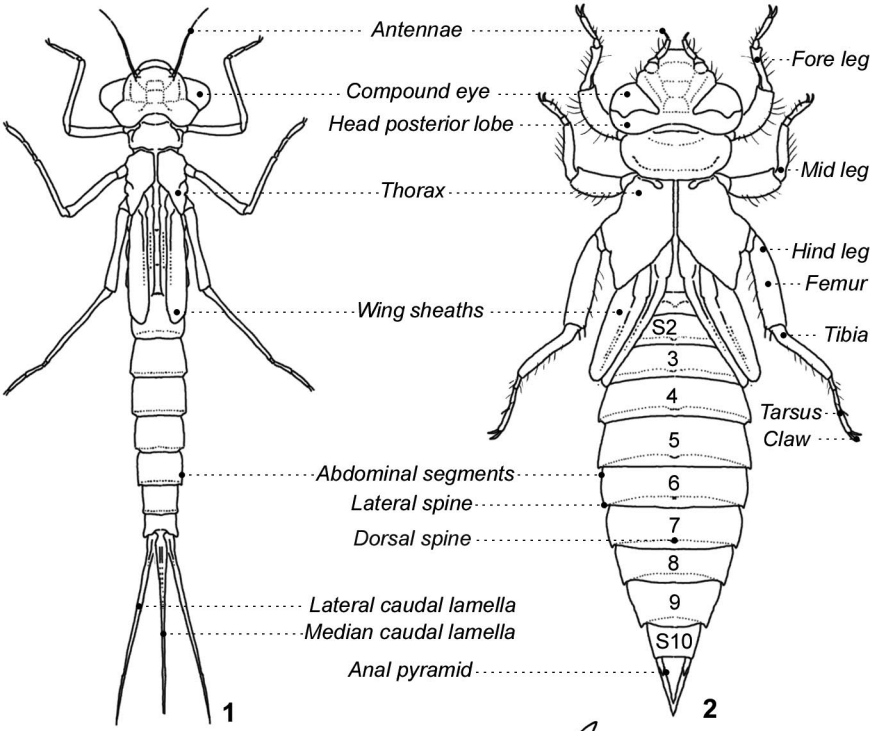
General habitus: The body has a typical insect appearance, i.e. consisting of head, thorax, and abdomen and having six legs [1-4].

Head: The head bears several relevant morphological elements that are useful identification characters. Besides the antennae, the eyes, the labium, and particularly projections of the cuticule situated between the antennae, on both sides of the antennae, below the eyes or at the posterior lobes of the head may be relevant [5]. The shape of the posterior lobes or their size relative to the eyes may also be specific.

Thorax: The central part of the body bearing three pairs of legs and two pairs of wing sheaths. The thorax does not provide many distinct characters. However, lateral prothoracic projections are relevant for identification of the Aeshnidae. In some cases, the total length of the legs is an identification character and is associated with larval behaviour and habitat.

Abdomen: The abdomen consists of ten segments, of which the first one is hardly visible. Counting should therefore be done from the back starting with segment 10, to which the caudal lamellae in Zygoptera [1, 3] or the anal pyramid in Anisoptera [2, 4] are attached. The abdominal segments are numbered as S10 (segment 10), S9, S8, etc.

Setae: These are hair-like projections of the cuticule situated over most of the body. Relevant characters may be setae on the inner side of the prementum, on the labial palps [Plate 02: 9], or on the abdominal segments (particularly on the rear ends, Plate 03). The number of setae is sometimes used for identification, but their value is limited due to wide variation. However, in some cases it will be necessary to open the labium to count setae. In many cases setae may cover other details that are relevant for identification, e.g. spines. We usually illustrate the body without setae; the difference is shown in [5] where one half of the head is illustrated with, the other one without setae (see also Plate 03: 2, 4).


Antennae
Compound eye
Head posterior lobe
Thorax
Wing sheaths
Abdominal segments
Lateral spine
Dorsal spine
Lateral caudal lamella
Median caudal lamella
Anal pyramid
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Fore leg
Mid leg
Hind leg
Femur
Tibia
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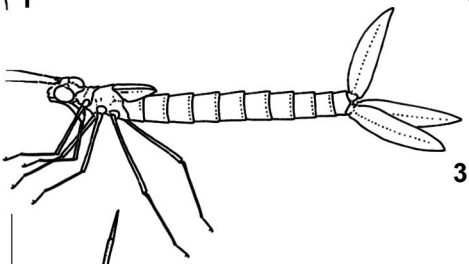
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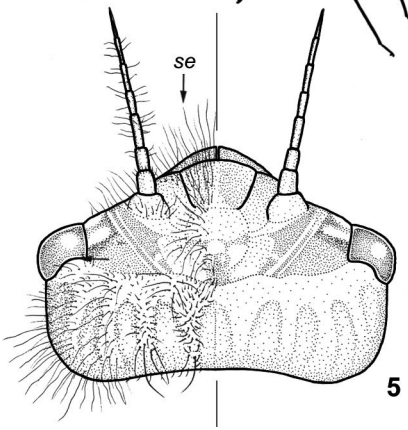
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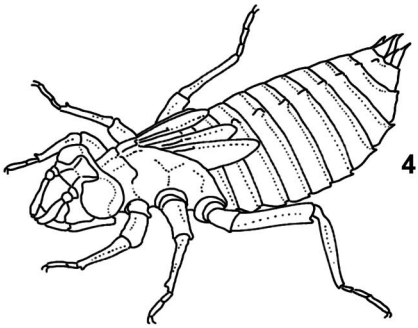
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Plate 01

Identification characters of the head and prothorax

Antenna	an
Antennomeres (segments)	as
Crenations	cr
Eye	ey
Gap	gp
Labium	la
Labial palpus	lp
Posterior lobe	pl
Prementum	pm
Prothorax projections	ppr
Head projetions	pr
Prothorax	pt
Setae	se

Compound eyes: The importance of vision varies; species that use mainly visual perception usually have large eyes bearing a higher number of ommatidia (the single lenses that form the compound eyes), while species with more tactile perception have small eyes. The shape and size of the eyes is used as a character in Aeshnidae and Libellulidae.

Antennae: The antennae are major sensory organs, which are used as mechano- as well as chemoreceptors. Together with receptors on the legs they allow tactile perception of prey. The antennae are often small [1, 2, 4] and may be covered by mud in bottom dwelling species. In Zygoptera they are usually longer to very prominent in Calopterygidae. The numbers of segments (antennomeres) of the antennae are four in gomphids [6, upper drawing] and six to seven in all other odonates [6, lower].

Labium: A unique character of odonate larvae is the extendable labium, which enlarges the operating distance for prey capture significantly [1, 3]. The labium consists of four moveable elements, the postmentum, the prementum and two labial palps. The prementum is the visible part of the labium when it is contracted. Two movable extensions of the prementum are the labial palps [7, 9, 10]. The prementum together with the palps occurs in two different types: forceps [1] and shovel-shaped [4]. In the shovel type the palps cover parts of the face [6]. In the forceps-like type the palps are sharp and do not cover the face. The anterior part of the prementum between the labial palps, the median lobe, can be differently shaped. Crenations of the palps [8] and setae [9, 10] are used as characters. Therefore, the labium has to be opened. In exuviae, this can be done after wetting the chitin for some minutes.

Projections: Protuberances of the cuticule situated between the antennae, on both sides of the antennae, below the eyes or at the posterior lobes of the head are relevant characters in gomphids [5]. In aeshnids there are such projections at the prothorax [2].

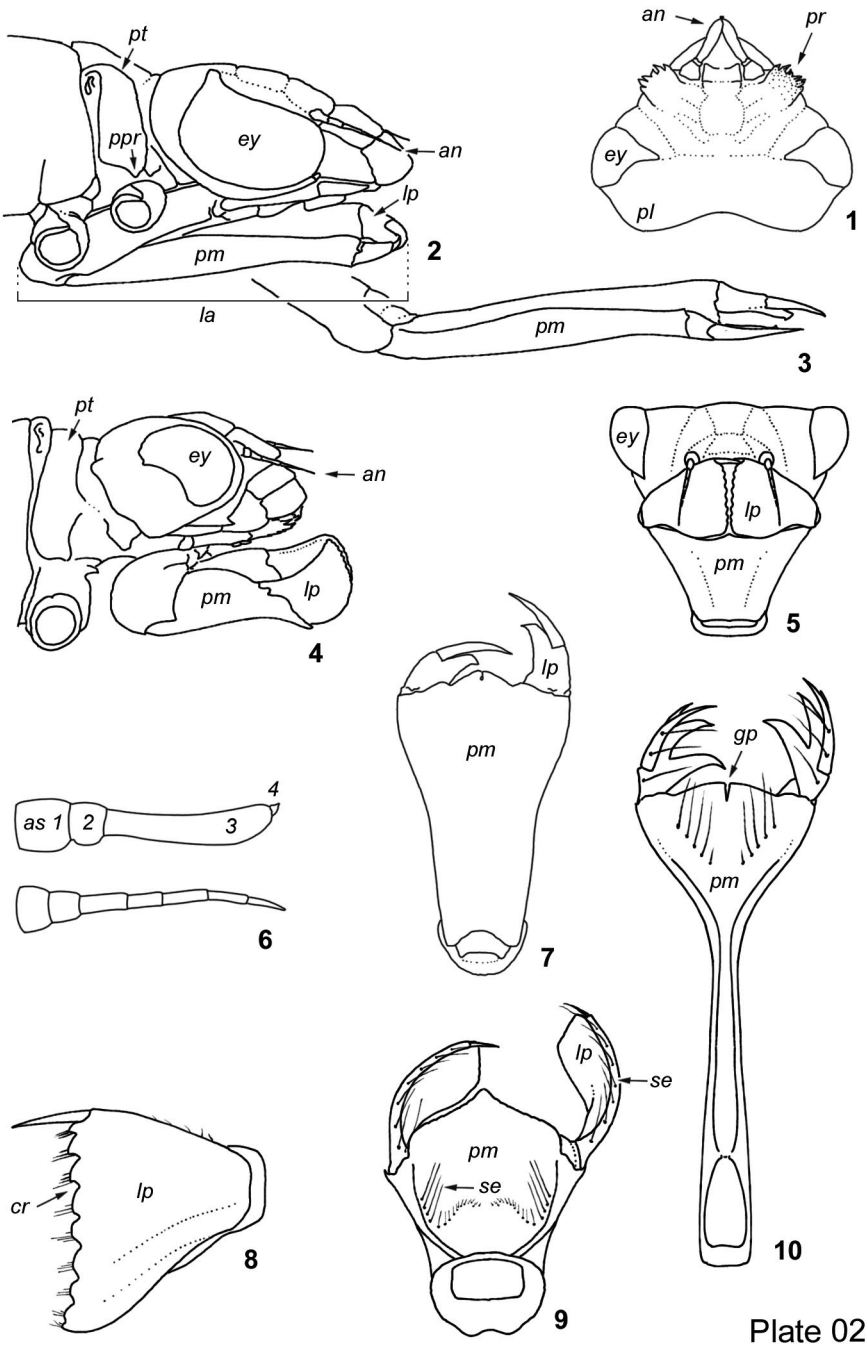
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Plate 02

Identification characters on the abdomen

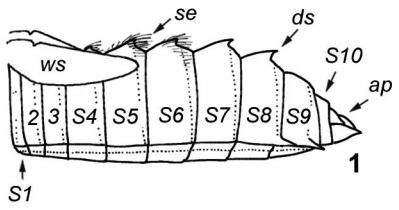
Anal pyramid	ap
Cercus	ce
Dorsal spine	ds
Epiproct	ep
Lateral spine	ls
Nodus	nd
Paraproct	pp
Abdominal Segment 10	S10
Setae	se
Tip of lamellae	tp
Wing-sheaths	ws

Colouration: Many larvae have colour-patterns as drawn in [4]; in some genera these are species-specific and can be used for identification, for instance on the lamellae of *Pseudagrion*.

Spines: Many Anisoptera larvae bear spines on the back (dorsal spines), which are best visible in lateral view [1, 2] and/or on the sides of the abdomen (lateral spines), which should be inspected in ventral or dorsal view [3, 4]. Sometimes these spines are very small and hidden by setae, as on S5 in [1], or covered by mud. It is often necessary to clean the abdomen from mud to determine whether spines are present [1] or not [2]. Dorsal spines may have a keel-like or a rather rounded base, they may be sharp, strongly curved or rather knob-like, without a real tip. "Dorsal spines on S8 and S9" means spines on the dorsum (tergites or upper part) of the abdomen on segments 8 and 9.

Anal pyramid: The rear end of the abdomen of Anisoptera is pyramid-shaped [1-8]. The pyramid consists of five parts [5-8], the central epiproct, two paraprocts and two cerci, which are movable and are used to close the rectum. Mainly in aeshnids the sharp anal pyramid can be used as a weapon to sting predators. The length of the pyramid in relation to the abdominal segments and the length relation between the epiproct, the paraprocts, the cerci and the lateral spines are used for identification.

Caudal lamellae: The zygopteran abdomen terminates in three leaf-like projections [9], two lateral lamellae and one median lamella. The median lamella is often slightly different in shape from the other two and in the Chlorocyphidae it is completely reduced. The shape, the colour patterns of the lamellae, the structure of the margins, and the shape of the tip [11] are useful identification characters. The dorsal margin may be disrupted by a 'nodus' [10]. The lamellae have a breakable joint to the abdomen and can therefore be discarded ('autotomised') or be accidentally broken when larvae are caught. One often finds Zygoptera with one or more missing lamellae. If the lamellae break off in earlier stadia they may regrow, but are then smaller than normal.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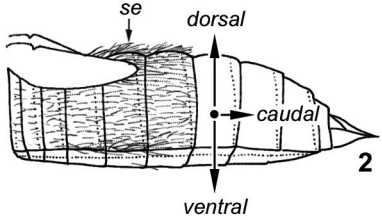
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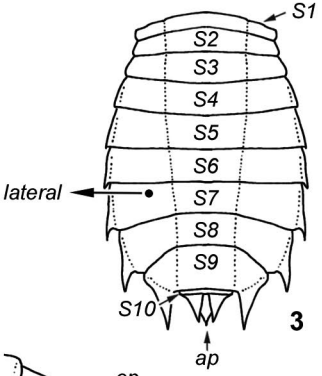
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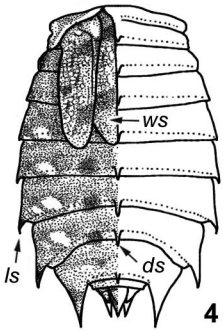
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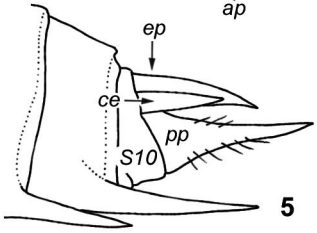
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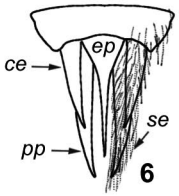
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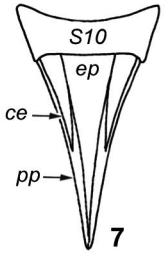
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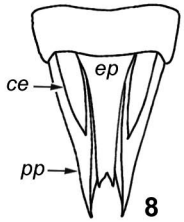
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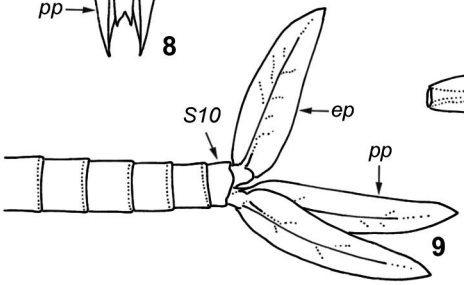
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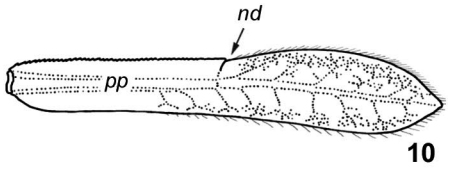
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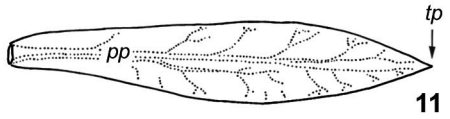
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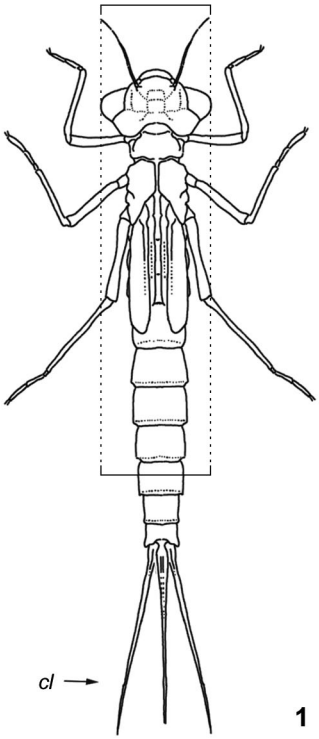
Plate 03

Key to the sub-orders

1 Larvae with three, sometimes two, caudal lamellae; body slender, head usually wider than widest part of abdomen [1], variation in habitus [1, 3-5] ..... **Zygoptera, p. 20**

– Larvae without caudal lamellae, but with anal pyramid; body robust; head not or only slightly wider than abdomen [2], variation in habitus [2, 6-8] ..... **Anisoptera, p. 22**



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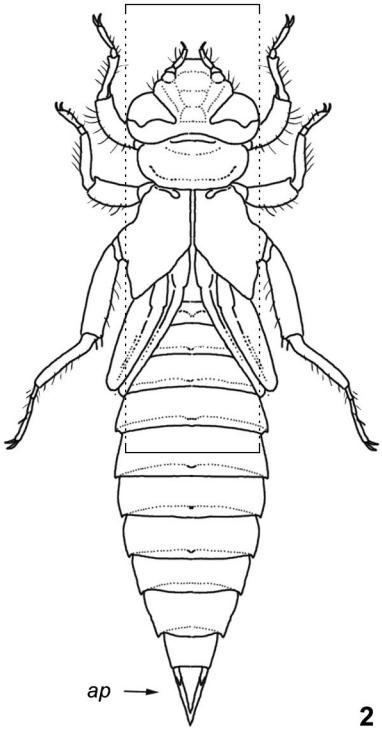

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Plate 04 - 05

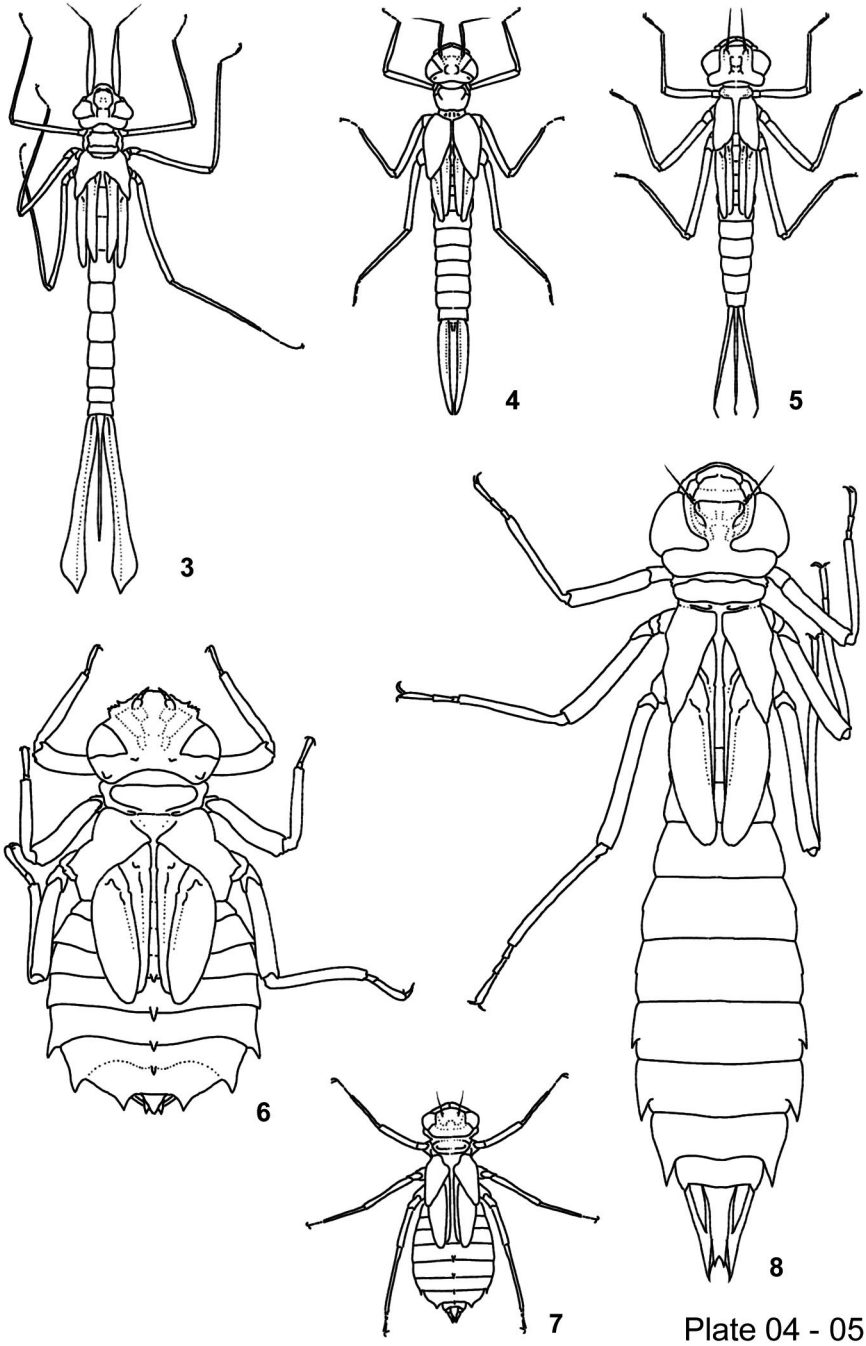


Plate 04 - 05

Zygoptera – key to the families

Species of five families occur: Calopterygidae, Chlorocyphidae, Lestidae, Platycnemididae (including the genus *Elattoneura*), and Coenagrionidae. The two latter families are here summarized as Coenagrionoidea, since distinct family characters could not be identified. In addition, we key out the family Synlestidae which has not been recorded from Namibia, but occurs in South Africa.

1 First antennal segment elongated, significantly longer than the other antennal segments [1] **2**

– First antennal segment short, about as long as the other segments [2] **3**

2(1) Three caudal lamellae [3], prementum with large central gap [4]; lamellae foliate in lateral view [5] ..... **Calopterygidae, p. 24**

– Two caudal lamallae [6], prementum with small central gap [7]; lamellae sabre-shaped [8] ..... **Chlorocyphidae, p. 26**

3(1) Caudal lamellae usually with a distinct tip [9]; labial palps with dorsal setae [10, 11] **4**

– Caudal lamellae without a tip, very rounded apically [12]; labial palps without dorsal setae ..... **Synlestidae, p. 20**

4(3) Prementum long and often spoon-shaped with median lobe incised [10]; eye as long as the length of the head; body very slender with head much wider than body [13] ..... **Lestidae, p. 28**

– Prementum short and trapeziform [11], not incised; eye at most ⅔ of the length of the head; body more compact [14] ..... **Coenagrionoidea, p. 30**

Synlestidae

The family Synlestidae occurs with a number of species in South Africa. Most larvae are not yet described, with the exception of *Chlorolestes conspicuus* Selys, 1862, described by Barnard (1921, 1937) and *C. fasciatus* (Burmeister, 1839) described by Samways & Whiteley (1997).

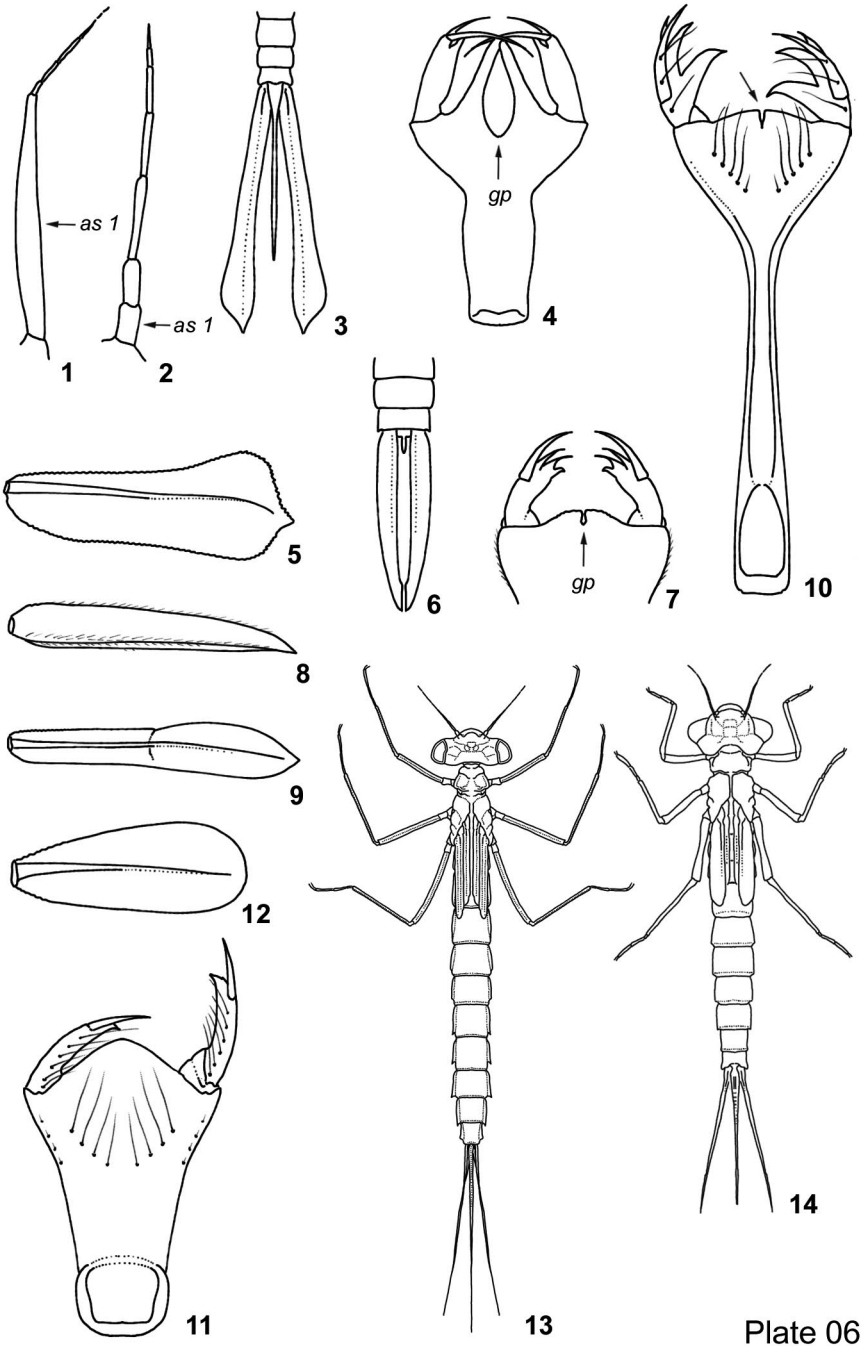


Plate 06

Anisoptera – key to the families

Four families occur: Gomphidae, Aeshnidae, Macromiidae, and Libellulidae. In addition we key out the Corduliidae s.l. of which some species occur in South Africa (see below).

1 Labium flat; does not cover the face when fully closed [1] **2**

– Labium shovel-shaped, the palpae cover the face up to the eyes when fully closed [2, 5, 7, 9] **3**

2(1) Antennae with four segments, third segment distinctly longer than the others, terminal segment sometimes hardly visible [3] ... **Gomphidae, p. 42**

– Antennae with seven segments, third segment is not longer than the other segments [4] ..... **Aeshnidae, p. 56**

3(1) Forehead with distinct horn-like projection [5]; crenations at distal margins of labial palps about as deep as wide [6]; larvae with extremely long spidery legs, hind leg about twice as long as abdomen length ..... **Macromiidae, p. 62**

– Never a horn on the forehead [7,9] (but sometimes projections on other parts of the head, and if so, no crenations at the labial palps); distal margins of labial palps with crenations less deep than wide [8] or without crenations [10]; legs shorter **4**

4(3) Cerci about as long as the paraprocts and anal pyramid not longer than S9 [11]; labial palps always with crenations as in [8|; medio-basal groove on the ventral surface of the prementum [14] . **Corduliidae s.l., p. 22**

– Cerci shorter, at most about or less than half as long as the paraprocts [12]; if cerci more than half as long as paraproct [13], anal pyramid longer than S9 or no crenations at labial palps as in [10]; no medio-basal groove on the ventral surface of the prementum [15] ..... **Libellulidae, p. 64**

Corduliidae s.l.

The family is not represented in Namibia but the genus *Syncordulia* occurs in the Western Cape, South Africa. The identification of several larvae in the NMNW collection as *Syncordulia* was due to misleading key characters. We included Corduliidae here mainly to avoid further misidentification. The characters used here would generally help to distinguish Corduliidae from Libellulidae. According to the most recent phylogeny it is not clear to which family the four South African species of *Syncordulia* may belong (Dijkstra et al. 2013). They are surely part of the Corduliidae in the broader sense. The larvae however look like Corduliidae s.str.

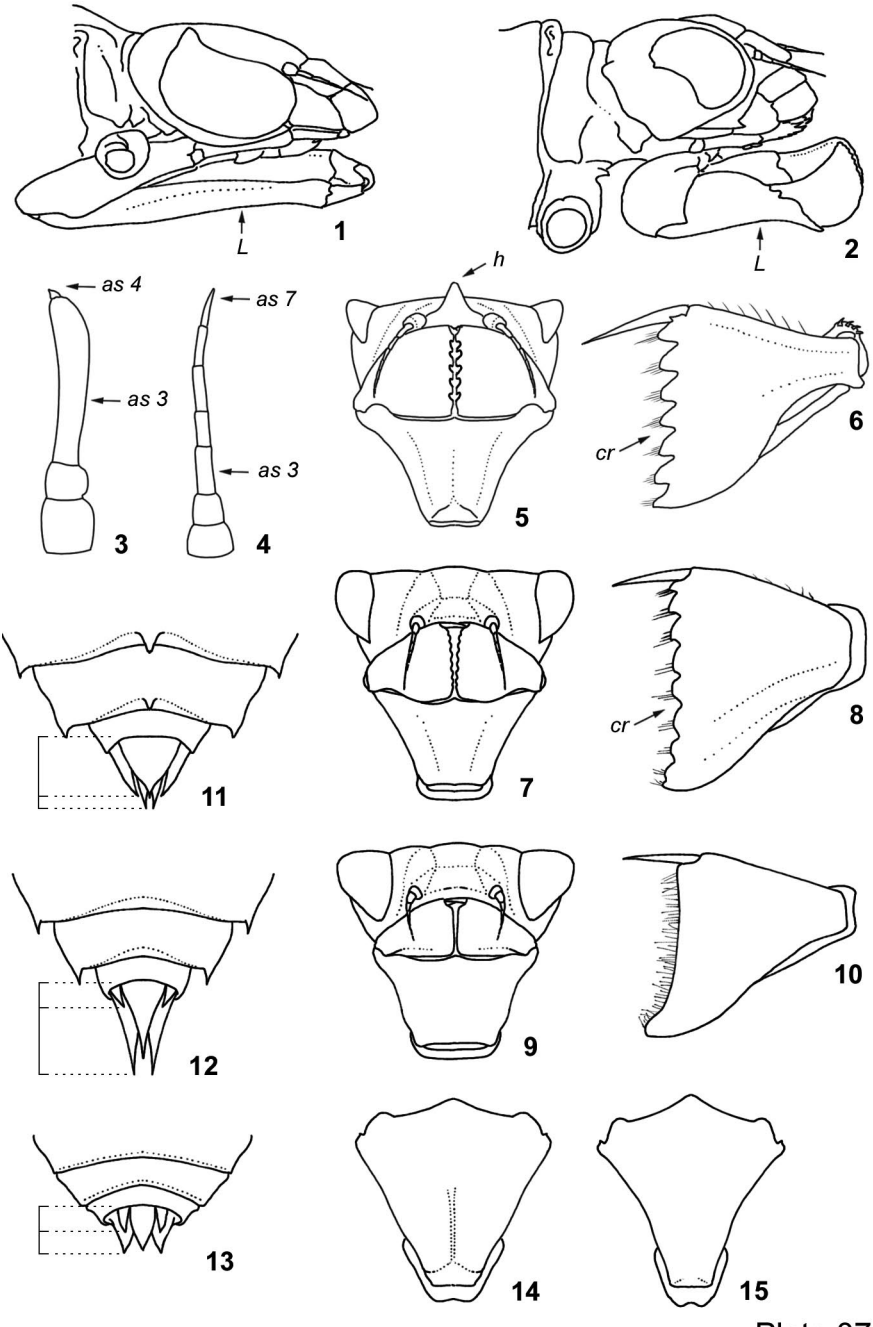


Plate 07

Calopterygidae

In Africa the family is relatively species-poor. Most of the 17 known spp., separated into the three genera *Phaon*, *Sapho* and *Umma* (Dijkstra 2003), have small ranges in the humid tropics of Africa.

The larvae of Calopterygidae are strict sit-and-wait predators which prey on small drifting animals touching their long antennae or long legs. The elongate body, long legs, long antennae, and rather stiff and long lamellae contribute to a somewhat stick-like appearance. This and the brownish colour may camouflage the larvae in their microhabitats. Microhabitats are predominantly roots and driftwood in perennial swift running waters with gallery forest or in forest.

Key to the genera

1 Slender larva with spidery legs; cylindrical abdomen without spines [1]; very long first antennal segment being twice as long as all others together [2] ..... ***Phaon*, p. 24**

– More compact larva with flattened femora; abdomen with lateral and dorsal spines [4]; first antennal segment just as long as all other segments together [3] ..... ***Umma*, p. 24**

Phaon

Phaon iridipennis is the only species in Namibia. It occurs at the Zambezi, Okavango and Kunene Rivers; there is a historic adult record from the Otavi Mts. The populations at the Kunene and Okavango Rivers are at the south-western limits of the species range. The larva has been described by Cammaerts (1967).

Umma

No species in Namibia. *Umma femina* has been recorded in south-western Angola (Serra da Chela). We therefore include the genus *Umma* in our key. The larva of *U. femina* is unknown, so that we had to base our key on descriptions of two other species of *Umma* by Legrand (1977); the habitus depicted in [4] shows *U. longistigma* redrawn from Legrand (1977). *Umma femina* may be less mottled and the caudal lamellae may be more elongate, such as in [5], which shows the lamellae of *U. mesostigma*.

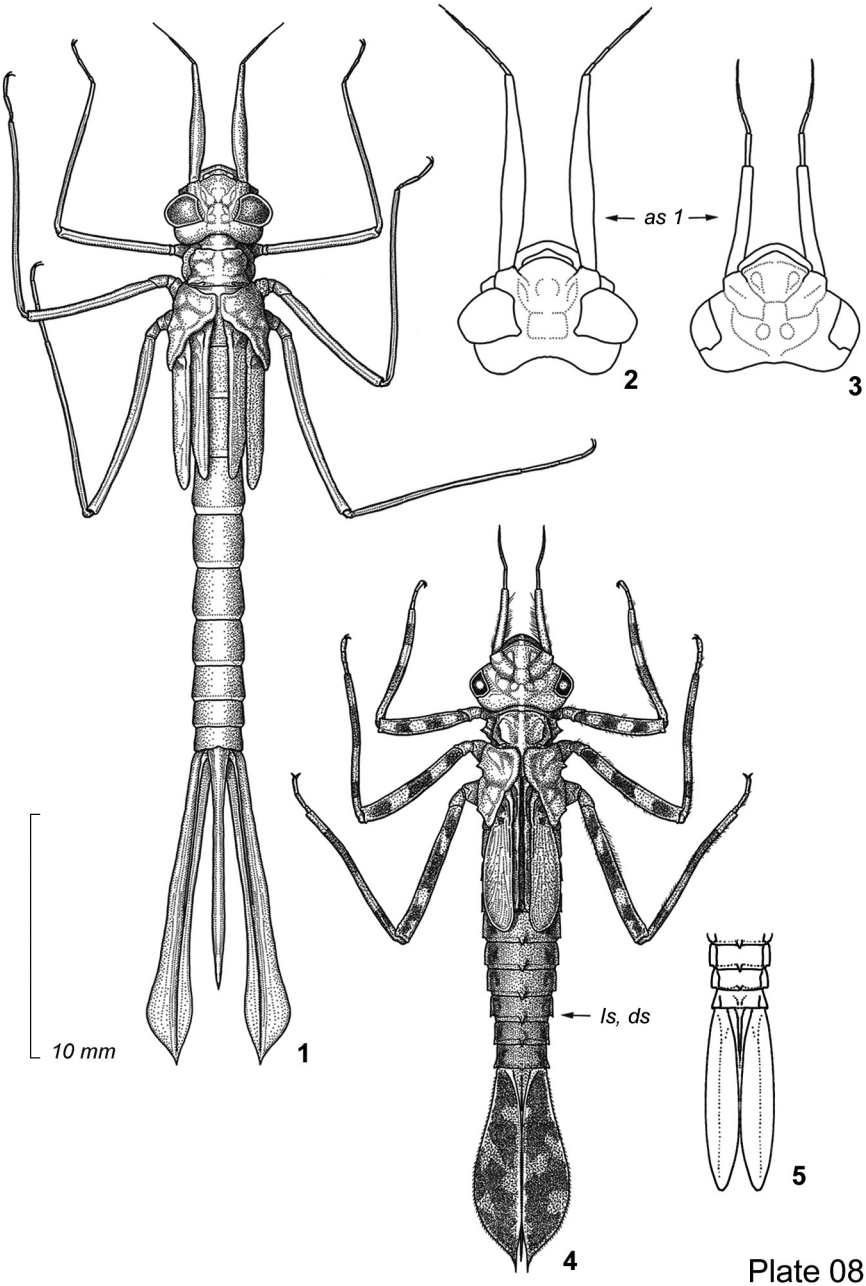


Plate 08

Chlorocyphidae

Members of the family occur in Asia and Africa with more than 100 spp. of which 40 are African. The African members belong to the genera *Africocypha*, *Chlorocypha* and *Platycypha* (Dijkstra 2003), of which the latter two genera occur in the region.

The larvae of the family differ from the other Zygoptera in their robust character and in having only two caudal lamellae [1]. Instead of the dorsal lamella there is only a short spur (dl) [2]. Also unique for damselfly larvae in the region are the short prementum having a small slender gap and spines on the outer margin of the prementum [3] and the sabre-like shape and dense row of spines of the caudal lamellae [4]. The larvae are likely sit-and-wait predators which prey on small drifting animals touching their antennae.

Key to the genera

1 First antennal segment twice as long as second antennal segment ..... ***Platycypha*, p. 26**

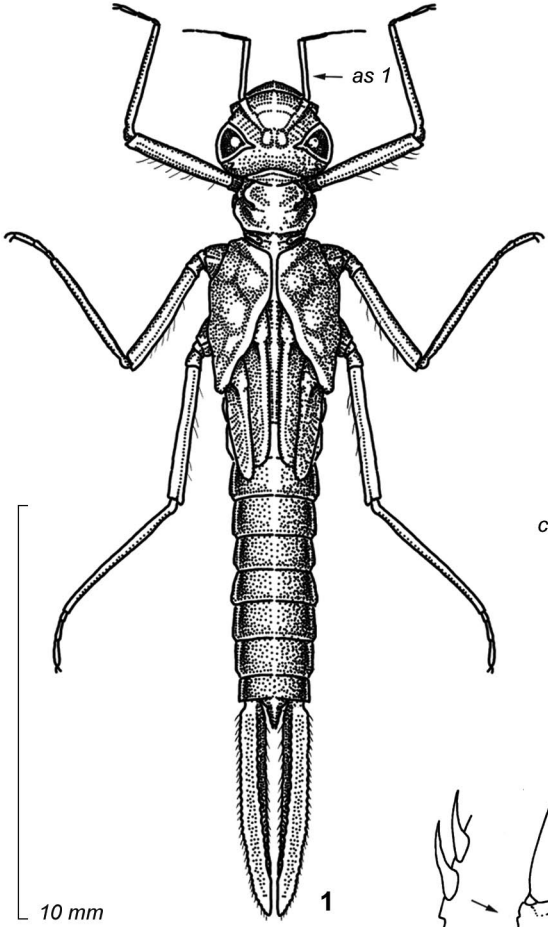
– First antennal segment three times as long as second antennal segment ..... ***Chlorocypha*, p. 26**

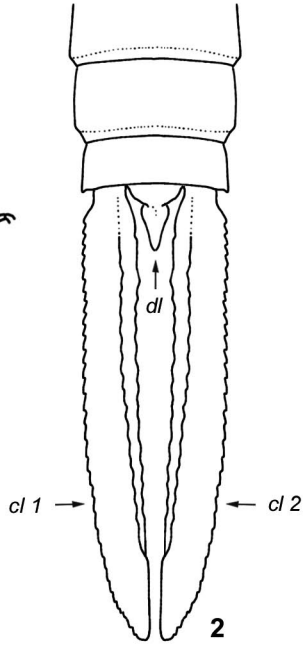
Platycypha

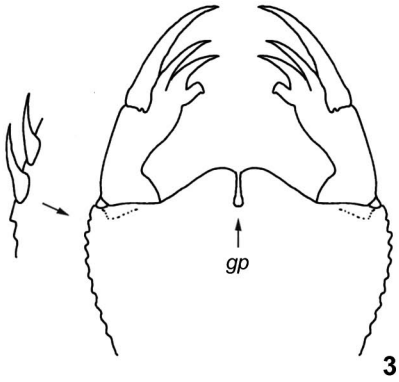
Only one species in Namibia: *Platycypha caligata* [1]. So far it is only found at few stretches of the Okavango and Zambezi Rivers. The populations at the Okavango River are at the southwestern limits of the species' range. The larvae live in rocky, torrential stretches of rivers and streams, next to driftwood where oviposition occurs.

Chlorocypha

No species in Namibia. *Chlorocypha bamptoni* occurs in southwestern Angola in the catchment of the Kunene River (Pinhey 1975). Thus, we include it here. However, there are no descriptions or material available. Therefore we base our key on the key for the genus by Pinhey (1959), unfortunately without good drawings.







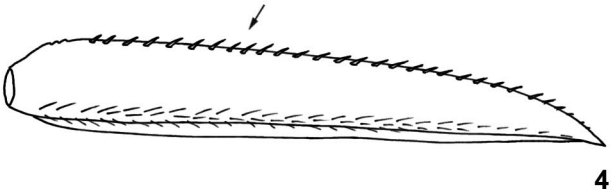


Plate 09

Lestidae

Only one genus occurs in the region: *Lestes*. Four species are recorded in Namibia, namely (in order of frequency of occurrence): *L. pallidus*, *L. dissimulans*, *L. pinheyi,* and *L. tridens*. *Lestes tridens* is very rare in Namibia; there are only two historic records from the border with Botswana. We had our own material of *L. pallidus* and the larva of *L. tridens* is described by Pinhey (1959), the latter with few details. We also add *L. plagiatus*, which is described by Cammaerts (1966), and *L. virgatus*, which is described by Samways *et al.* (1992). The latter two species are known from Botswana. Since the larvae of *L. dissimulans* and *L. pinheyi* remain unknown we do not provide a dichotomous key here. Some characters that may aid identification are presented in Table 1.

Larvae of Lestidae are particularly elongate and slender, e.g. *L. pallidus* [1]. The main character is the long to very long prementum, which is formed like a spoon with handle [2, 3]. The prementum of the South African *L. virgatus*, which is depicted here for comparison [4], may be the shortest variety.

Most species of *Lestes* develop in temporary waters. The larvae have a rapid growth and are active hunters. Although larval development lasts only 1-3 months most species are univoltine due to an egg diapause and sometimes also an adult diapause. Thus, occurrence of larvae is highly seasonal; larval development starts with the onset of the rainy season. *Lestes dissimulans* and *L. pinheyi* occur in temporary pools in the Okavango, Kwando and Zambezi floodplains, as well as in rain pools of northern Kalahari dune valleys. The only desert species is *L. pallidus*.

Table 1. Some characters and measurements [mm] of exuviae of *Lestes* species. The absolute size may vary strongly within the species (more than indicated by the measurements here). The length/width relation of the prementum (L/W ratio) is thereby expected to be a more useful character.

Species	Prementum				Lamellae max length
	Length	Width	L/W	Figures	
Lestes pallidus	2.6-3.3	1.4-1.5	2.1-2.3	2, 5	7.8-8.5
Lestes plagiatus	3.9-4.1	1.6-1.8	2.3-2.5	3, 6	11.5
Lestes tridens	3.7-4.2	1.3-1.4	2.8-3.0	–	8.9-9.5
Lestes virgatus	3.3-3.4	2.1-2.3	1.5-1.6	4, 7	7.0-7.5

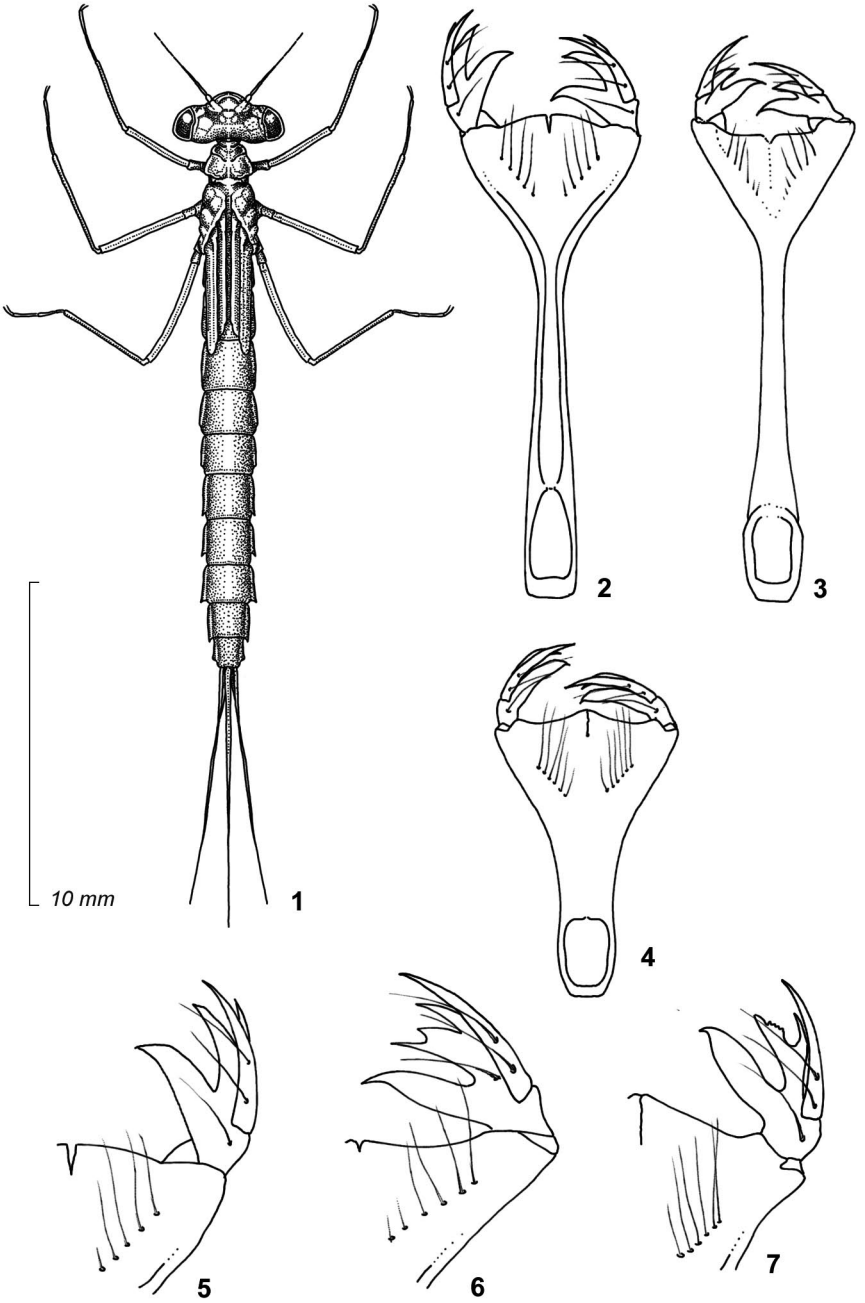


Plate 10

Coenagrionoidea: Coenagrionidae and Platycnemididae

The superfamily Coenagrionoidea includes two families in the region: Coenagrionidae and Platycnemididae including Elattoneura (formerly Protoneuridae). We did not find well-defined family characters for the larvae of the region. Therefore, we decided to produce only a composite key to the genera. The Coenagrionidae have 39 species in eight genera: *Aciagrion* (1-3 spp.), *Agriocnemis* (6 spp.), *Africallagma* (2 spp.), *Azuragrion* (1 sp.), *Ceriagrion* (4 spp.), *Ischnura* (1 sp.), *Pinheyagrion* (1 sp.), and *Pseudagrion* (21 spp.). The Platycnemididae consist of three species in two genera: *Mesocnemis* (1 sp.) and *Elattoneura* (2 spp.).

The Coenagrionoidea constitutes our biggest problem in developing a key because the larvae of 24 species are still unknown, i.e. more than half the number of species. Moreover, some published species descriptions are not very detailed. For this reason we do not present keys to the species here, except for those genera which are represented by one species only, e.g. *Ischnura*. Two genera could not be keyed:

1) *Pinheyagrion angolicum*, the only species in this genus, has not been recorded in Namibia yet, but it has been found in Botswana and Angola, and thus probably occurs in Namibia also; the larva should be similar to *Africallagma* and *Azuragrion*.
2) Of *Aciagrion* only one single individual of *A. heterosticta* is known from Namibia and two more species occur rarely in Botswana. The larvae of the African species of this genus have not yet been described. We therefore did not include the genus in our key. The key could have been made based on the Asian species *A. migratum* (Ishida et al. 1988). However, the taxonomy of the genus is badly resolved and adult characters suggest that it may include more than one group, hence the validity of using characters of *A. migratum* for African *Aciagrion* is insecure.

All species in this superfamily are relatively similar in general appearance. Genera or even species, that can readily be distinguished by the habitus, as in gomphids and some libellulids, are uncommon. This is probably due to the fact that most larvae share very similar types of habitats. Most species dwell in submerged vegetation, such as floating macrophytes, reeds or submerged grasses. The relatively slender body is well shaped to move in these environments and also to hide behind stems. Platycnemidids often live among coarse detritus and are strictly riverine. This may explain their somewhat more stout habitus.

The caudal lamellae are the most diverse character in this group and thus used by us for the key. Unfortunately, the lamellae easily break off even in living larvae. The joint to the abdomen has a specialized breakage plane so that the lamellae can be discarded. The amputation of a body part (autotomy) like the tail of a lizard

is an escape mechanism. Thus, lamellae easily break off when one is catching larvae or finding exuviae. Therefore, the character is not always present. We suggest using the numbers of setae on the prementum and the labial palps in these cases. Also, the lamellae can regrow after being discarded. In such cases the lamellae are often smaller than normal and may also look slightly different.

The habitats of *Aciagrion* spp. are least understood since the records of the three species known from the larger region are very scattered. They seem to occur predominantly in shallow swamp areas which may dry out.

All six species of *Agriocnemis* occur in dense reedy or grassy vegetation in lentic and lotic waters. Whereas *A. exilis* is fairly widespread and may occur in desert habitats, all other species seem to be confined to the Okavango, Kwando and Zambezi Rivers, with the Kwando hosting five species. The newly described *A. bumhilli* has only been encountered in a small area of the Kwando River so far (Kipping et al. 2012), where it seems to live exclusively at the fringe of the river channel.

The 'bluets' *Africallagma*, *Azuragrion*, and *Pinheyagrion* occur in various habitats. *Africallagma glaucum* and *Azuragrion nigridorsum* are the only species in desert environments, where they can be found predominantly in small running waters and perennial ponds. *Africallagma subtile* dwells in temporary pools of the Okavango floodplain and may also occur in the Oshanas. *Pinheyagrion angolicum* is found in the Okavango Delta and should also occur along the Okavango and maybe Kwando Rivers. *Ischnura senegalensis* is the most widespread coenagrionid, and often the only zygopteran species in temporary desert pools (sometimes together with *Lestes pallidus*).

The larvae of the large genus *Pseudagrion* almost exclusively occur in lotic waters; only *P. massaicum* may also breed in perennial lentic pools. Consequently, the genus is best represented by far along the large perennial rivers. Only *P. massaicum*, which is the most widespread species, *P. sublacteum*, *P. salisburyense* and *P. kersteni* regularly occur at desert habitats; *P. kersteni* only occupies a few perennial streams in the Naukluft Mountains, the Baynes and Otjihipa Mountains, and at Ongongo Falls. Populations at the Waterberg and in the Otavi Mts seem to have been eradicated by over-exploitation of the springs. *Pseudagrion angolense* is endemic to SW Angola and may well occur in small streams in the badly explored region along the Kunene. *Pseudagrion citricola* is known from Augrabis Falls on the Orange River.

Key to the genera

1 Prementum extends back only to the base of coxae of forelegs [1]; no setae dorsally on prementum [3]; caudal lamellae as in [7] without setae along the margins ..... ***Mesocnemis*, p. 34**

– Prementum extends back beyond the base of coxae of forelegs [2]; at least 2 setae dorsally on prementum [5, 6]; caudal lamellae different [8-13], usually with setae (not shown in the Figures) **2**

2(1) Spiniform setae along the margins of prementum [4]; spiniform plus normal setae along the margin of the caudal lamellae [8] ..... ***Elattoneura*, p. 34**

– Only normal setae along margins of prementum [5] and caudal lamellae [10] **3**

3(2) Caudal lamellae broad, their width strongly increasing to the posterior end and with a distinct distal tip [9]; body stout, length of the head is ⅕ of body length excluding lamellae [Plate 12: 4] ..... ***Ceriagrion*, p. 34**

– Caudal lamellae more slender, not as widened at the posterior end [10-13], body more slender, length of the head is ⅙ to ⅛ of body length [e.g. Plate 13: 1] **4**

4(3) Caudal lamellae with distinct nodus in the dorsal part [10]; 2 setae dorsally on prementum [5] ..... ***Pseudagrion*, p. 36**

– Caudal lamellae without distinct nodus in the dorsal part [11-13]; more than 2 setae on prementum [6] **5**

5(4) Caudal lamellae shaped like the tip of a lance [11]; tiny exuviae, body length about 10 mm (without lamellae) ..... ***Agriocnemis*, p. 40**

– Caudal lamellae not shaped like the tip of a lance [12-13]; exuviae mostly longer than 12 mm (without lamellae) **6**

6(5) Caudal lamellae leaf-like without sharply pointed apex [12]; no dark spots in front of wing sheaths of larvae .. ***Africallagma* and *Azuragrion*, p. 40**

– Caudal lamellae with sharply pointed apex [13] **7**

7(6) 10 setae on prementum; dark spots at the base of each wing-sheath* [Plate 15: 4] ..... ***Ischnura*, p. 40**

– 8 setae on prementum; no such dark pattern ..... ***Proischnura*, p. 40**

***Note:** Colour pattern only weakly or not at all be visible in exuviae.

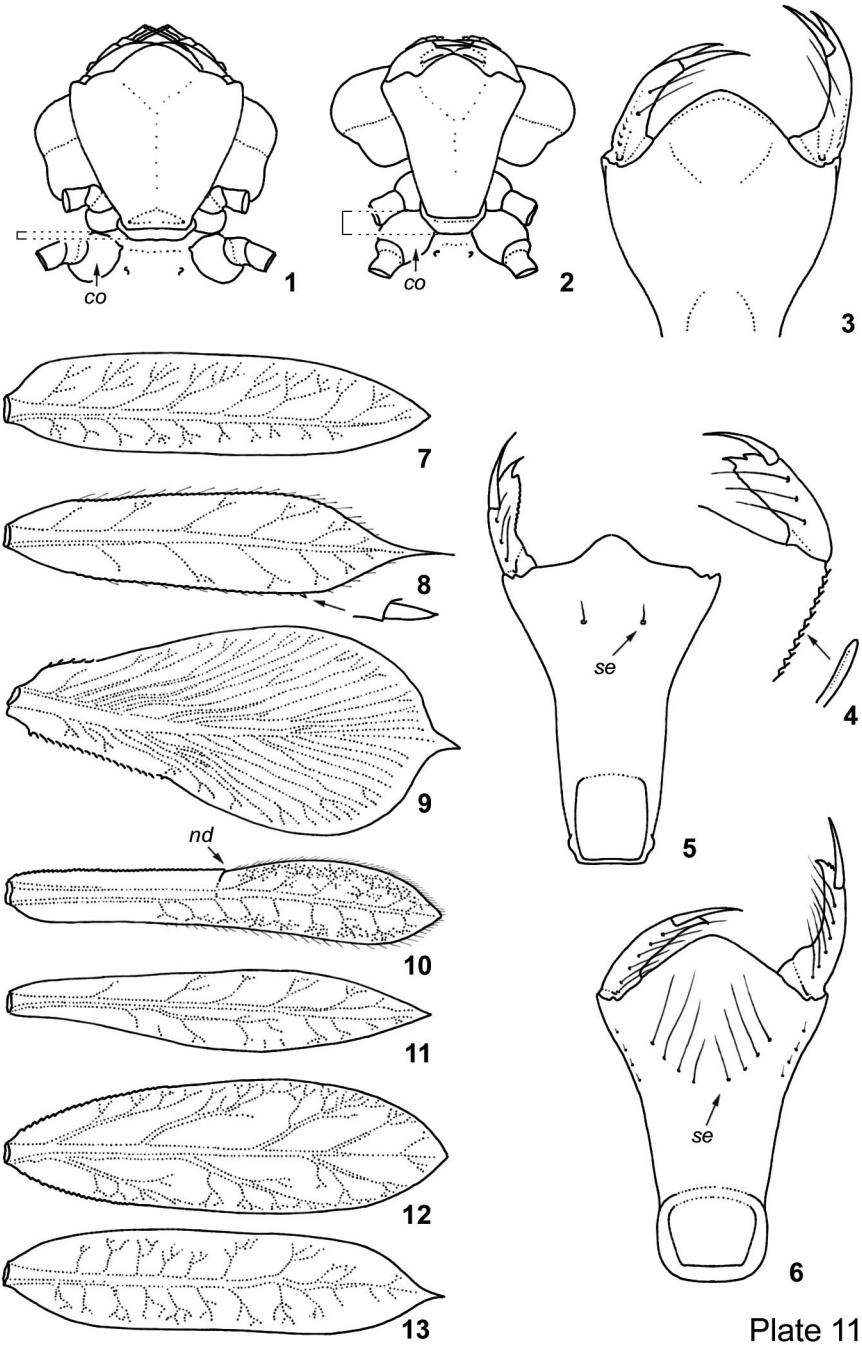


Plate 11

Mesocnemis

The only species in the region is *M. singularis* (described by Corbet 1956b as *Metacnemis valida*). The body is rather compact in shape and the posterior lobe of the head is distinctly angled [1]. The inside (dorsal surface) of the prementum is without setae and the labial palps have two setae each [2]. The margins of the caudal lamellae are without setae [3]. *Mesocnemis singularis* occurs at all large northern rivers. At the Orange River it has been found at Augrabies Falls and may therefore also occur downstream in Namibia.

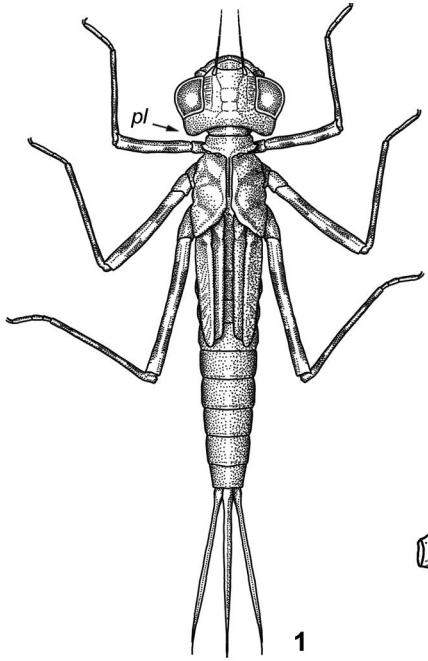
In South Africa some other Platycnemididae exist. The larva of *Allocnemis leucosticta* is described by Barnard (1937).

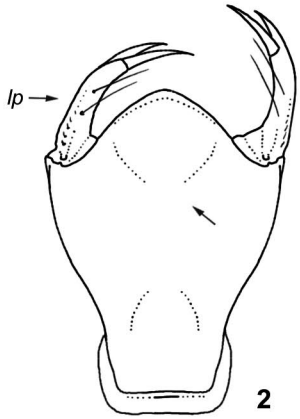
Elattoneura

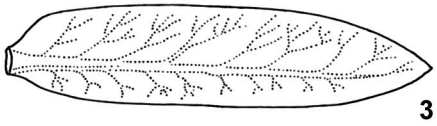
Two species are recorded, with *E. glauca* being common along Kunene, Okavango, Chobe and Zambezi Rivers; *E. cellularis* has only been recorded at the Chobe so far. The larvae of neither have been described. The generic characters are based on drawings and descriptions of the South African *E. frenulata* (Barnard 1937). We do not have our own material and were not able to depict the habitus. The larva has distinct spiniform setae along the margins of the prementum and the caudal lamellae [Plate 11: 4]. The caudal lamellae have no nodus. The labium has 2 normal setae on the prementum and 3 on each palp (as most *Pseudagrion*). The larval microhabitat of both species is unknown to us.

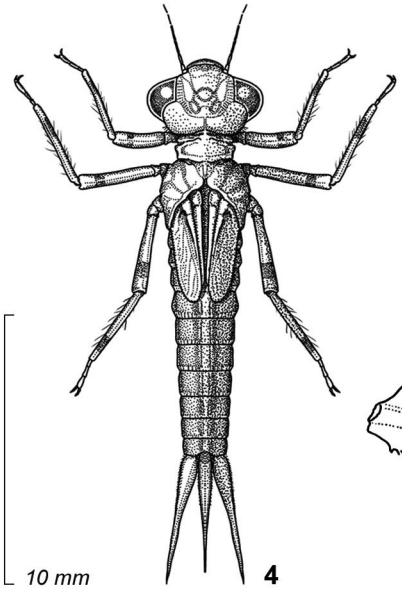
Ceriagrion

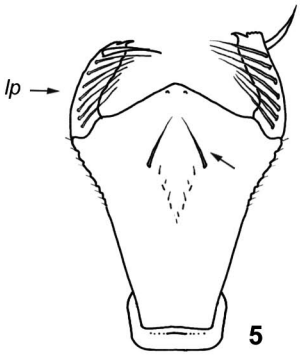
Ceriagrion corallinum, *C. glabrum*, *C. katamborae*, and *C. suave* are recorded in the region. Only the *C. glabrum* larva, which is the only species recorded outside Caprivi, has been described (Corbet 1956b). The body is rather compact in shape compared to other coenagrionids, with the length of the head being ⅕ of the body length [4], and only resembles *Mesocnemis* in shape. We do not have material of the other species available. We suppose that the other *Ceriagrion* species also share these characters. The prementum of *C. glabrum* has one pair of setae dorsally [5]. The labial palps have seven setae each. *Ceriagrion* is unique among the Coenagrionoidea by the shape of its caudal lamellae [6].











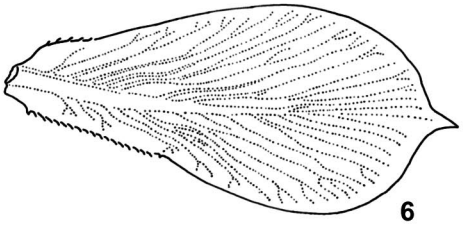


Plate 12

Pseudagrion

The genus is the largest in the region, including 21 species. The larvae are slender in body shape [1]. The labium has two setae on the prementum and three to five setae on each palpus [2]. Very characteristic are the patterns on the caudal lamellae [3]. According to our own experience these patterns seem to be species-specific [see Plate 14] and would therefore be useful key characters for a species key. However, because too many species are not yet known we only present drawings of the lamellae of the species known so far, instead of a key to the species.

The genus can be divided into two distinct groups (A and B), particularly by the appearance of the adults. Following Chutter (1961, 1962) the larvae of these groups could be separated mainly by the shape of the labial palps.

1 Labial palp at the distal margin about as long as it is broad [4] ..... **Group A**

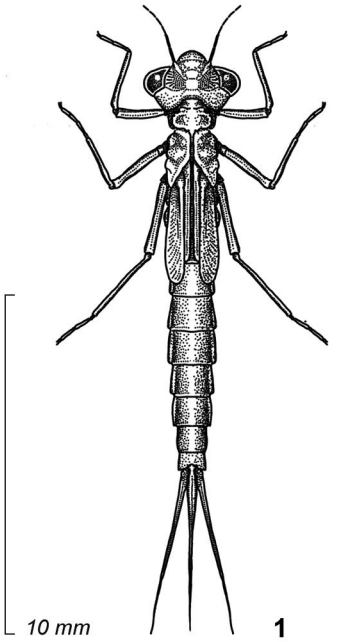
– Labial palp at the distal margin narrower, longer than broad [5] ..... **Group B**

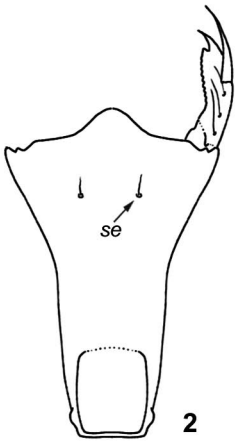
Group A

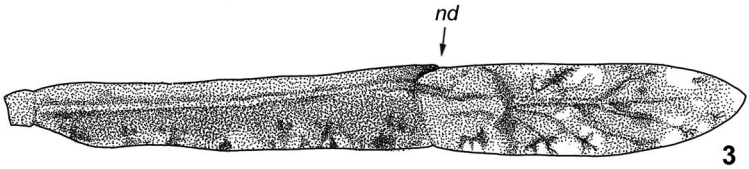
In Namibia only *P. kersteni* and *P. salisburyense* have been encountered, which are described by Chutter (1961). Both occur in the arid parts of the country, e.g. the Naukluft Mts. Besides these, *P. fisheri* and *P. hageni* occur in Botswana, *P. angolensis* in southern Angola, and *P. citricola* in the Northern Cape Province of South Africa. *Pseudagrion hageni* (as *P. angolense*) and *P. citricola* are described by Chutter (1961, 1962). We redrew some of the illustrations from Chutter here since we do not have our own material, for instance of *P. citricola*.

Group B

Chutter (1961, 1962) described the larvae of *P. acaciae*, *P. massaicum*, *P. sublacteum* (as *P. pseudomassaicum*, Chutter 1962) and *P. vaalense* (also as *P. pseudomassaicum*, Chutter 1961, 1962). We add characters of *P. deningi* and *P. rufostigma* collected at the Kwando River. The two latter species have very slender caudal lamellae compared to the other species (Plate 14: 9, 10). From their patterns on the lamellae [Plate 14: 1-10] the discrimination of most of these species is quite distinct, with the exception of those of *P. massaicum* and *P. sublacteum*. We do not provide a key here because too few larvae of this group are known, but Table 2 compiles some characters of the known species.







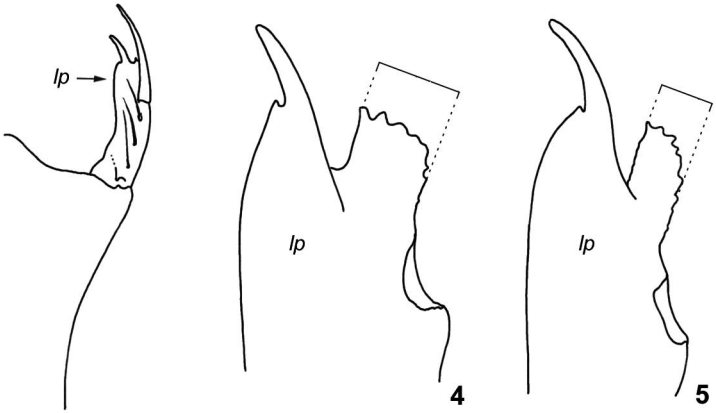


Plate 13

Table 2. Length and width measurements of the lamellae of *Pseudagrion* species (Group A and B).

Species	Group	Length [mm]	Width [mm]	Length/ width ratio	Drawing
P. hageni	A	7.1	1.3	5.5	[1]
P. kersteni	A	5.5	0.9	6.1	[2]
P. salisburyense	A	7.7	1.4	5.5	[3]
P. citricola	A	7.5	1.2	6.3	[4]
P. acaciae	B	6.2	1.2	5.2	[5]
P. massaicum	B	6.2	1.3	4.8	[6]
P. sublacteum	B	5.5	1.2	4.6	[7]
P. vaalense	B	5.9	1.5	3.9	[8]
P. deningi	B	6.2	0.8	7.8	[9]
P. rufostigma	B	5.8	0.7	8.3	[10]

Key to the taxa in the Namibian desert

1 Labial palp at the distal margin about as long as it is broad [Plate 13: 4] ..... ***P. massaicum, P. sublacteum***

– Labial palp at the distal margin much longer than broad [Plate 13: 5] **2**

2(1) Anterior part of the central lamella dorsally covered with numerous setae; in the posterior area the setae at the dorsal margin are very long; dark lamellae with not very distinct colour-pattern [2]; basal antennal segment longer than antennal segment 4 ..... ***P. kersteni***

– Anterior part of the central lamella dorsally covered with only few setae; in the posterior area the setae at the dorsal margin are short; distinct colour pattern, with three elongated spots along the central trachea [3]; basal antennal segment not longer than segment 4 ..... ***P. salisburyense***

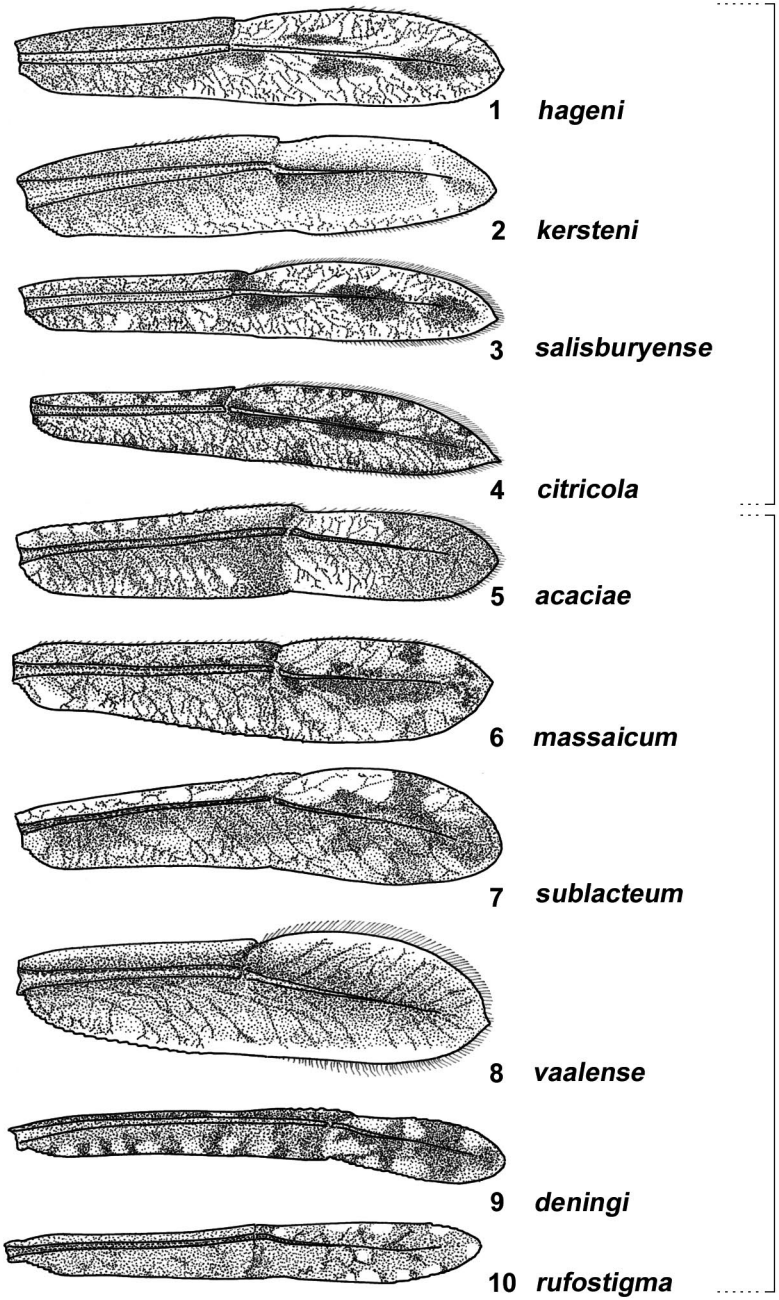

1 hageni
2 kersteni
3 salisburyense
4 citricola
5 acaciae
6 massaicum
7 sublacteum
8 vaalense
9 deningi
10 rufostigma
A group
B group

Plate 14

Agriocnemis

Of the six species occurring in the region, *A. exilis* is the most widespread. The exuviae are tiny; excluding lamellae the body length is about 10 mm [1]. The lamellae are shaped like the head of a lance [5]. The labium has 10-12 premental setae, which are hardly visible, and four on each palpus. Our key characters and the depicted habitus of the genus are based on our own material of *A. exilis* and the description of *A. pinheyi* (Carchini et al. 1995).

Africallagma and *Azuragrion*

The two genera have relatively similar larvae, with caudal lamellae not ending in a sharp tip [6]. Three species occur in our region. We have material of the two species occurring in the deserts, *A. glaucum* [2] and *A. nigridorsum*; the larva of *A. subtile* is unknown.

Key to the species

1 Abdomen dorsally with 2 dark zigzag lines [2]*; 6 setae on each labial palp ..... ***Africallagma glaucum***

– Abdomen with black lateral spot on basal edge of some segments, at least on S6-9*; 5 setae on each labial palp ..... ***Azuragrion nigridorsum***

***Note:** The colour pattern described is only weakly, or not at all, visible in exuviae.

Ischnura

The only species is *I. senegalensis* [3]. The caudal lamellae are acutely tipped [7]. The labium has eight larger, plus two smaller, setae on the prementum and six setae on each palpus. In larvae often dark spots at the base of the wing sheaths are visible [4]. *Ischnura senegalensis* is the only coenagrionid species that is widespread all over Namibia, including the desert.

Proischnura

No species have been found in the region covered. But, *P. subfurcatum* occurs in Zimbabwe close to the Botswana border and *P. polychromaticum* in the Western Cape. The larva of the latter has been described by Barnard (1937).

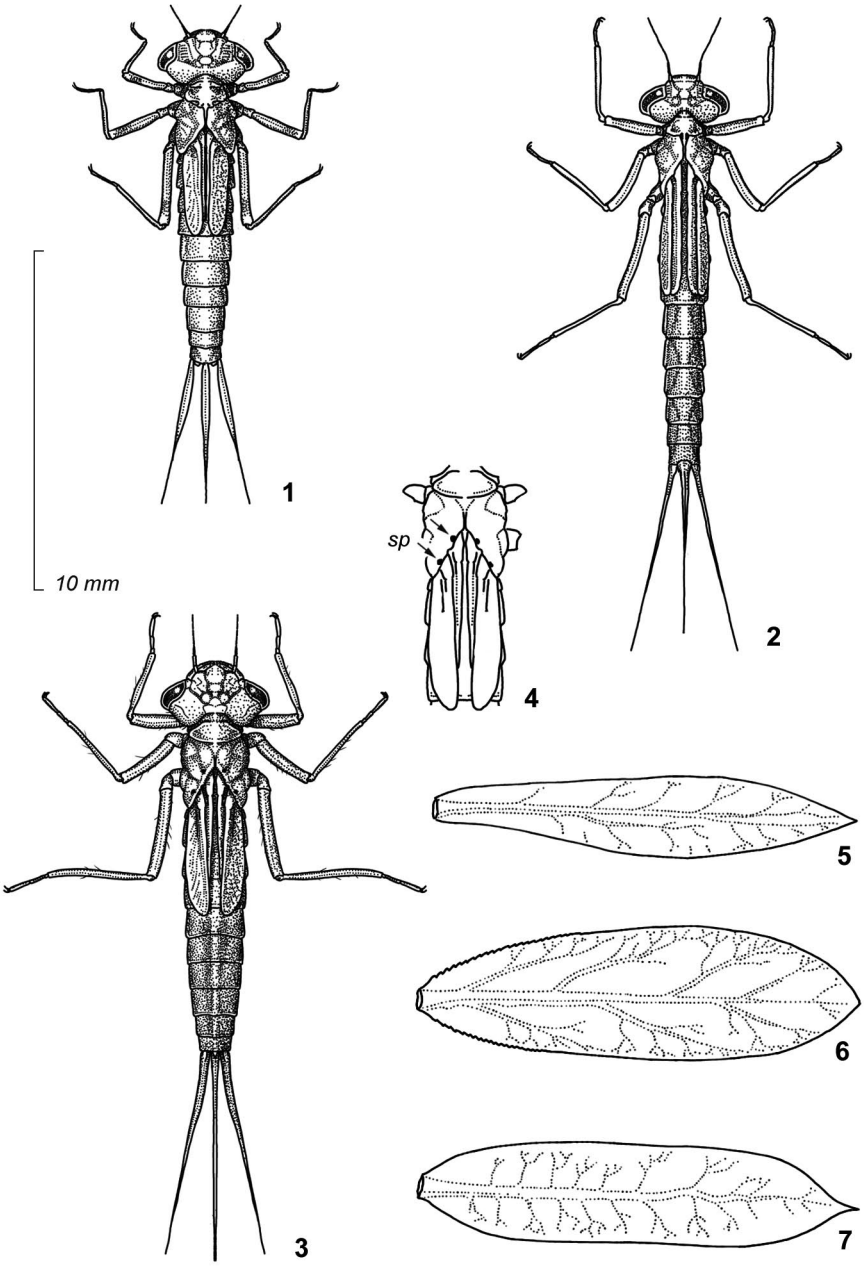


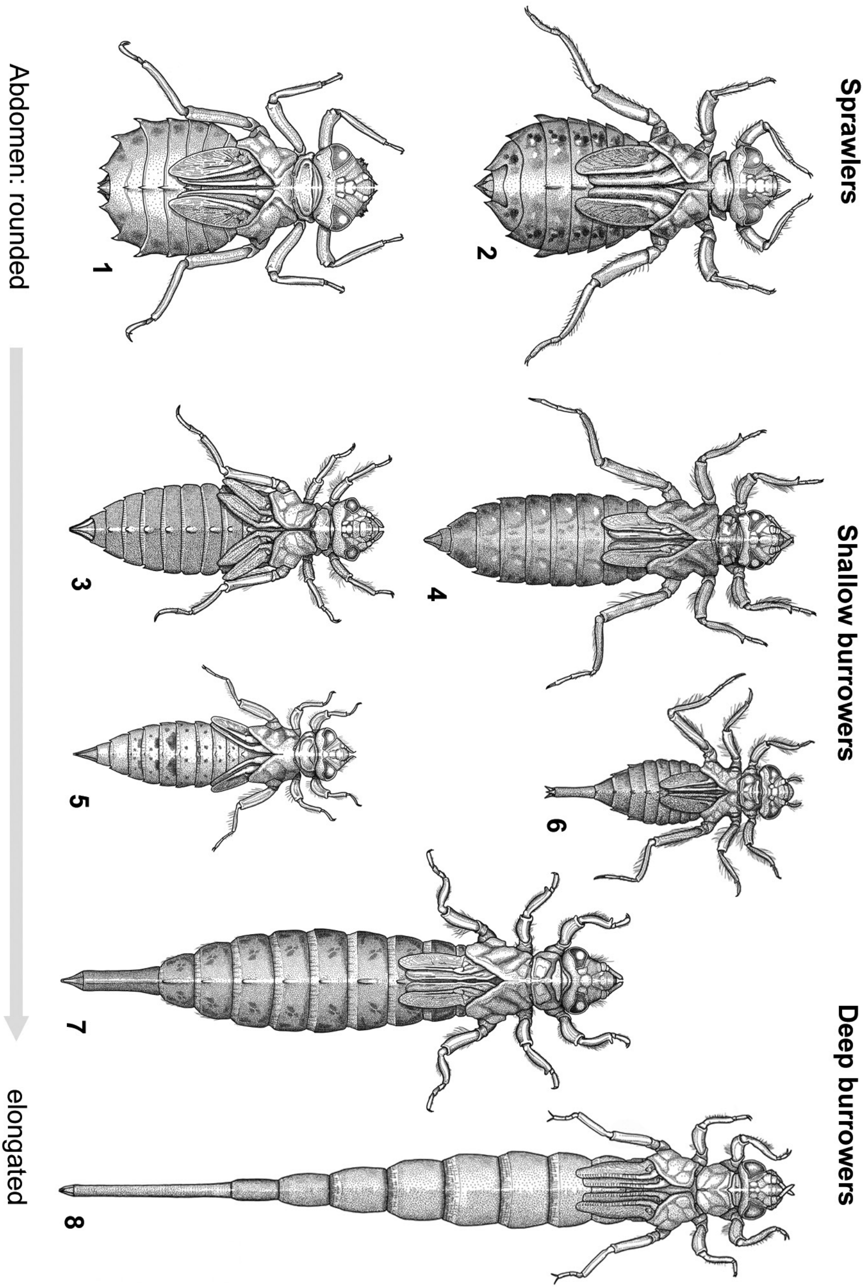
Plate 15

Gomphidae

The Gomphidae are one of the larger families in the region with eight genera and 18 species recorded so far. Most diverse is *Paragomphus* with five species followed by the closely related *Crenigomphus* (3 spp.). We split *Neurogomphus* (3 spp.) into two genera, *Neurogomphus* (2 spp.) and *Mastigogomphus* (1 sp.), based particularly on the differing larval morphology (see key). The other genera are *Lestinogomphus* (2 spp.), *Ictinogomphus* (2 spp.), *Gomphidia* (1 sp.), and *Ceratogomphus* (1 sp.). We also consider *Notogomphus* and *Onychogomphus* in our key, although they do not occur in Namibia.

The most distinct character of gomphids is that the antennae have four segments, of which the third is usually massively built. The massive shape may protect the antennae while moving in the sediment. Concerning general larval morphology the gomphids are surely the most diverse odonate family. There is a gradient from short and bulky to elongated abdomens, often with a breathing tube (Plate 16). *Gomphidia* [1] and *Ictinogomphus* [2] have rounded, bulky abdomens. They seem not to burrow, but hide between rocks or detritus (Sprawlers). Their long legs prevent *Ictinogomphus* larvae from sinking in their muddy habitats. *Onychogomphus* [3] and *Notogomphus* [4] are shallow burrowers which also often hide between detritus or stones. Larvae of *Paragomphus* [5] and *Crenigomphus* are Shallow burrowers that are suited to live in the shifting sands of the stream channels where larvae of other species may be entombed. The behaviour of *P. genei* may be termed 'sand-swimming'. Short legs support this life-style. The larvae of *Lestinogomphus* [6], *Phyllogomphus* [7], *Neurogomphus* [8], and *Mastigogomphus* have remarkable breathing tubes formed by abdominal segment 10. These tubes are often interpreted as adaptations to a deep burrowing life-style in soft sediment (Corbet 1962). The elongate and short-legged *Phyllogomphus* and *Neurogomphus* behave this way, since short legs are well suited for digging movements. However, the long-legged *Lestinogomphus* seem to be shallow burrowers according to our own observations, despite of their breathing tubes.

Most gomphids are riverine species; with few exceptions the larvae live in the lotic parts of rivers. *Lestinogomphus*, *Neurogomphus*, *Phyllogomphus, Gomphidia*, and *Crenigomphus* as well as most *Paragomphus* only occur along the perennial rivers. *Paragomphus cataractae* has mainly been found in larger rapids and cataracts, such as Popa Falls at the Okavango, Epupa Falls at the Kunene, and the Zambezi rapids at Katima Mulilo. The larval microhabitat of *Gomphidia quarrei* remains unclear. We found it in rapids at the Okavango but also in the slow flowing Kwando River. Maybe the larvae are mainly lentic water dwellers, which are able using the lentic zones in the rapids, for instance between larger stones. The similar shaped *Ictinogomphus ferox* uses all kinds of lentic and lotic perennial habitats including rivers, horseshoe lakes, and large impoundment lakes. The latter are also the habitat for *Ceratogomphus pictus* in Namibia. Most remarkable for being a gomphid is *Paragomphus genei*, which is able to develop in temporary pools due to a short larval period of about 60 to 80 days (Suhling et al. 2004). The larvae are most common in wetlands of ephemeral rivers where they occur in high density.



Sprawlers
Shallow burrowers
Deep burrowers
Abdomen: rounded
elongated
1
2
3
4
5
6
7
8

Plate 16

Key to the genera

1 Abdomen conspicuously broadened, without breathing tube; ventral suture between S8 and S9 distinctly kinked [Plate 19: 3]; S10 enveloped by S9 (dorsal view) [1, 2]; tarsae of hind legs two-segmented [3] **2**

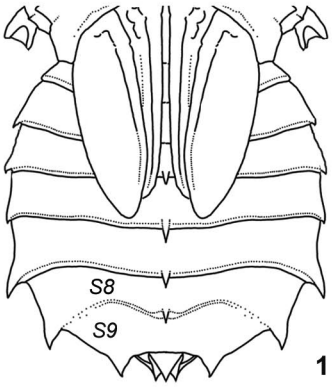
– Abdomen more elongate, sometimes with long breathing tube; S10 not enveloped by S9 [4, 5]; ventral suture between S8 and S9 not kinked; tarsae of hind legs three-segmented [6] **3**

2(1) Posterior margin of S9 laterally not projecting over S10 [1]; anterior margin of head with hair-like projections between eyes and antennae [7] ..... ***Gomphidia*, p. 48**

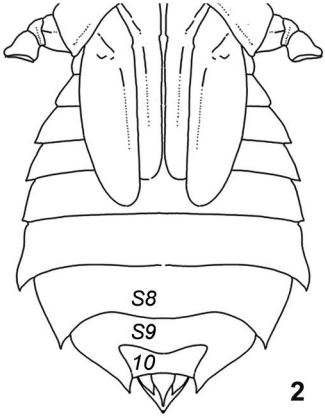
– Posterior margin of S9 laterally projecting over S10 [2], anterior margin of head with knob-like projections between eyes and antennae [8] ..... ***Ictinogomphus*, p. 48**

3(1) S10 longer than S9, forming a breathing tube [4] **4**

– S10 at most as long as S9 [5] **6**



1



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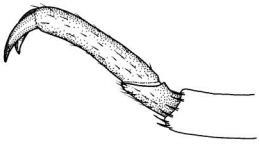
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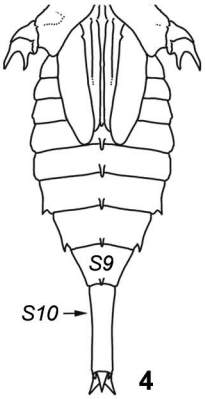

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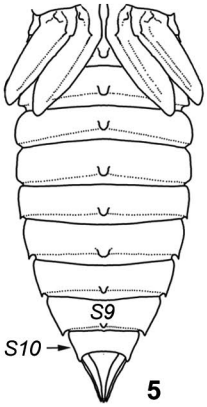

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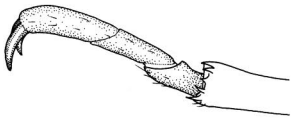
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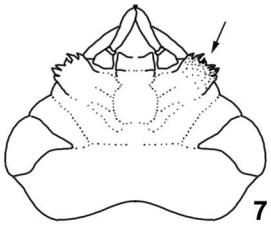
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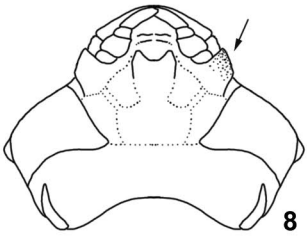

8

Plate 17

4(3) Hind legs as long as or longer than abdomen, excluding breathing tube [1]; S3-9 with distinct, sharp dorsal spines; (S6)S7-8 with distinct lateral spines ..... ***Lestinogomphus*, p. 50**

– Hind legs shorter than abdomen [2]; at least S5-7 without dorsal spines or these when present small and blunt; usually no lateral spines, at most S8-9 with small lateral spines **5**

5(4) S10 about as long as S8-9 together [3]; S9 about as broad as long [3]; abdomen with dorsal knobs and sometimes small lateral spines on S8-9 ..... ***Phyllogomphus*, p. 50**

– S10 distinctly longer than S8-9 together [4]; S9 distinctly longer than broad [4]; abdomen devoid of dorsal or lateral spines ..... ***Neurogomphus*** and ***Mastigogomphus*, p. 50**

6(3) Antennal segment 4 elongate and sharply bent outwards [5| ..... ***Crenigomphus*** and ***Paragomphus*, p. 52**

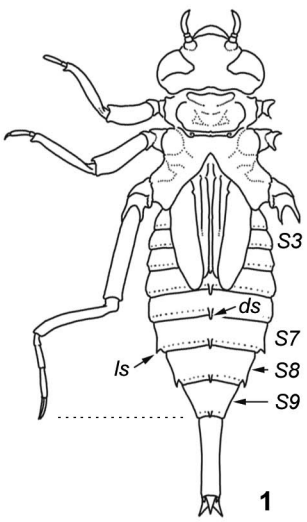
– Antennal segment 4 a minute knob [6] **7**

7(6) Abdomen without dorsal knobs or spines [7] ..... ***Notogomphus*, p. 54**

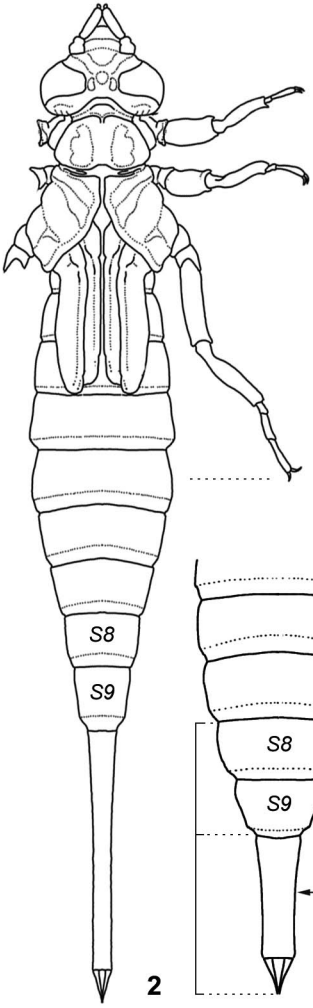
– S2-9 with dorsal knobs or keel-like spines [8, 9] **8**

8(7) Abdomen with knobs or spines with rounded base [8], third antennal segment flattened and dilated, wider than other segments ..... ***Onychogomphus*, p. 54**

– Abdomen with dorsal abdominal spines with slim base in cross-section ("keel-like") [9], third antennal segment slender and cylindrical, scarcely wider than other segments ..... ***Ceratogomphus*, p. 54**

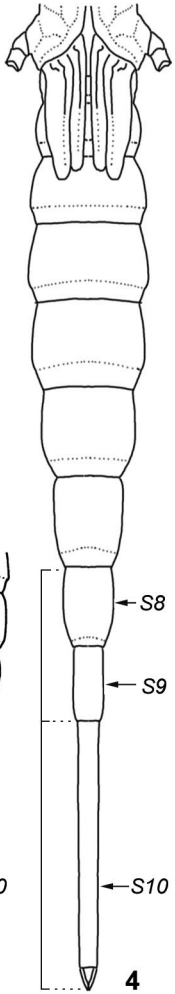


1



2

3



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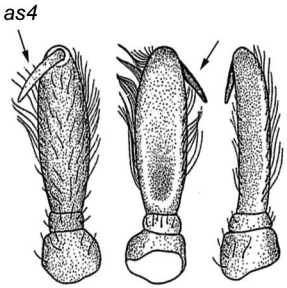

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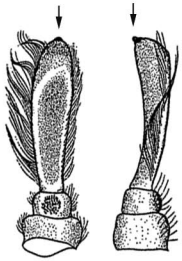

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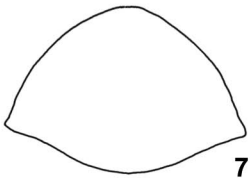

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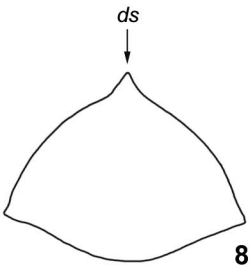

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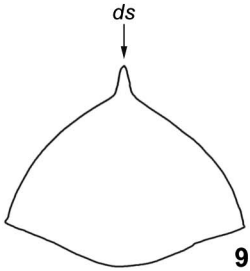


9

Plate 18

Gomphidia

The only species in the region is *G. quarrei* [1]. Due to their specific abdomen shape larvae of *Gomphidia* can only be confused with those of *Ictinogomphus*, but are smaller in the last stadium (about 20 mm in length) and have an even more rounded appearance of the abdomen. The head of *G. quarrei* has typical cuticula projections at the lateral margin [2] and between the antennae and the eyes [Plate 17: 7]. The ventral suture between S8 and S9 is distinctly kinked [3], a character shared with *Ictinogomphus*, and, interestingly, also with the two riverine libellulid genera *Zygonoides* and *Olpogastra* (Dijkstra et al. 2006). Müller et al. (2005) compare the larvae of *G. quarrei* with *G. bredoi*, which occurs e.g. in the Congo River system in northern Angola.

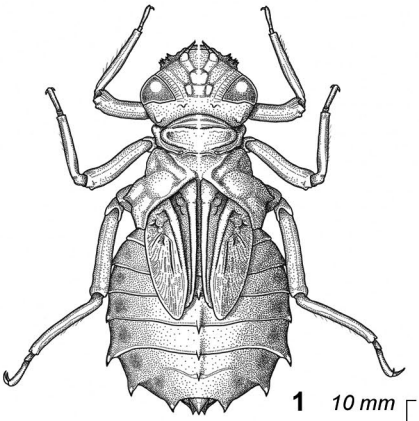
Ictinogomphus

The larvae of *Ictinogomphus* are massive, in total 25-30 mm in length and up to 15 mm in width at the abdomen in the final stadium. The larvae are similar to those of *Gomphidia* (see there for differences). Of the two species in the region only the larva of *I. ferox* has been described before (Corbet 1956a). The characters of *I. dundoensis* are based on our own material collected at the Kwando River. There are four species of *Ictinogomphus* in total in Africa, and a third species of the genus, *I. fraseri* from western Africa, has been described by Corbet (1977). The habitus drawing [4] shows the most common species, *I. ferox*.

Key to the species

1 Abdomen in ventral view rather oval-shaped [5]; convex anterior border of prementum without an indentation [6] ..... ***I. ferox***

– Abdomen in ventral view rather egg shaped [8]; convex anterior border of prementum with a small median indentation [7] ..... ***I. dundoensis***



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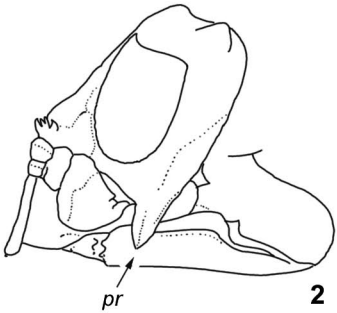

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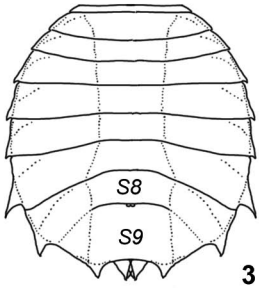

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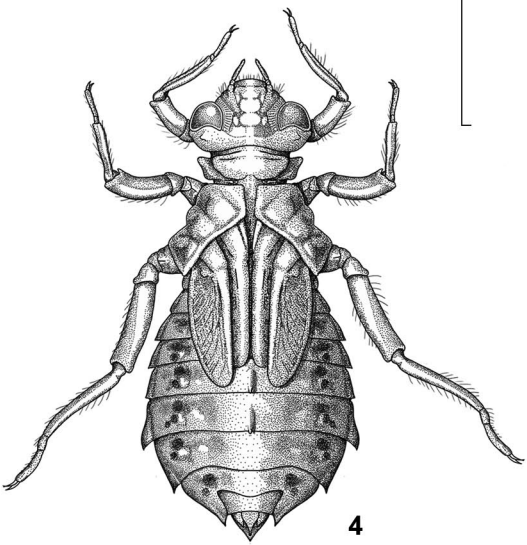

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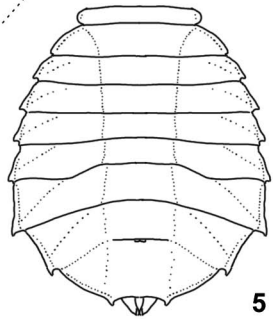

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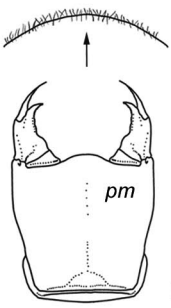

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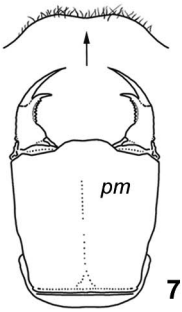

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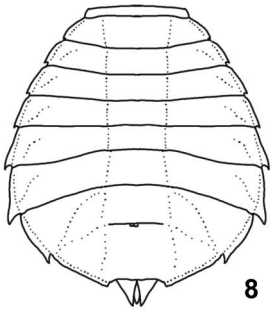


8

Plate 19

Lestinogomphus

The larvae of this genus are unmistakable due to the breathing tube in combination with long hind legs, sharp mid-dorsal spines, and small size [1]. The larva of the common species *L. angustus* was described by Corbet (1956b). The larva of *L. silkeae* from the Okavango River is unknown.

Phyllogomphus

One species, *P. selysii*, occurs in all northern perennial rivers. Di Domenico et al. (1994) described the larva under the synonym *P. brunneus*. Despite discovering many exuviae and larvae at several sites at the Okavango, Kunene and Zambezi Rivers, we never observed any adult. The larva is very distinct in having a long, flat abdomen with the breathing tube formed by S10 about as long as S8 and S9 together. It has also very short legs compared to the body length [2].

Neurogomphus and *Mastigogomphus*

Three species occur in the region. *Mastigogomphus* is regarded as a subgenus of *Neurogomphus* by Cammaerts (2004), but differs significantly in larval characters from *Neurogomphus* s. str., for instance in shape of the prementum but also in the proportions between leg length and abdomen size. *Mastigogomphus* exuviae [3] are also much smaller than those of *Neurogomphus* (see key). We therefore regard *Mastigogomphus* as a separate genus. Of *Neurogomphus* s. str. [4] we collected exuviae of both forms described by Cammaerts (2004), but did not see emergence so that we cannot verify his presumptions about species characters. Nevertheless, we use the key characters here to separate between *N. cocytius* and *N. zambeziensis*. However, we consider that the species may later need to be interchanged.

Key to the species

1 Anterior border of prementum convex [5]; smaller exuviae, length ≈ 35 mm [3] ..... ***Mastigogomphus dissimilis***

– Anterior border of prementum concave [6, 7]; larger exuviae, length > 50 mm [4] **2**

2(1) Anterior margin of prementum strongly concave and tub-shaped [6]; labial palps with very deep crenations being deeper than the length of the setae on the margin of the prementum ..... ***Neurogomphus cocytius***

– Anterior margin of prementum only slightly concave [7]; labial palps with less deep crenations being about as deep as the length of the setae on the margin of the prementum ..... ***Neurogomphus zambeziensis***

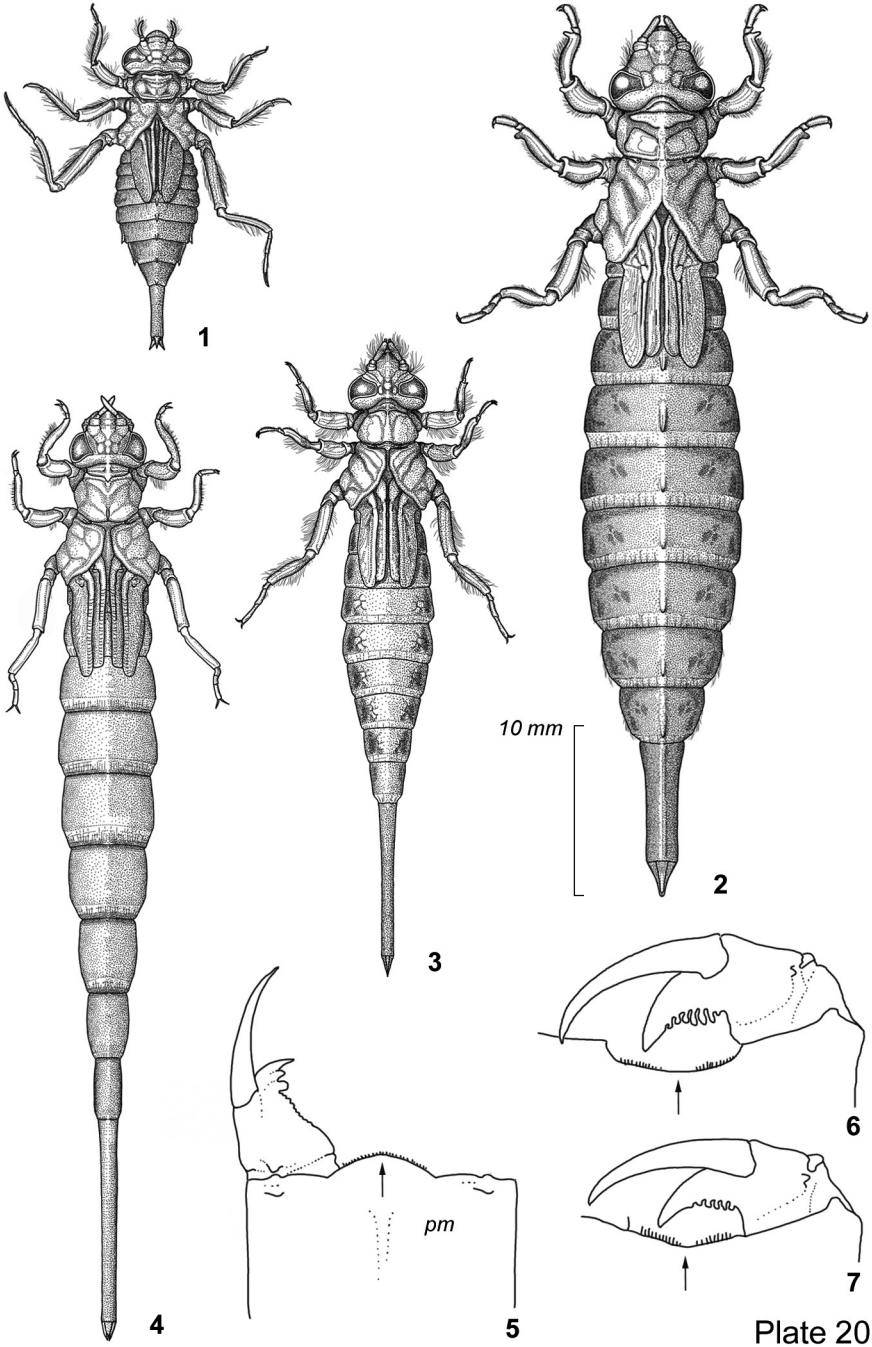


Plate 20

Paragomphus and *Crenigomphus*

The two genera are closely related. The larvae resemble each other in appearance, and we did not find elegant characters that are exclusive to either of the two genera. Both genera share a distinct character: the fourth segment of the antenna is rather long and sharply bent outwards [Plate 18: 5], whereas in other gomphids this segment is usually very short. *Paragomphus* [1] includes five species in the region, *Crenigomphus* [2] three, of which *C. kavangoensis* may be endemic to the middle section of the Okavango River. The differences between the species are sometimes not very distinct; we recommend using characters given in Table 3 in addition to the key.

Key to the species

1 Frontal part of the head with triangular appearance in dorsal view [3]; posterior lobe of the head shorter than the eye [3] ..... ***Paragomphus*, 2**

– Head with more oval appearance, frontal part more stout [4]; posterior lobe of the head as long as the eye [4] ..... ***Crenigomphus*, 6**

2(1) Anal pyramid very long with length of paraprocts being more than 2.5 times longer than S10 (ventral view); cerci half as long as paraprocts [5] ..... ***P. sabicus***

– Anal pyramid shorter with paraprocts being less than 2 times longer than S10; cerci about as long as paraprocts [6] **3**

3(2) Small lateral spine at S10 ..... ***P. elpidius***

– No lateral spine at S10 ..... **4**

4(3) Lateral spines on S2 to S9; dorsal part of abdomen densely covered with long setae ..... ***P. cataractae***

– Lateral spines on S5-9 or S7-9; less setae on abdomen **5**

5(4) Width of anterior median lobe of prementum about ⅓ of the maximum prementum width; uniform colouration ..... ***P. cognatus***

– Width of anterior median lobe of prementum more than ⅖ of the maximum prementum width; colouration on the dorsum of the abdomen as depicted [1] ..... ***P. genei***

6(1) Anal pyramid and rest of abdomen uniformly coloured ..... ***C. hartmanni***

– Anal pyramid with cream-coloured tip and dark base; S10 also dark **7**

7(6) Acute dorsal spines on S2-9 ..... ***C. cornutus***

– Acute dorsal spines on S2-3(4), on following segments only knobs ..... ***C. kavangoensis***

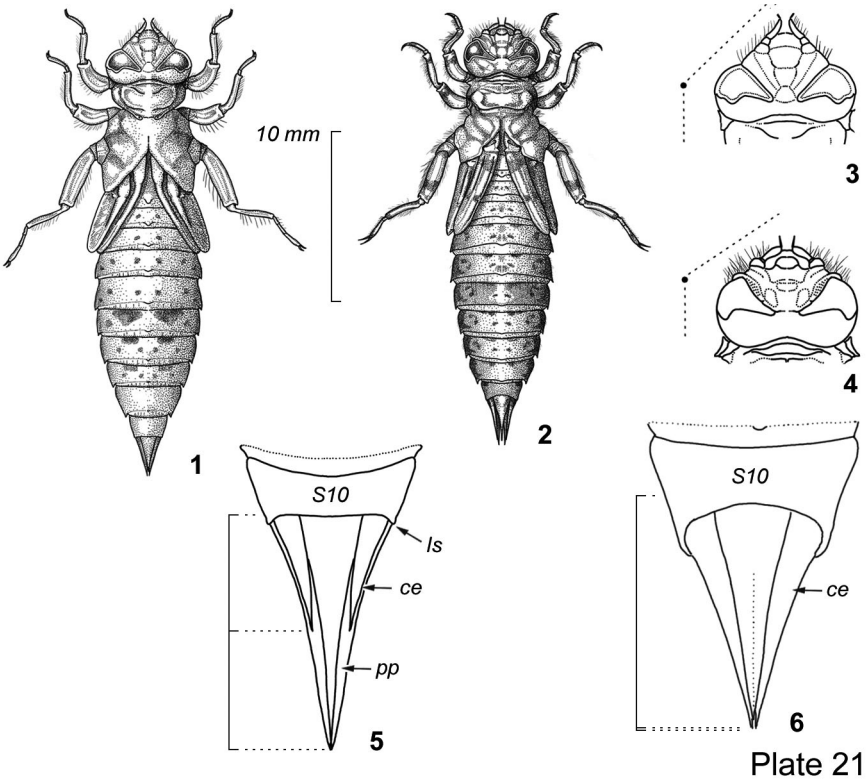


Table 3. Measurements (mm) of larvae of *Paragomphus* and *Crenigomphus*. An4, An3: lengths of segments 4 and 3 of the antenna; 4/3: ratio of An4 to An3; PmL: lengths of prementum; PmW: width of prementum; L/W: ratio PmL/PmW; Ml: width of anterior median lobe of prementum; Dors: abdominal segments with clearly visible dorsal spines or hooks; Lat: abdominal segments with clearly visible lateral spines; Pp: length of paraprocts; Cc: length of cerci; Pp/10: length Pp/length S10.

Species	An4	An3	4/3	PmL	PmW	L/W	Ml	Dors	Lat	Pp	Cc	Pp/10
P. cataractae	0.28	0.90	0.30	2.73	2.29	1.2	0.73	2-3	2-9	2.04	1.96	1.6
P. cognatus	0.25	0.88	0.30	3.10	2.20	1.4	0.73	2-3	7-9	1.88	1.71	1.4
P. elpidius	0.25	1.05	0.20	3.10	2.22	1.4	0.69	2-3	6-10	1.96	1.89	1.5
P. genei	0.35	1.40	0.25	3.10	2.53	1.2	1.14	2-3	5-9	2.04	1.88	1.6
P. sabicus	0.25	1.45	0.20	3.06	2.12	1.4	0.86	2-4	3-9	3.10	1.59	2.7
C. cornutus	0.40	1.14	0.35	3.10	2.12	1.4	0.82	2-9	2-9	2.60	2.50	1.8
C. hartmanni	0.30	1.45	0.20	3.18	2.45	1.3	0.98	2-9	6-9	1.88	1.88	1.3
C. kavangoensis	0.18	1.18	0.15	2.93	2.20	1.3	0.71	2-3	2-9	1.76	1.76	1.4

Notogomphus

A historical record of *N. praetorius* exists for Namibia at Mariental. The species' presence is doubtful since the habitat conditions at the locality are unsuitable. We however keep the genus in the key since it occurs widely in South Africa and its occurrence in southern Angola cannot be excluded. *Notogomphus praetorius* [1] occurs in mountain regions in eastern South Africa and Zimbabwe. The larva has been depicted by Samways & Whiteley (1997).

Ceratogomphus

The only species is *C. pictus*, which occurs mainly at large impoundment lakes in the Fish River system and around Windhoek. The larva [2] has first been described by Barnard (1937). A second species, *C. triceraticus*, is endemic to the Western Cape, South Africa.

Onychogomphus

No species is recorded yet, but *O. rossi*, which has been described from the middle Okavango River in southern Angola (Pinhey 1966), may occur. The larva of this species is unknown. The larval characters used in the key are based on *O. styx* and *O. supinus*. The latter is widespread in the eastern part of South Africa. The habitus drawing of *Onychogomphus* [3] is based on *O. styx*.

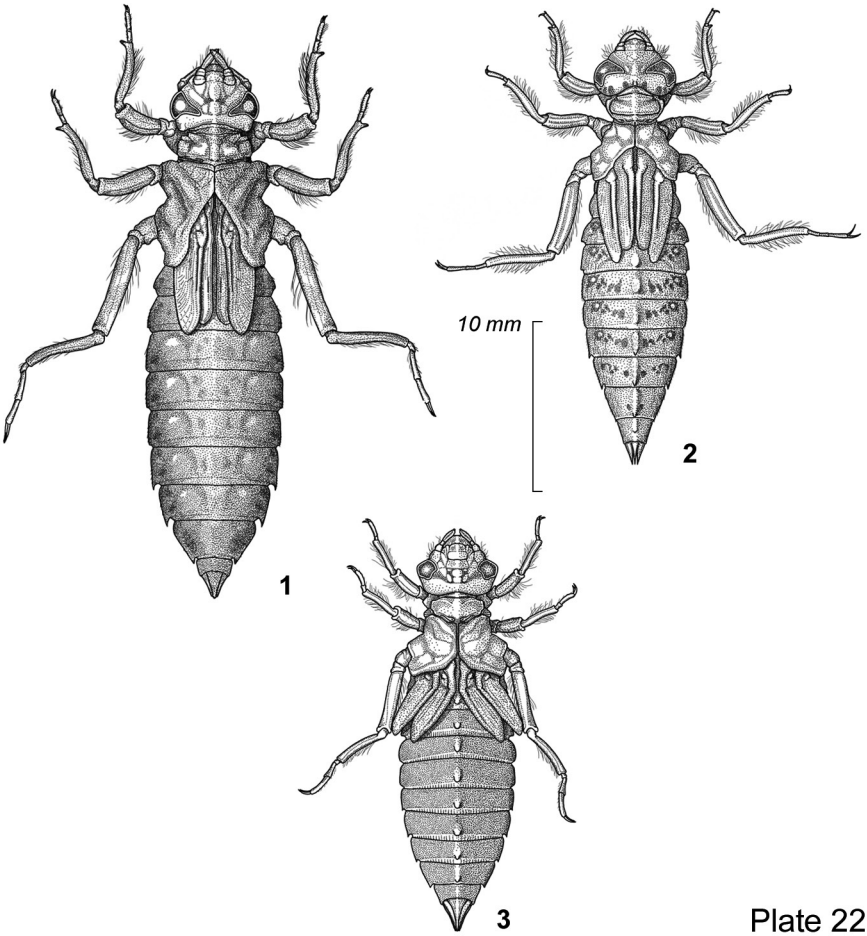


Plate 22

Aeshnidae

Four genera of Aeshnidae are known from the area, of which *Anax* [1] with five species occurs all over the region; at least one species, *A. ephippiger*, is an obligate seasonal migrant. The African members of the former genus *Aeshna* have recently been revised (Peters & Theischinger 2011). The newly created genus *Zosteraeschna* [2] is represented by *Z. minuscula*. We also include the genus *Pinheyschna* [3] which is represented in South Africa and in southern Angola. Our separation of the former members of *Aeshna* is based on Chelmick (2001). Two *Gynacantha* [4] species have occasionally been observed in the more humid areas, i.e. in the Caprivi.

All aeshnid larvae are comparatively uniform in having an elongate appearance of the body with the head measured over the eyes being about as wide as the abdomen. Most aeshnids detect prey visually. Consequently, the eyes are comparatively large even in the early larval stages. This is most conspicuous in *Anax* larvae [5]. The labium is mostly long, the labial palps having one stiletto-like movable hook each [6]. These hooks are perfectly suited for catching large prey such as fish, tadpoles, and other dragonfly larvae up to the size of the aeshnid larva itself. *Anax* larvae also feed on snails. Due to the long labium, the larva can strike from quite a distance. Although usually hunting from ambush, the larvae can actively chase prey by swimming using jet propulsion. The larvae are claspers, i.e. climbing in submerged vegetation, between tree roots, or among debris. Due to the very bendable abdomen the long and sharp pyramid, together with the lateral abdominal spines, can be used as a defence against predators. It has been observed that the pyramid was even used to secure larger prey.

The most species-rich genus *Anax* is also most variable in habitat use. Whereas *A. tristis* and *A. ephippiger* are typical dwellers of temporary waters, the latter even in desert rain pools, *A. speratus* occurs in small perennial streams, all in montane country. *Anax bangweuluensis* is only known from swamps in the Okavango Panhandle and Kwando floodplain. *Anax imperator* is the most widespread *Anax* and can be seen at all kinds of habitats; but larvae develop mostly in perennial lentic and sometimes lotic waters. *Zosteraeschna* and *Pinheyschna* occur in small streams. The habitats of the two species of *Gynacantha* are probably temporary wetlands in more humid areas. But, not much is known about these two species.

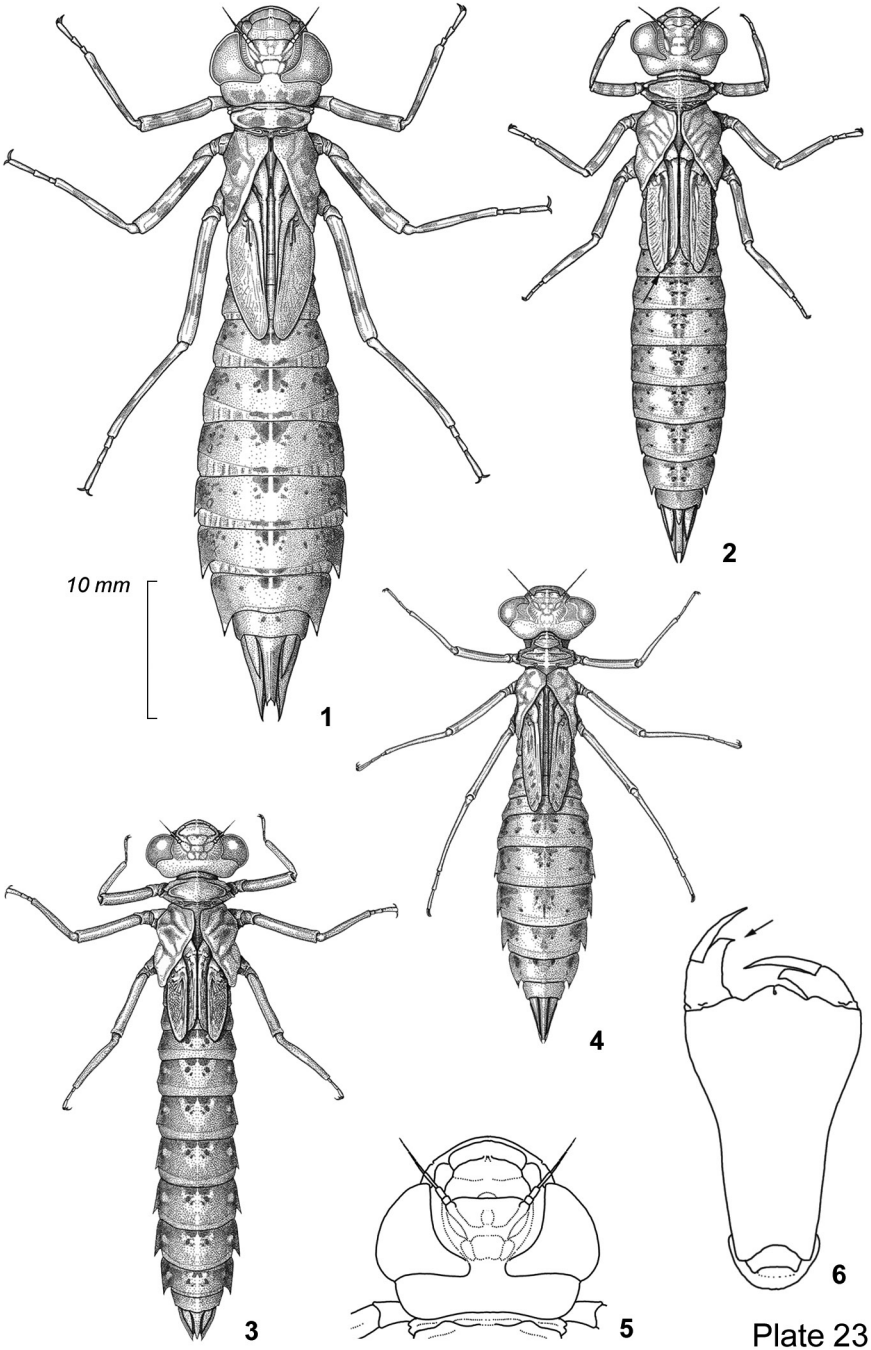


Plate 23

Key to genera

1 Head with posterior margin almost straight; the eye more than half the length of the head [1]; cerci half as long or shorter than paraprocts [3] ..... ***Anax*, p. 60**

– Head with posterior margin concave; the eye about half the length of the head [2]; cerci more than half as long as paraprocts [4-6] **2**

2(1) Anal pyramid stout, about as long as S10 dorsally [4] .... ***Pinheyschna*, p. 58**

– Anal pyramid longer, more than twice as long as S10 [5, 6] **3**

3(2) Cerci much shorter than the paraprocts [5] ..... ***Zosteraeschna*, p. 58**

– Cerci almost as long as the paraprocts [6] ..... ***Gynacantha*, p. 58**

Pinheyschna

Major characteristic of the larvae is the stout anal pyramid, which is about as long as S10 in dorsal view [4]; lateral spines at least on S6-9; labial palps without setae. No species has been recorded in Namibia. *Pinheyschna subpupillata* occurs in South Africa. In southern Angola another form has been recorded, which is close to *P. rileyi*, with an unknown taxonomic status; therefore we use the latter here for our key.

Key to the species

1 Lateral spines on S5-9; size of exuviae ± 45 mm ..... ***P. subpupillata***

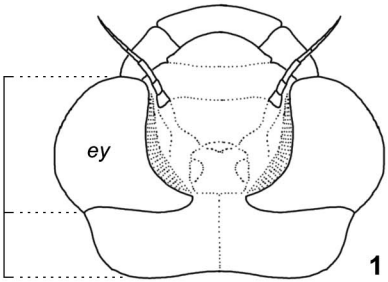
– Lateral spines on S6-9; smaller species < 40 mm ..... ***P. rileyi***

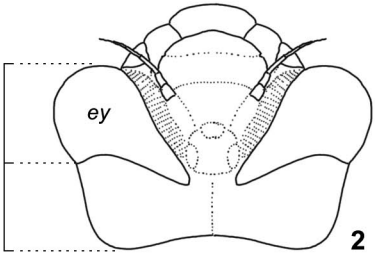
Zosteraeschna

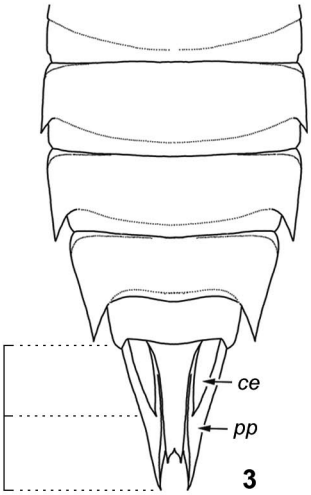
Only *Z. minuscula* (formerly *Aeshna minuscula*) has been recorded from a few localities in Namibia. The species is characterised by an anal pyramid, which is twice as long as S10. The larvae have usually spines on S7-9 (Samways et al. 1993; Chelmick 2001). At least one of our exuviae from Namibia has spines on S8-9 [5]. The labial palps have setae on the palpus and the movable hook.

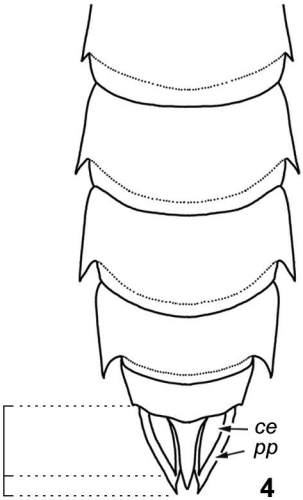
Gynacantha

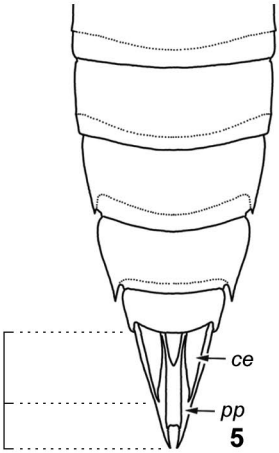
No larva of the two species occurring in the region, *G. manderica* and *G. villosa*, has been described yet. Some exuviae collected in Ivory Coast by K. Grabow probably belong to *G. manderica*. The characters given are based on these exuviae and on descriptions of *G. cylindrata* by Pinhey (1959) and of the Japanese *G. japonica* (Ishida et al. 1988). The habitus of the supposed *G. manderica* from Ivory Coast is depicted on Plate 23 [4].











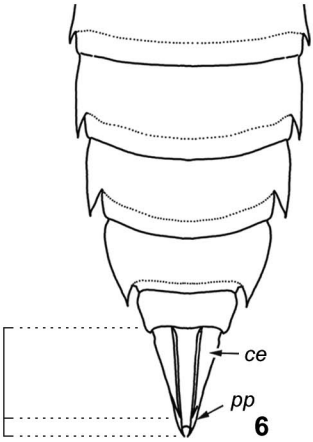


Plate 24

Anax

The genus *Anax* represents on average the largest dragonfly larvae in the region, being between 40 and 70 mm in total length. Five species have been recorded, most being widespread. Our key is based on Chelmick (1999) but altered for *A. speratus* and *A. imperator* and with *A. bangweuluensis* included.

Key to the species

1 Labial palps are in the form of pointed and slightly decurved hooks [1]; very large larvae and exuviae, body length 60-70 mm ..... ***A. tristis***

– Labial palps in the form of thickened lobes with end points, which are directed to the prementum [2-4]; body length < 60 mm **2**

2(1) End points of the labial palps are very small and sometimes hardly visible [2]; body length of exuviae about 40 mm ..... ***A. ephippiger***

– End points of the labial palps larger and clearly visible [3, 4]; body length of exuviae > 45 mm **3**

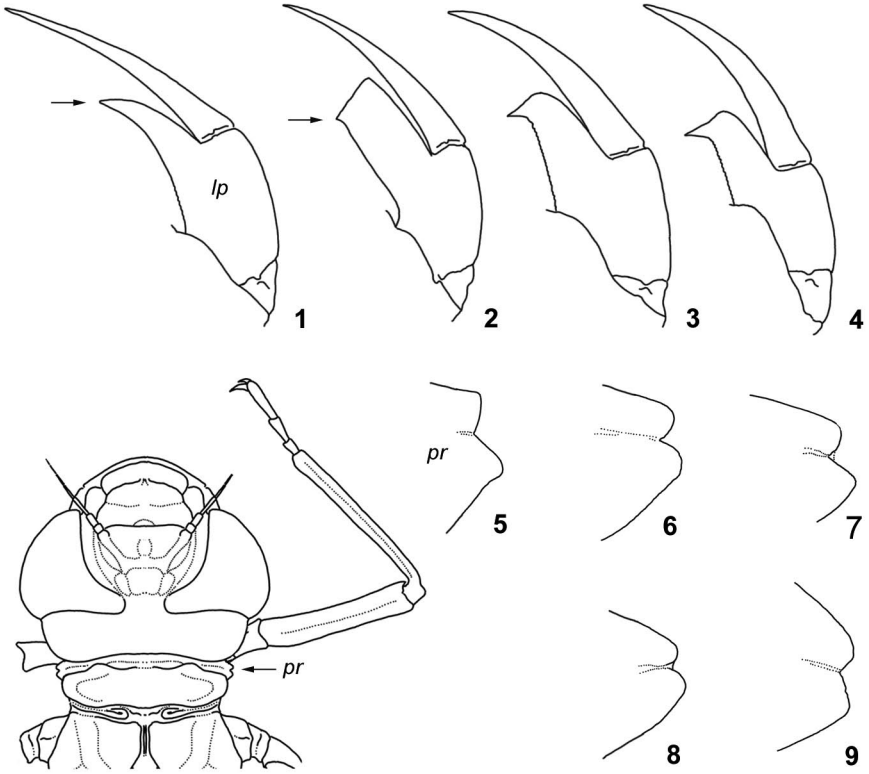
3(2) Projections of the prothorax angular and strongly obtuse [5]; prementum generally slender and only moderately widened distally [10] ..... ***A. bangweuluensis***

– Projections of the prothorax rather rounded and right-angled or weakly obtuse [6-7]; labium more widened distally [11, 12] **4**

4(3) Cerci about half as long as anal pyramid dorsally; distal margin of prementum with a single lobe separated by the median cleft; prementum max. length/max. width < 2 [11]; end points of labial palps as in [3]; body length 48-52 mm ..... ***A. imperator***

– Cerci less than half as long as anal pyramid; distal margin of prementum bi-lobed, separately curved on either side of the median cleft; prementum more slender and max. length/max. width = 2 [12]; end points of labial palps as in [4]; body length 51-56 mm ..... ***A. speratus***

Note: For identification see also the shapes of the projections of the prothorax: *A. bangweuluensis* [5], *A. imperator* [6], *A. speratus* [7|, *A. ephippiger* [8], *A. tristis* [9].



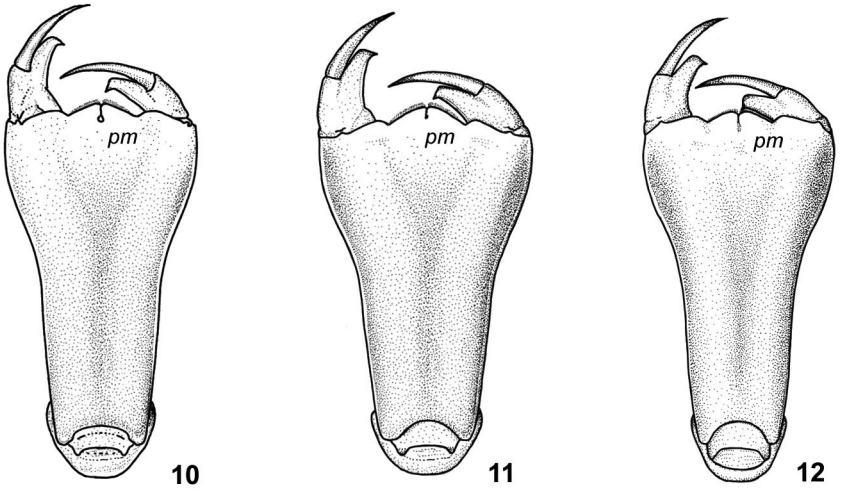


Plate 25

Macromiidae

Only one genus, *Phyllomacromia* occurs; species in Namibia are *P. contumax* (synonym *P. bifasciata*), *P. overlaeti* (*P. paludosa*), and *P. picta*. Corbet (1957a) described the larvae of *P. contumax* and *P. picta*. The characters of *P. overlaeti* are by presumption, based on one larva with distinct characters sampled in the Kwando River and one exuvia from the Zambezi R., where adults of *P. overlaeti* have been observed. The larva of a fourth species, *P. kimminsi*, found rarely in Botswana, remains unknown.

Characteristic for macromiid larvae are the long legs [1], which give the larvae a spider-like appearance. The legs are covered with sensory setae and are used for tactile prey detection. The eyes are comparatively small and probably do not contribute much to prey detection. The labium is shovel-shaped, short and has very clearly visible crenations (compared to libellulids). Unique is a prominent horn-like projection on the head; its function is unclear. The dorsal patterns of dark spots on sand-coloured ground make the larvae well camouflaged. In addition, the larvae may cover the body with some sand, but they are not able to burrow in the sediment due to the long legs. The larvae are typical sprawlers.

All *Phyllomacromia* are predominantly running water species. The larvae are bottom dwellers living among fine detritus or on sand in slow flowing or lentic waters. Most records are from the northern rivers, where macromiid exuviae can be found on tree trunks up to three or four metres high, often in abundance. Whereas *P. overlaeti* is restricted to the Okavango, Kwando and Zambezi Rivers, *P. contumax* is also found at the Kunene and the Otjikoto Lake (but no larval records at the lake yet). *Phyllomacromia picta* is most widespread occurring at all large rivers including the Orange River; one population is established in the Oanob Lake near Rehobot.

Key to the species

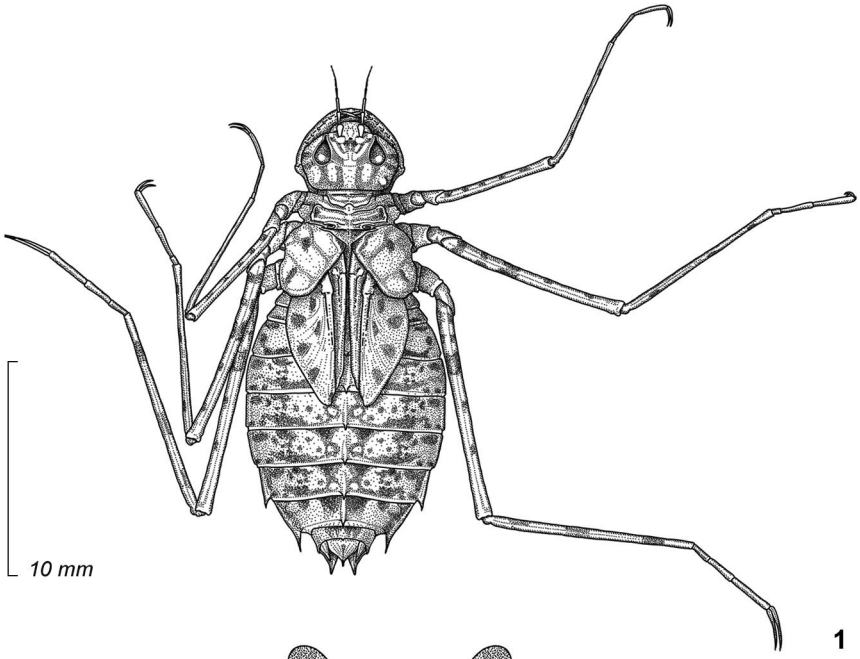
1 Distal margins of labial palps with three very deep crenations [2, 3] ..... ***P. contumax***

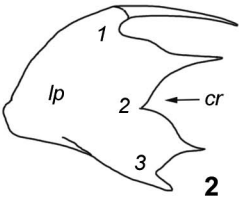
– Distal margins of labial palps with more than three distinct crenations [4-6] **2**

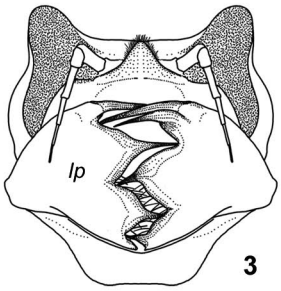
2(1) Mid-dorsal horn on head is at least as high as the eyes in frontal view [5] ..... ***P. overlaeti***

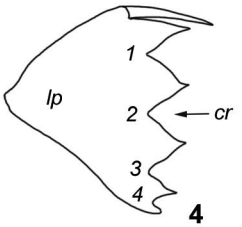
– Mid-dorsal horn on head is not as high as the eyes in frontal view [6] ..... ***P. picta***

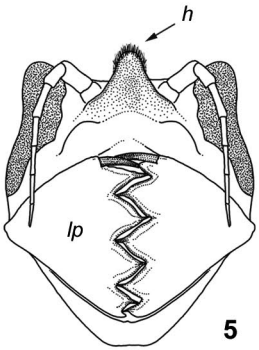
Note: The shapes of the mid-dorsal horns can also be used for identification.











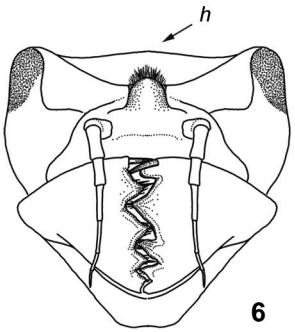


Plate 26

Libellulidae

The Libellulidae are by far the largest family in the region, with 24 genera and 64 species; this is slightly more than 40% of all genera and species. In the desert parts the libellulids are even more dominant, representing about 75% of all species (Suhling et al. 2009).

The larvae of two genera remain unknown, and these are each represented by one species in the area:

1) *Aethiothemis*: In Namibia *A. solitaria* occurs in the lower Okavango river, where it has a huge population. The larvae may be similar to *Orthetrum*.
2) *Trithetrum* is represented by *T. navasi*, formerly *Sympetrum navasi*. The genus has been revised by Dijkstra & Pilgrim (2007). In Namibia the species occurs in swampy areas mainly in the Okavango and Kwando Rivers.

Identifying libellulid larvae at the species level at this stage is often impossible. This is mainly due to the larvae of many species still being unknown. For instance, in the most species-rich genera *Trithemis* (15 species) and *Orthetrum* (12) we know too few species to present a key. The other genera are less speciose. *Palpopleura* has four species in the region, *Brachythemis*, *Crocothemis*, and *Rhyothemis* have three each. All other genera include only one or two species.

Larvae of Libellulidae differ from most other dragonfly larvae in the region in that their labium has enlarged palps that cover the lower parts of the head and leave only the eyes free (shovel- or spoon-shaped labium). The labium shape is well suited to capture smaller prey items, e.g. small crustaceans. But some libellulid larvae are also hunters of larger prey up to the size of other odonate larvae, water beetles and tadpoles. For instance, *Pantala flavescens* often feeds on tadpoles (Sherratt 1989), while *Tramea* larvae are effective in catching water beetles (A. Martens unpubl. obs.).

The general body shape of libellulid larvae is often very uniform. There are, however, some exceptions, which often comprise species associated with flowing water. These may have very specific larvae, e.g. some are very compact and robust, such as *Zygonyx* and *Zygonoides*. Species of both genera have flattened femora and a thick cuticle which may be interpreted as adaptations to cope with fast running water conditions (see below).

One group of Libellulidae, represented by *Orthetrum* and *Nesciothemis*, varies from all others in having a rectangular head shape and relatively small eyes. Their prey detection is mainly tactile, whereas species with larger eyes usually use a visual foraging mode. The larvae are shallow burrowers or bottom dwellers, and thus occur in micro-habitats where vision is probably handicapped. Characteristic in this group is the fact that the body is densely covered with long setae that

collect mud and fine detritus, effectively camouflaging their bodies. This mud-cover requires cleaning of the larvae to see properly other characters, such as dorsal spines.

In the key to the genera presented below, the presence of lateral and dorsal spines on the abdomen plays an important role. While some species have sometimes very prominent lateral and dorsal spines, others have only prominent lateral spines and others have only very small inconspicuous spines. The function of the spines is still not fully resolved. Experimental studies show that in some cases spines are effective anti-predation traits against fish (Mikolajewski & Rolff 2004). However, it seems that this protection requires dorsal and lateral spines. Some taxa such as *Olpogastra*, *Zygonoides*, *Brachythemis*, *Parazyxomma*, and *Urothemis* have both strong dorsal and lateral spines and indeed occur in habitats were fish are common. By contrast, *Pantala* and *Tramea* have strong lateral but no dorsal spines and occur in usually fish-free temporary waters. Thus, their spines probably have other functions.

We also use markings on the abdomen as identification characters. For instance, *Trithemis* larvae have markings that may be species-specific (Plate 33: 2-3) and *Palpopleura* larvae and others have a distinct whitish mid-dorsal line (Plate 35: 3, 6-7). An obstacle with such patterns is that they may not always be visible. Dragonfly larvae are able to change body colour after moults. For instance, larvae of *Crocothemis erythraea* have usually reddish colour on the underside of the last few abdominal segments, which is very characteristic. But, sometimes larvae from very muddy habitats are completely black (similar to *Diplacodes lefebrvii*).

Libellulid larvae can be found in all kinds of freshwater habitats, from perennial rivers to temporary waters. At one extreme are *Zygonyx* larvae, which live in fast current, including rapids and waterfalls, where they hold themselves tightly to stones, drift wood or water plants to avoid being washed away. Also *Olpogastra* larvae occur in swiftly flowing water but were found in dense submerged vegetation. *Brachythemis* and most *Trithemis* also may occur mainly in running waters but the larvae are more common in lentic parts at the edges or well-vegetated areas. At the other extreme are several species that live in temporary waters, such as *Pantala flavescens* and *Sympetrum fonscolombii*. The majority of species occur in well-vegetated habitats, mostly swampy river courses, swamps and vleis. The genus *Orthetrum* is present in a wide variety of habitats. *Orthetrum julia* and *O. abbotti* are widely restricted to spring habitats, which in the case of *O. julia* may be widely shaded and very small waterbodies. In contrast, *O. trinacria* prefers large, open habitats such as impoundment and oxbow lakes. *Orthetrum machadoi* and O*. icteromelas* are swamp species. *Orthetrum brachiale* and *O. chrysostigma* are able to live under various conditions, including temporary waters. But *O. brachiale* is more restricted to the wetter areas, whereas *O. chrysostigma* is common in the deserts.

Key to the genera

1 Eyes small, extending in length from ⅓ up to ⅖ of the lateral head margin; margins of head behind eyes almost parallel [1] **20**

– Eyes extending in length from at least ½ of the lateral head margin; margins of head curved and convergent [2, 3] **2**

2(1) Distinct dorsal spines present [4, 5] **3**

– No dorsal spines present or dorsal spines hardly visible [6] **13**

3(2) Dorsal spine on S9 present [4] **4**

– No dorsal spine on S9, at maximum a ridge [5| **10**

4(3) Ventral suture between S8 and S9 distinctly kinked [7, 8] **5**

– Ventral suture between S8 and S9 not distinctly kinked but gently curved [9] **6**

5(4) Lateral spines present on S7-9 with that of S9 extending well beyond the anal pyramid [7]; femora not flattened ..... ***Olpogastra*, p. 72**

– Lateral spines present on S6-9, with that of S9 reaching only as far posteriorly as anal pyramid [8]; femora flattened ..... ***Zygonoides*, p. 72**

6(4) Labium short and stout, at the anterior margin not much wider than at the base, reaching coxa of foreleg [10]; femora of all legs flattened ..... ***Zygonyx*, p. 72**

– Labium longer and extending further back, at the anterior margin clearly wider than at the base, reaching coxa of midleg [11]; femora not flattened **7**

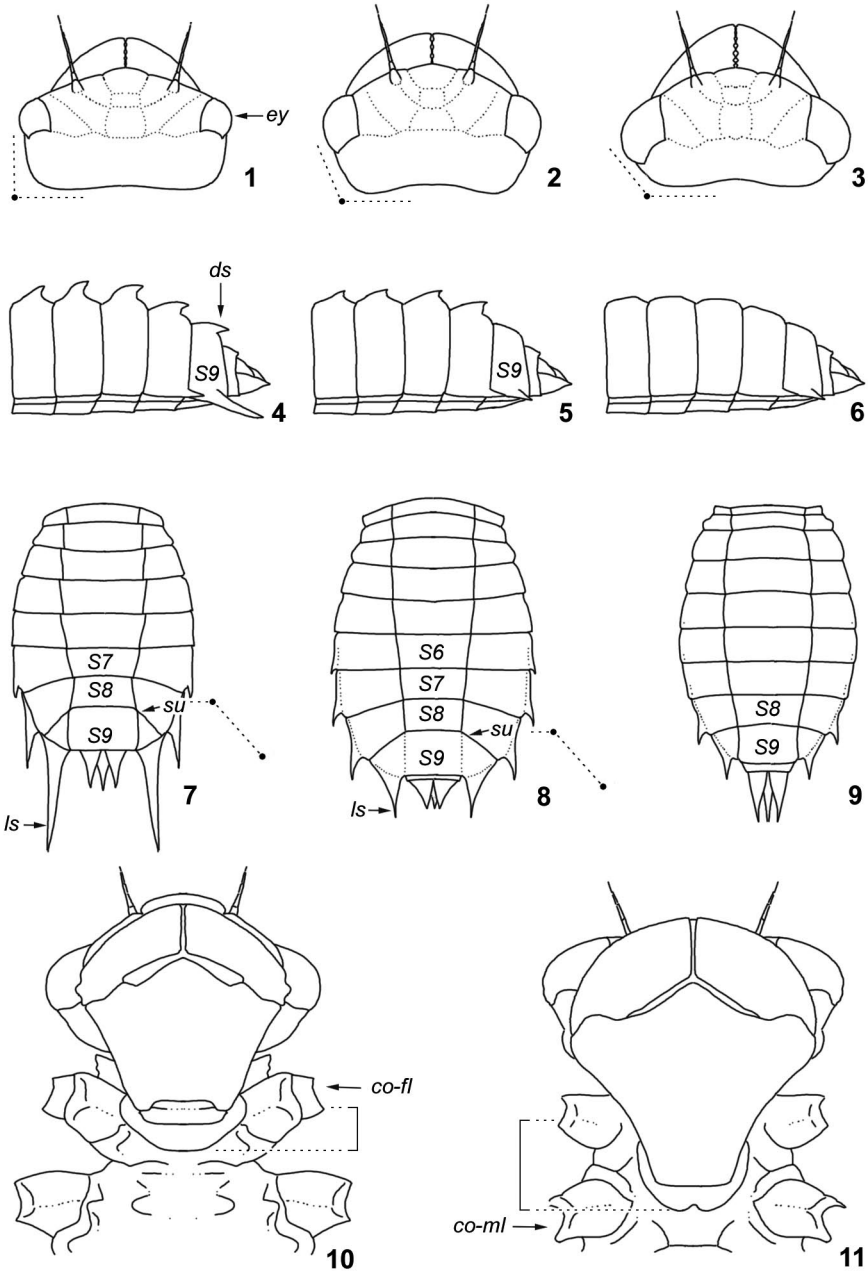

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Plate 27

7(6) Lateral spines on S8 pointing outwards [1]; lateral spines on S9 long, half the length of S9 or longer ..... ***Brachythemis*** and ***Parazyxomma*****, p. 76**

– Lateral spines on S8 pointing rearwards [2, 3]; lateral spines on S9 short, much less than half the length of S9 ..... **8**

8(7) Labial palps with distinct, rather ragged-edged crenations [4]; anal pyramid distinctly shorter than broad at its base [5] ..... ***Tetrathemis*****, p. 76**

– Labial palps with less distinct crenations [6]; anal pyramid slightly longer to distinctly longer than broad at its base [2, 3] **9**

9(8) Dorsal spines on S6-9 forming a distinct keel in cross-section [7]; anal pyramid distinctly elongate [2]; note: young larvae black and white striped ..... ***Tholymis*****, p. 76**

– Dorsal spines do not form such a keel [8]; anal pyramid not elongate [3]; pattern on abdomen present, but not black and white ..... ***Trithemis*****, p. 78**

10(3) Anal pyramid only slightly projecting behind S9 [9]; abdomen egg-shaped ..... ***Rhyothemis*****, p. 74**

– Anal pyramid distinctly projecting behind S9 [10-12]; abdomen more oval **11**

11(10) Anal pyramid longer and sharply pointed, with slender epiproct [10] ..... ***Chalcostephia*****, p. 74**

– Anal pyramid short and stout, with broad epiproct [11, 12] **12**

12(11) Lateral spines on S9 distinctly shorter than length of S9 [11]; small species, body length <15 mm ..... ***Aethriamantha*****, p. 74**

– Lateral spines on S9 longer, about half the length of S9 [12]; larger species, body length ≥ 20 mm ..... ***Urothemis*****, p. 74**

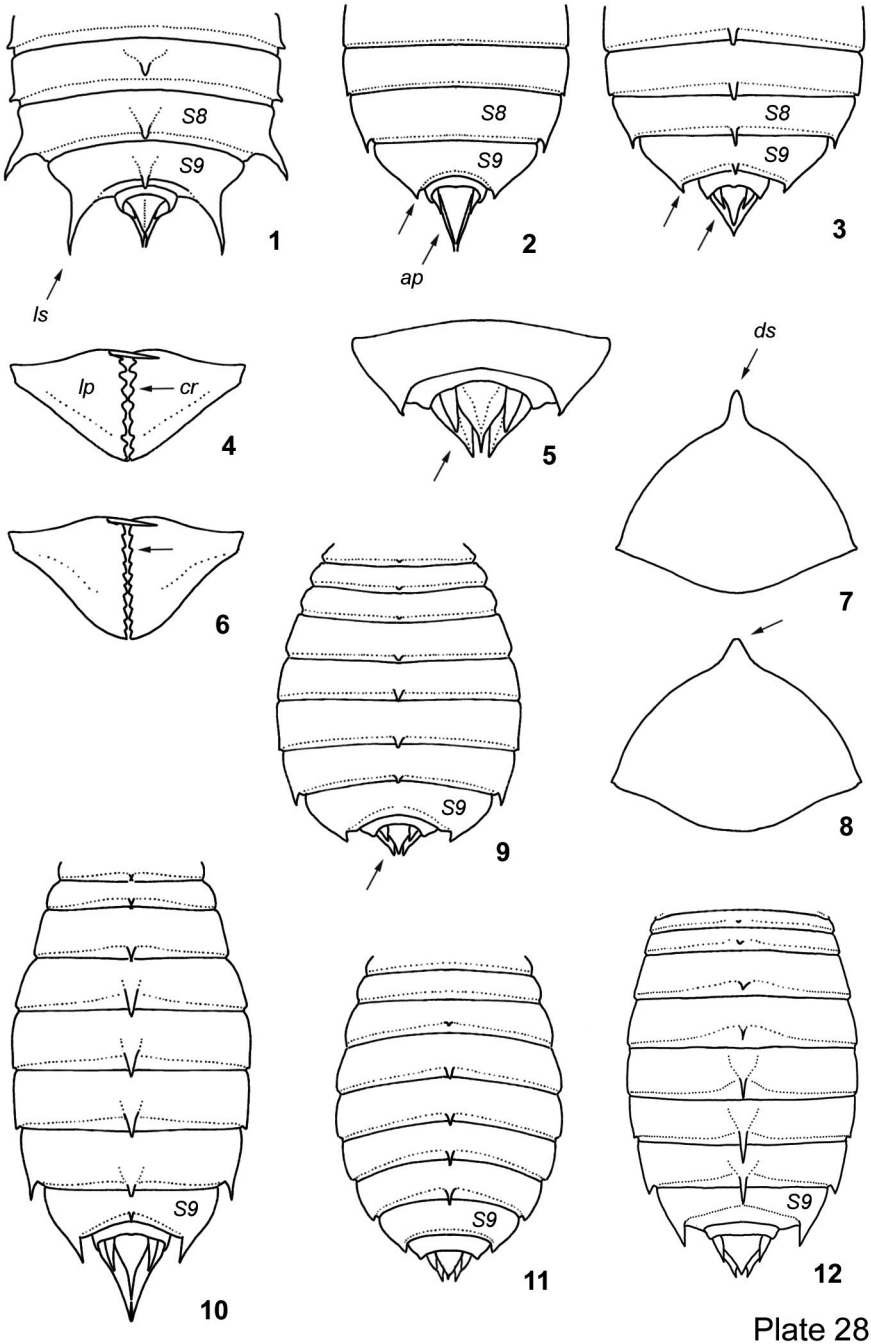


Plate 28

13(2) Distinct lateral spines on S8-9 [1-3]; distinct crenations at labial palps **14**

– Short or no lateral spines on S8-9 [4-7]; indistinct crenations at labial palps **16**

14(13) Lateral spines on S9 shorter than anal pyramid [1]; abdomen with narrow light coloured mid-dorsal line ..... ***Bradinopyga*, p. 80**

– Sharp lateral spines at S9 about as long as anal pyramid [2, 3]; abdomen without light mid-dorsal line **15**

15(14) Lateral spines at S8 shorter than those at S9 [2]; black tarsi of mid- and hind legs ..... ***Pantala*, p. 80**

– Lateral spines at S8 as long as those at S9 [3]; no black tarsi ..... ***Tramea*, p. 80**

16(13) Cerci > ⅔ as long as paraproct [4]; small exuviae (< 15 mm) ..... ***Acisoma*, p. 82**

– Cerci not, or only slightly, more than half as long as paraprocts [e.g. 8]; exuviae small to large **17**

17(16) Abdomen with distinctly contrasting whitish mid-dorsal band [5]; very small exuviae <15 mm ..... ***Hemistigma*** and ***Palpopleura*, p. 82**

– No whitish mid-dorsal linear band on abdomen [7, 8], at most a light area between two dark bands as in [6], if so exuviae > 15 mm **18**

18(17) Hind legs when stretched out almost 2 times as long as abdomen; abdomen with two dark, sometimes faded, dorsal bands [6] ..... ***Sympetrum*, p. 82**

– Hind legs when stretched out at most 1.5 times as long as abdomen; abdomen without such bands **19**

19(18) Hind legs when stretched out about as long as abdomen; abdomen ventrally and dorsally with irregular dark pattern or completely dark [7] ..... ***Diplacodes*, p. 84**

– Hind legs when stretched out about 1.5 times as long as abdomen; abdomen dorsally without such pattern [8]; often last abdominal segments reddish ventrally ..... ***Crocothemis*, p. 84**

20(1) Long hind legs that clearly project posteriorly behind the abdomen [9]; one strong seta on tibia of hind leg [11] ..... ***Nesciothemis*, p. 86**

– Hind legs do not, or only slightly, project posteriorly behind the abdomen [10]; no single strong seta on tibia of hind leg ..... ***Orthetrum*, p. 86**

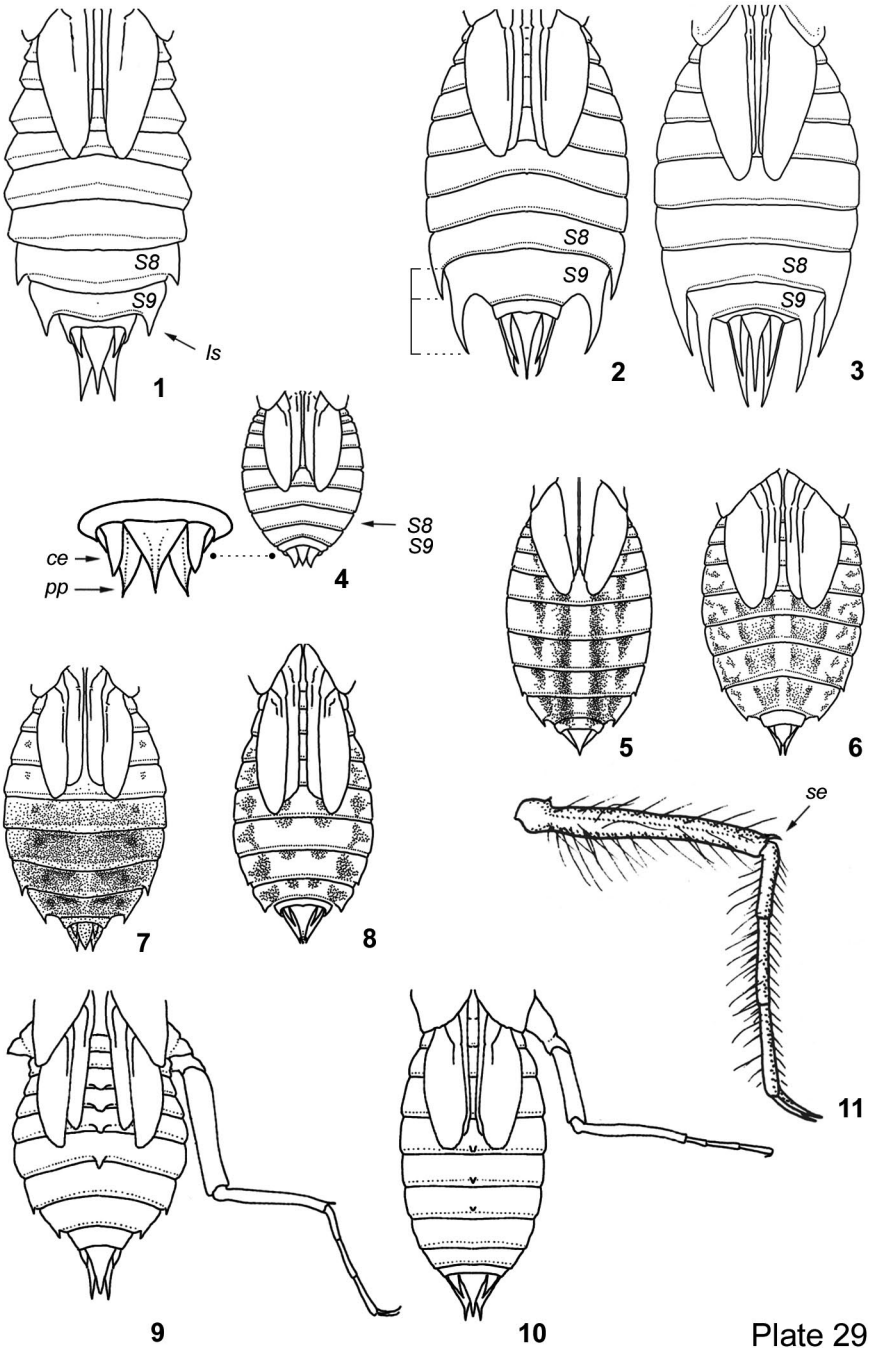


Plate 29

Olpogastra

Only one species belongs to this genus, *O. lugubris*. The larva is very conspicuous [1] due to its very long lateral spines at S9 and cannot be mistaken, even in smaller larval stadia. The larvae were found in submerged vegetation in fast current of rivers.

Zygonoides

The larvae of the three African species of *Zygonoides* were described and keyed by Dijkstra *et al.* (2006). In Namibia only *Z. fuelleborni* [2] occurs along the Kunene, Okavango, Kwando and Zambezi rivers. The larval microhabitat is unknown. Exuviae were found particularly in trees at fast flowing sections.

Zygonyx

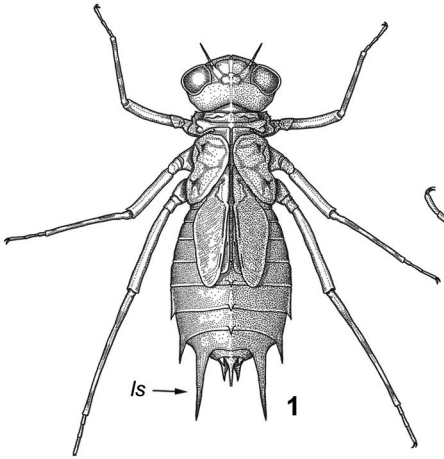
Two species of *Zygonyx* occur in the region, of which *Z. natalensis* [3] has only been recorded from large rivers, whereas *Z. torridus* [4] also occurs in smaller streams and springbrooks in the desert, particularly at waterfalls and swift flowing stretches. Other *Zygonyx* spp. that occur in northern Zambia all have much longer lateral spines.

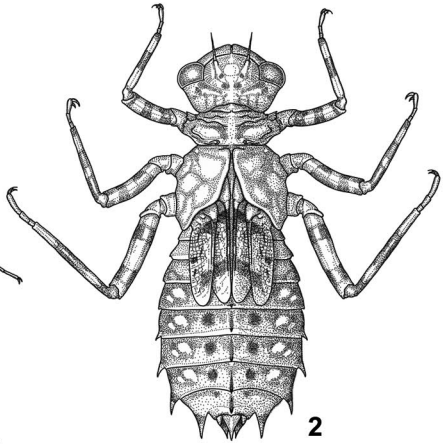
Key to the species

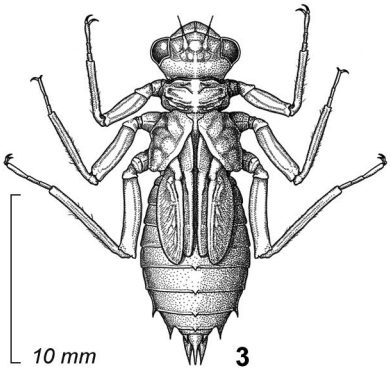
1 Lateral spines pointing downwards [5]; distal margin of the prementum projecting and pointed [6]; 8 long and 4 short setae on each side of the prementum ..... ***Z. torridus***

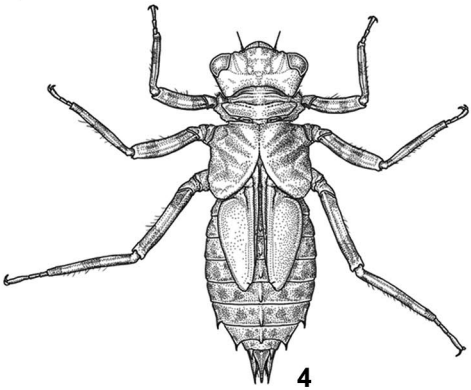
– Lateral spines not, or only slightly, pointing downwards [7]; distal margin of the prementum projecting, but more rounded [8]; 10 long and 3 short setae on each side of the prementum ..... ***Z. natalensis***

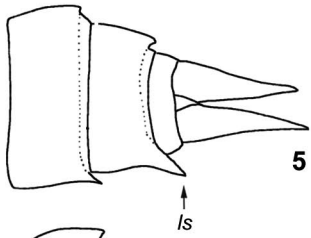
Note: The larvae of the three genera described on this page and illustrated on Plate 30 are very distinct from all other libellulids in the region due to their very prominent lateral abdominal spines (*Olpogastra*) or due to their general body shape with massive legs having flattened femora. All three include species that develop in running waters.

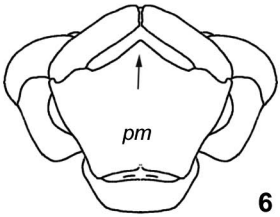


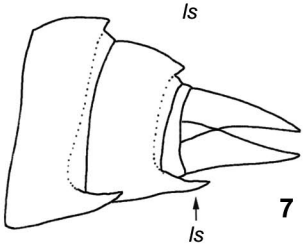












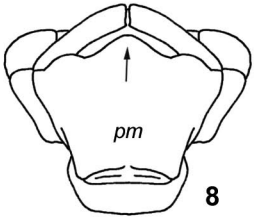


Plate 30

Rhyothemis

The final instar larvae are small and have an egg-shaped abdomen with stout anal pyramid and inwardly-curved lateral spines. Three species are recorded of which only the larva of *R. semihyalina* [1] has been described so far. While *R. semihyalina* exuviae have straight lateral spines at S8 one exuviae found by us at the Kwando River differs from this in having distinctly incurved lateral spines at S8. It may belong to *R. fenestrina*, which is common at the Kwando.

Chalcostephia

Only one species, *C. flavifrons* [2], which occurs in swampy habitats along the northern perennial rivers. The larvae are relatively slender compared to other libellulids. The anal pyramid is strongly pointed. There is no dorsal spine on S9, but a sharp ridge. The species occurs along the northern perennial rivers.

Aethriamanta

The larva of *A. rezia* [3], the only species in the region, has recently been described by Fleck & Legrand (2005). In general habitus it looks like *Urothemis* but the exuviae are much smaller in body length. The abdomen is covered with long setae – a character otherwise typical for *Orthetrum* and *Nesciothemis* and also present in *Acisoma*. *Aethriamanta rezia* occurs in the northeast of the region, Caprivi, Okavango Delta etc.

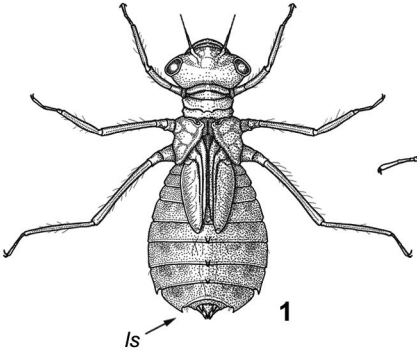
Urothemis

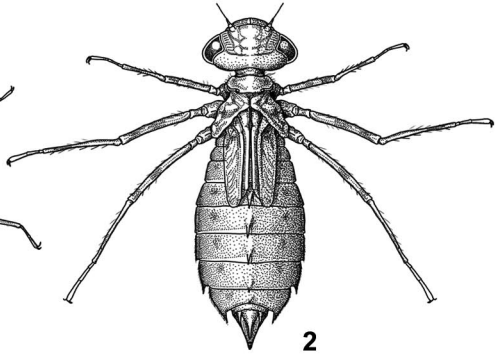
Two species occur in the region. *Urothemis edwardsii* is common along the riverine swamps of the Okavango and Kwando Rivers. The dorsal spines particularly in *U. edwardsii* are quite sharp. Exuviae of *U. edwardsii* were found on lotus leaves at the Kwando river. It is widespread in swampy habitats mainly along rivers but also occurs in other swampy wetlands. *Urothemis assignata* [4] has only been recorded from few habitats in central Namibia, but is also found in the Okavango swamps in Botswana.

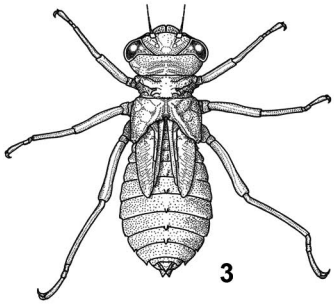
Key to the species

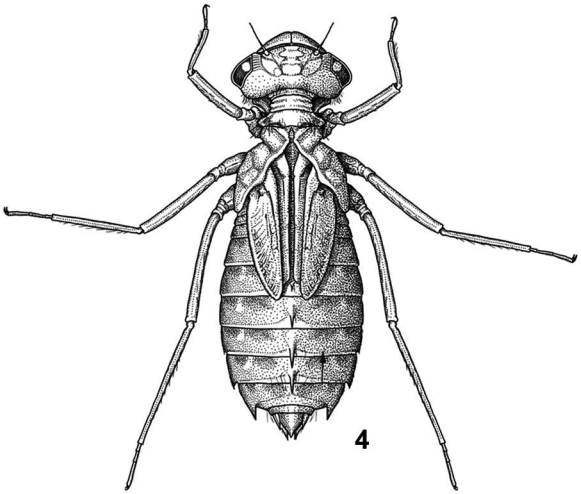
1 Dorsal spine S8 projects half way over S9; lateral spines on S9 do not project over the anal pyramid [5] ..... ***U. assignata***

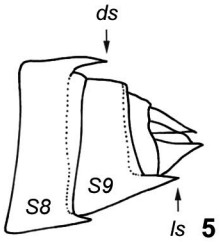
– Dorsal spine on S8 projects to the rear end of S9; lateral spines on S9 project over the anal pyramid [6] ..... ***U. edwardsii***











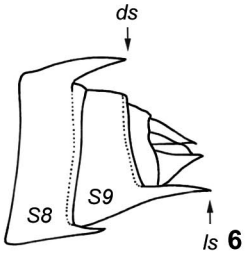


Plate 31

Brachythemis and Parazyxomma

The larvae of *P. flavicans* [1], *B. leucosticta*, and *B. lacustris* share a similar habitus and most general characters. Therefore we did not separate the two genera in the main key. All three species have relatively slender, erect dorsal spines on most segments and outwardly pointing lateral spines, at least on S8. The abdomen is rather egg-shaped. Due to this combination of characters the habitus of *Brachythemis* and *Parazyxomma* cannot be confused with any other libellulid in the region. The larva of *B. wilsoni*, occurring in the Okavango Delta and at the Kwando R. is unknown.

Key to the species

1 Lateral spines on S9 point distinctly downwards in lateral view; most dorsal spines straight and erect with only the tips slightly hooked; dorsal spine on S9 slightly hooked [2] ..... ***P. flavicans***

– Lateral spines on S9 do not point downwards; dorsal spines hooked almost from base; dorsal spine on S9 not hooked [3] **2**

2(1) Lateral spines on S9 reaching tip of anal pyramid [4] ..... ***B. lacustris***

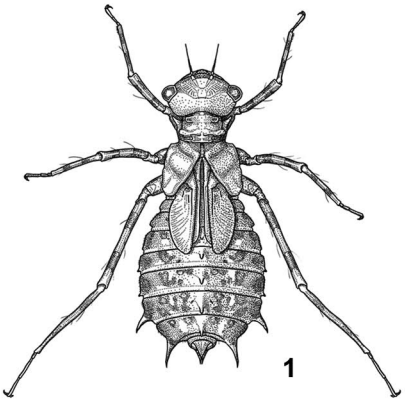
– Lateral spines on S9 not reaching tip of anal pyramid [5] ..... ***B. leucosticta***

Tetrathemis

One species, *Tetrathemis polleni*, [6] is found in the region, where it only occurs at Victoria Falls. The characters used are based on exuviae of *T. bifida* collected by K. Grabow and on the description of the larva of *T. longfieldae* (Legrand 1977). The labial palps are rather coarsely crenated [Plate 28: 4]. The exuviae are relatively small (< 15 mm in length), have strong dorsal spines, including those on S9, but relatively small lateral spines on S8-9. The anal pyramid is stout and points slightly upwards in lateral view [7].

Tholymis

One species, *Tholymis tillarga* [8]. The larva is distinct due to a keel-shaped row of dorsal abdominal spines [9, 10] and the sharply pointed anal pyramid [8, 10]. *Trithemis* may look similar with respect to the dorsal spines, but the exuviae are much smaller. The larvae of *T. tillarga* dwell in swampy habitats. Due to the migratory behaviour of the adults of the species, the larvae may also be found in freshwaters in the desert regions.



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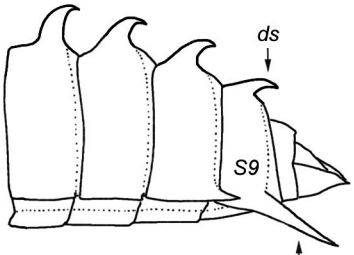

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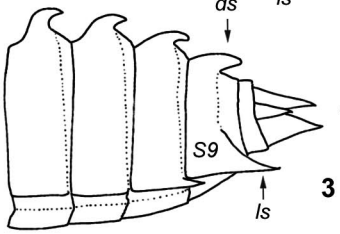

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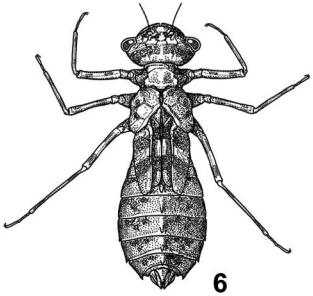

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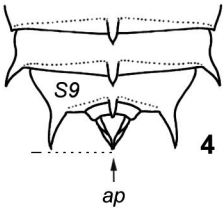

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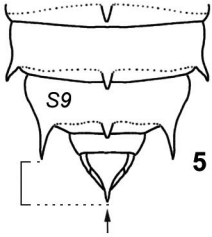

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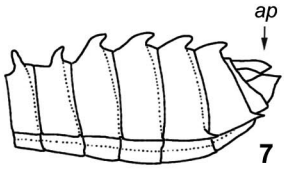

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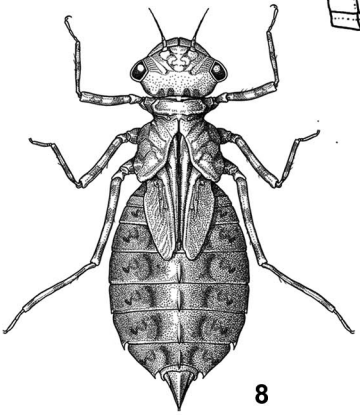

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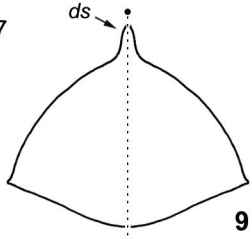

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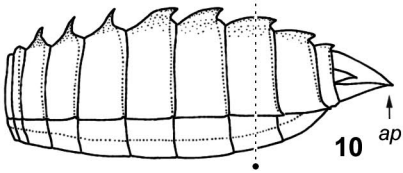

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Plate 32

Trithemis

So far 15 species have been recorded in the region; the larvae of seven of these are unknown. This concerns mainly the species having their stronghold in the northeast of the region, e.g. in the Okavango and Zambezi swamps, viz. *T. aequalis*, *T. brydeni*, *T. morrisoni*, *T. palustris*, *T. aconita*, *T. hecate*, and *T. pluvialis*. Besides our own material we base the key on Samways et al. (1993b), Carchini et al. (1992a), and Brochard et al. (2013). Most species occur in running waters or larger lakes, with the exception of *T. kirbyi*, which colonises desert wetlands. The key below is valid mainly for the desert regions.

Key to the species

1 Abdomen egg-shaped, with S6 and S7 almost equal in width [1, 2]; dark transverse band on abdomen reaches S6 [2]; dorsal spine on S6 as in [4] ..... ***T. stictica***

– Abdomen elliptical, with S6 wider than S7; dark transverse band absent or faded on S6 [3] **2**

2(1) Anal pyramid long, length/width > 1.2 ..... **3**

– Anal pyramid shorter, length/width is 1.0 to at most 1.15 ..... **5**

3(2) Dorsal spine on S6 pointing upwards [5] ..... ***T. annulata***

– Dorsal spine on S6 with a flat upper edge, pointing backwards [6, 7] **4**

4(3) Cercal length ⅖ of epiproct; marginal setae on palpus as in [11] ..... ***T. kirbyi***

– Cercal length ⅓ of epiproct; marginal setae on palpus as in [12] .. ***T. dorsalis***

Note: *T. dorsalis* has not yet been found in Namibia; it is known from the Orange R. at Augrabies Falls. Larvae found in Namibia are probably *T. kirbyi.*

5(2) Mesosternum between coxa with one pair of long setae and a row of six smaller setae [13]; dorsal spine on S6 as in [8] ..... ***T. werneri***

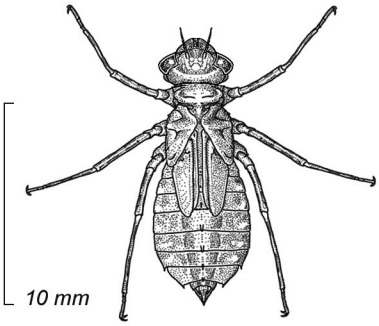
– Mesosternum with 2 pairs of setae between coxa [14] **6**

6(5) Dorsal spine on S6 with a flat upper edge, pointing backwards [9] ... ***T. furva***

– Dorsal spine on S6 more rounded and pointing upwards [10] **7**

7(6) Lateral spines on S9 short, not or just reaching over S10; lateral spines on S8 straight; dorsal markings on S7-S9 usually clearly visible .. ***T. arteriosa***

– Lateral spines on S9 longer, clearly reaching over S10; lateral spines at S8 pointing outwards; dorsal markings on S7-S9 very weak ... ***T. donaldsoni***



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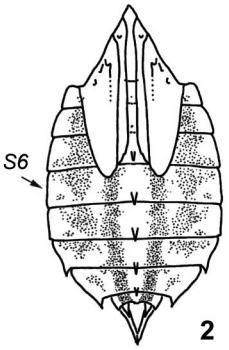

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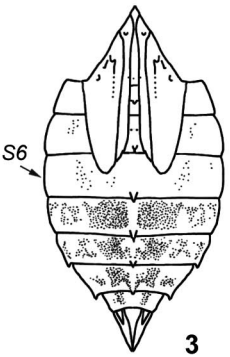


3

4 *T. stictica*

5 *T. annulata*

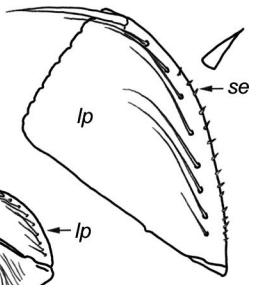
6 *T. kirbyi*

7 *T. dorsalis*

8 *T. werneri*

9 *T. furva*

10 *T. arteriosa*
T. donaldsoni



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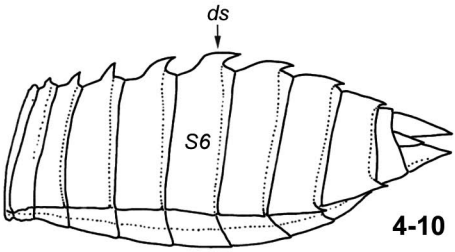

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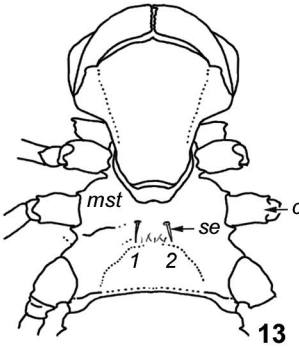

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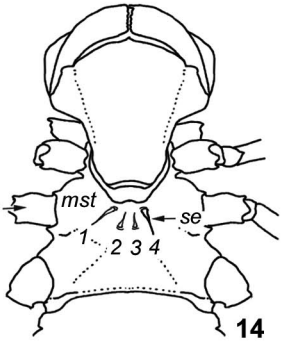

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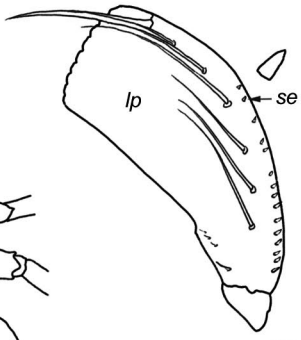

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Plate 33

Bradinopyga

One species, *B. cornuta*. The larva is quite typical in appearance due to distinctive lateral spines, which however do not reach the end of the anal pyramid [1]. Larvae live in rock pools, which are more or less bare of substrate. The species is very scattered in Namibia.

Pantala

Only one species, *P. flavescens* [2], the larva being larger than most other libellulids and might only be confused with those of the genus *Tramea* due to the character combination of long lateral spines and no dorsal spines. Larvae of *P. flavescens* have black tarsi on middle and hind legs. The lateral spine on S8 is shorter than that on S9 [3]. The larvae predominently occur in temporary waters which are colonised with the first rains. These waters may be bare of vegetation. The larvae are often the top-predators in these environments. The development is very rapid, lasting about 35 days from ovipositon to emergence.

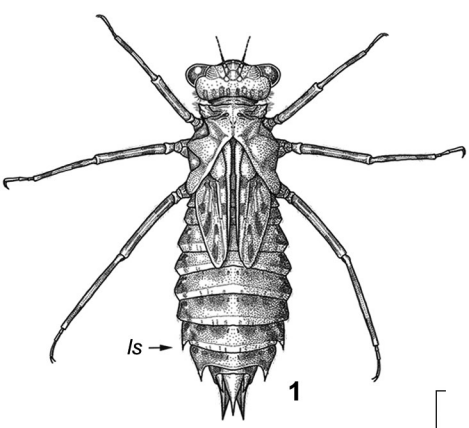
Tramea

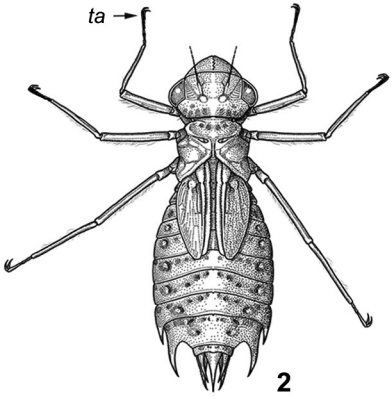
Two species occur of which only *T. basilaris* [4] is common, *T. limbata* (synonym *T. continentalis*) has only be seen occasionally. The *Tramea* larvae have similar sized lateral spines on S8 and S9 [5]. A unique character is the presence of two rows of dense setae along the tibia of the fore- and mid-legs. In larvae these setae may be covered with mud; in exuviae they are often glued to the legs. The larvae live in temporary waters, but contrary to *P. flavescens* the species prefers vegetation-rich habitats. The larvae dwell in dense vegetation.

Key to the species

1 Epiproct nearly as long as paraprocts [6] ..... ***T. basilaris***

– Epiproct distinctly (about 25%) shorter than paraprocts [7] ..... ***T. limbata***





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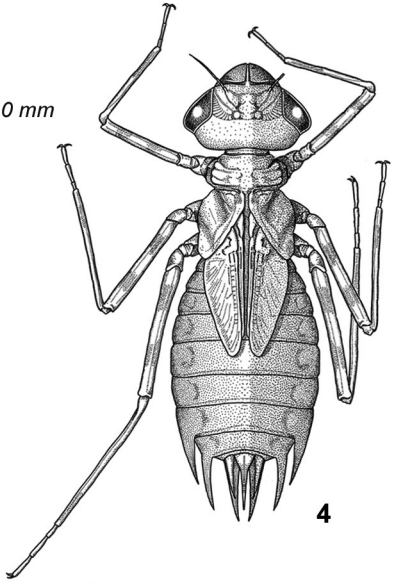
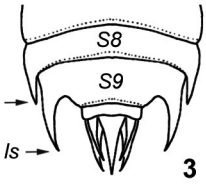
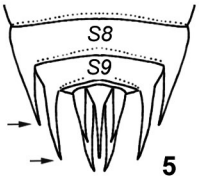
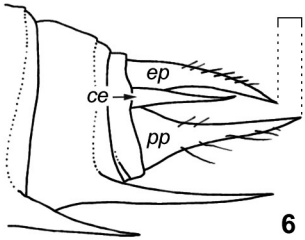








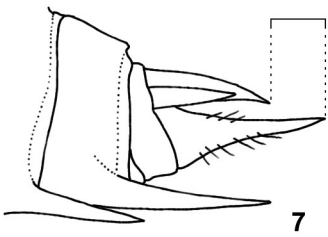


Plate 34

Acisoma

One species, *A. panorpoides ascalaphoides*, has been recorded so far [1]. A second species, *A. trifidum*, occurs in Angola. The exuviae are small (< 15 mm). Characteristic is the anal pyramid of *A. panorpoides* in having cerci about as long as paraprocts.

Key to the species

1 Cerci about as long as paraprocts ..... ***A. panorpoides***

– Cerci about ⅔ of the length of paraprocts ..... ***A. trifidum***

Sympetrum

Only one species occurs, *S. fonscolombii* [2]. The larvae and exuviae have distinct dark bands on both sides of the middle line of the abdomen. Sometimes they may have a very small dorsal spine on S9. The lateral spines on S8-9 are very small. The species breeds particularly in temporary waters and pans, which are colonised after the onset of the rainy season.

Hemistigma and *Palpopleura*

One species of *Hemistigma* and four species of *Palpopleura* are recorded, namely *H. albipunctum*, *P. deceptor*, *P. jucunda*, *P. lucia*, and *P. portia*. The larva of the latter is unknown. All known species in this group share a distinct whitish band on the abdomen. We combine here key characters reported by S. Butler (unpublished) with our own observations. The habitus of *P. lucia* is shown in [3].

Key to the species

1 Head with w-shaped dark markings between the insertions of the antennae; labial palps lacking a row of setae external to the palpal setae ..... ***H. albipunctum***

– Head lacking w-shaped markings; labial palps with external row of setae **2**

2(1) Lateral spines at S9 reach as far rearwards as the end of S10 [4]; mid dorsal white band small and not reaching to S10 [6]; very small species ≤ 12 mm ..... ***P. jucunda***

– Lateral spines less distinct and never reaching as far rearwards [5]; mid dorsal white band broad and reaching to S10 [7]; somewhat larger species **3**

3(2) Cerci almost as long as epiproct (⅞ of its length) [8], lateral spines on S9 and particularly S8 very small; total length of exuvia 15-17 mm ... ***P. lucia***

– Cerci ¾ as long as epiproct [9], lateral spines on S9 and particularly S8 overlapping next segment; total length of exuvia about 13 mm .. ***P. deceptor***

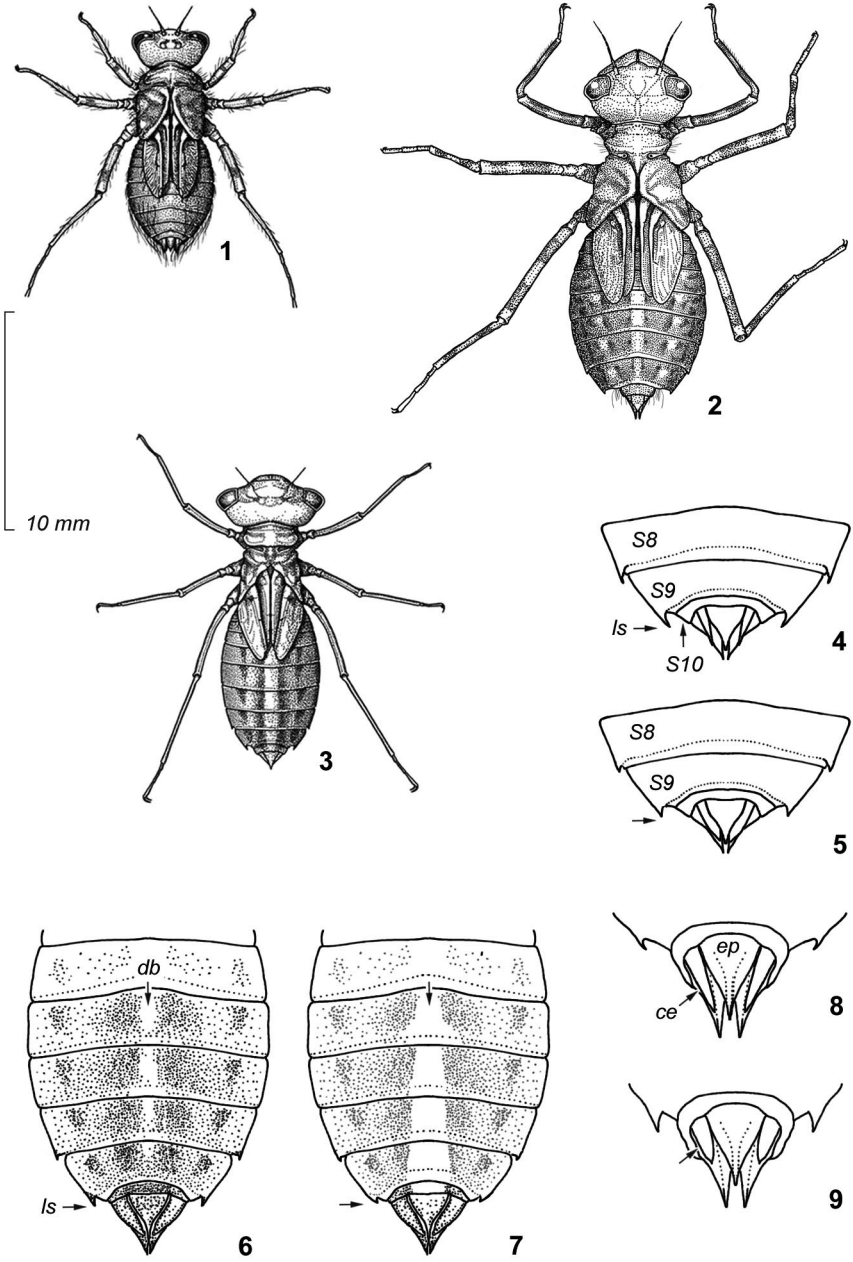


Plate 35

Diplacodes

Three species of *Diplacodes* occur: *D. luminans* (formerly *Philonomon luminans*), *D. lefebvrii*, and *D. deminuta* (*D. okavangoensis*). The larva of *D. deminuta*, which only occurs in the Okavango and Kwando swamps, is unknown. The genus has recently been reviewed (Dijkstra 2006). The habitus of *D. lefebvrei* is shown in [1]. The larva of *D. lefebvrei* is very small and often very dark or even widely black in colour. The larva of *D. luminans* has a somewhat truncated appearence.

Key to the species

1 Truncate appearance of the posterior end of the abdomen [2]; abdomen not dark coloured ..... ***D. luminans***

– Posterior end of abdomen normal [3]; abdomen uniformly dark ventrally and dorsally with irregular dark pattern ..... ***D. lefebvrei***

Crocothemis

Three species are known from the region, of which the larva of *C. divisa* is undescribed. The latter is rather uncommon in the region, whereas the two other species keyed below are moderately common to frequent. For habitus of *C. erythraea* see [4].

Key to the species

1 Body ventrally uniformly blackish coloured or increasing reddish in colour from S7 to S10 [5]; lateral spines on S8 and S9 distinct, spine on S9 is as long as ⅕ the length of the lateral margin of S9, posterior margin of S7 sternite with distinct row of short setae [7] ..... ***C. erythraea***

– Body ventrally uniformly brown; spines on S8 and S9 very small and hardly visible [6]; spine on S9 is $^1/_{10}$ to $^1/_{20}$ the length of the lateral margin of S9 ..... ***C. sanguinolenta***

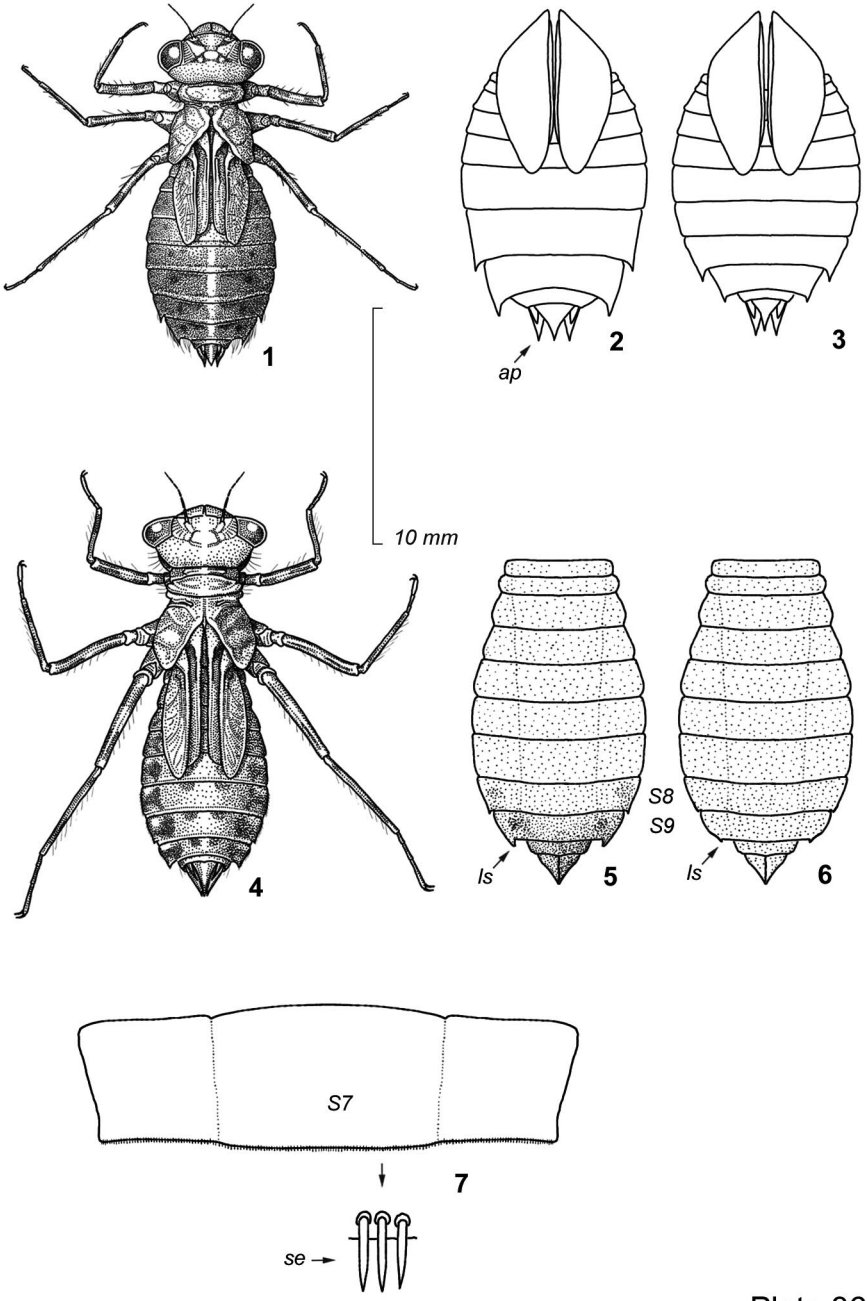


Plate 36

Nesciothemis

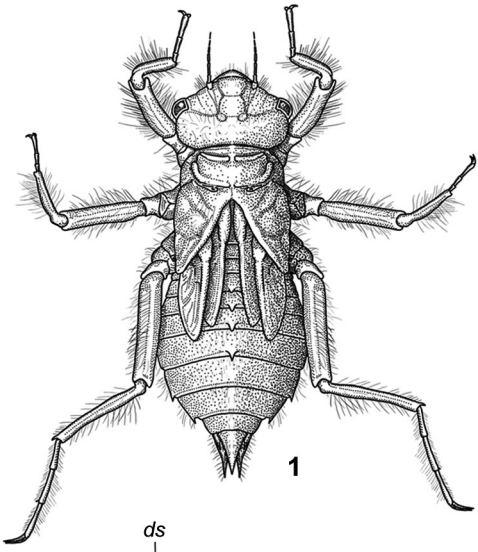
The larvae in general resemble those of *Orthetrum*, but have longer hind legs and a single spine at the anterior margin of each tibia [3]. Only one species occurs, *N. farinosa* [1]. The exuviae of *N. farinosa* differ regionally: those from western Namibia have dorsal spines on S4-7 [2] (cf. Suhling et al. 2004), while those from the Okavango and Kwando have also a small spine on S8.

Orthetrum

The rectangular head-shape combined with very small eyes makes *Orthetrum* [6] unique among the Namibian odonate larvae, only *Nesciothemis* being similar in this character. All *Orthetrum* are densely covered with often very long setae. Twelve species of *Orthetrum* are recorded, of which only six are described and/or available to us. Moreover, the published descriptions are sometimes not very detailed. We therefore do not present a key. Table 4 presents characters of most species in the arid parts of the region. The only unmistakable species is *O. trinacria* due to its large size and long anal pyramid [4], which distinctly differs from the short pyramids of the other species [5]. In *O. brachiale* long dense setae cover the pyramid ventrally. Lateral spines may be present or not and may also be hidden by long setae [7]. In all cases, identification requires cleaning.

Table 4. Identification characters of *Orthetrum*. Pp: length of the paraprocts, S10: length of segment 10 (both dorsal measures), Pp/S10: ratio of paraproct length divided by length of S10, DS: segments with dorsal spines, LS: segments with lateral spines, Length: total length; measurements in mm.

Species	Pp	S10	Pp/S10	DS	LS	Length
O. trinacria	3.25	0.45	7.0	S4-5 (small)	S8-9 (distinct)	> 23
O. robustum	3.00	0.50	6.0	S4-6 (distinct)	S8-9 (distinct)	> 23
O. brachiale	1.75	0.35	5.0	no spines	S8-9 (small)	< 20
O. chrysostigma	0.95	0.28	3.4	no spines	S8-9 (tiny)	< 20
O. julia falsum	1.00	0.30	3.3	S4-6 (tiny)	S8-9 (tiny)	< 20
O. machadoi	1.00	0.33	2.9	S4-7 (4, 5 distinct)	S8-9 (distinct)	< 20



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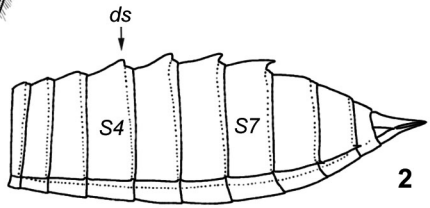

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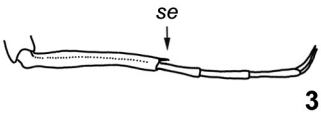

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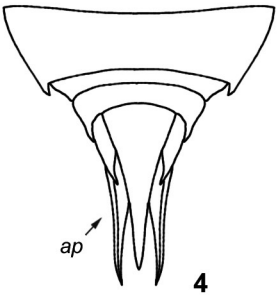

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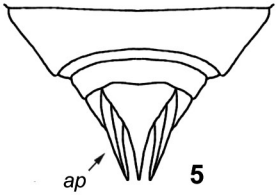

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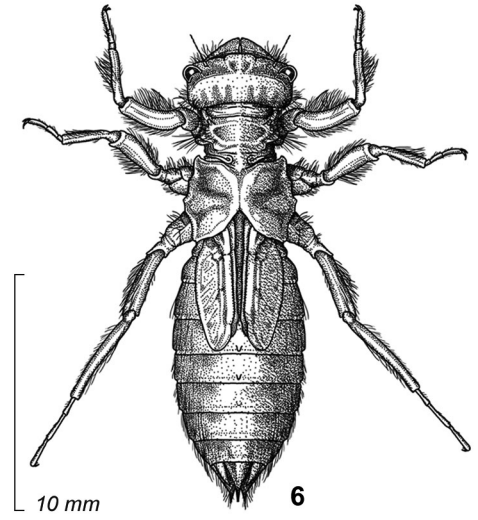

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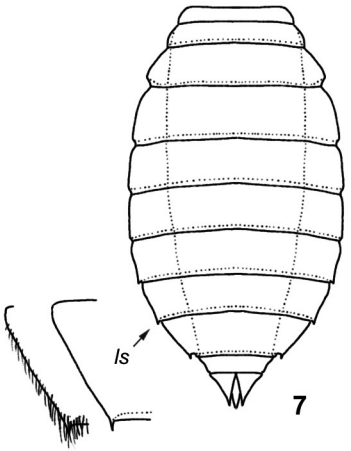

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Plate 37

Conclusions

Our aim was to present a tool that permits the identification of dragonfly larvae, for instance for the purpose of using them as indicators for the health of freshwater ecosystems (cf. Corbet 1993; Clausnitzer & Jödicke 2004). The key presented here has still some major gaps, such as in the Coenagrionoidea and also to some extent in the Libellulidae. Hence, is this tool applicable although a number of species cannot yet be identified? We think: yes!

For two groups of dragonflies the key is already well developed. The one group are the Odonata that occur in the arid southern and western parts of Namibia. In most cases keys for these are available or at least their characters are described. The second group are the Odonata that typically occur in lotic waters, i.e. make up a relevant part of the community of the large perennial rivers. This group comprises the Calopterygidae, Chlorocyphidae, Platycnemididae, Gomphidae, and Macromiidae, of which most species are keyed. This is also true for many typical running water Libellulidae, i.e. the genera *Brachythemis*, *Parazyxomma*, *Olpogastra*, *Zygonoides*, and *Zygonyx*. Particularly such lotic water species are presumed to be valuable indicators for the health of the river systems.

However, there are still several odonate larvae to be identified. This includes many species of *Trithemis* and *Pseudagrion*, two genera that make up relevant parts of river communities, as well as most species of *Agriocnemis*, *Ceriagrion*, and *Aciagrion*, and many *Orthetrum* require attention and collecting material of these should be a priority. Publishing our key has therefore another aim as well: motivating others to continue. We hope in this aim we will succeed.

Acknowledgements

We thank all those who provided exuviae and/or larvae of African dragonflies. Without their support the production of the key would have been impossible. In particular we thank Karsten Grabow, Viola Clausnitzer, and Klaas-Douwe (KD) B. Dijkstra. Stephen Butler sent us his unpublished key to the *Palpopleura* species. Special thanks also to David Chelmick who allowed us to use his unpublished key to the dragonfly larvae of Cameroon and to Michael Samways who sent us his key to the South African odonate larvae. KD Dijkstra and Viola Clausnitzer made valuable comments on taxonomic problems and gave us early insight into drafts of their manuscripts, which enabled us to use an up-to-date taxonomy (although we could not follow KD's speed entirely). Göran Sahlén and Ida Suhling reviewed early drafts of the manuscript and insisted on consistent use of terminology, which improved the key considerably. Graham Vick, Klaus Guido Leipelt, and Ida Suhling revised the final draft under high time contraints – thanks a lot! All mistakes left over are fully in our responsibility. Our work was supported by a grant of the German Bundesministerium für Bildung und Forschung (BMBF 01LC0024) from 2001 to 2004 and by research permits of the Namibian Ministry of Environments and Tourism. Many thanks also to all those supporting our field work in Namibia, in particular to Eugène Marais.

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Appendix 1. Sources of specimens and of published larval descriptions of genera considered in the key. Collection abbreviations: AM: Andreas Martens, Namibia, Natal, Mauritius; FS: Frank Suhling, Namibia, France; JK: Jens Kipping, Botswana, Namibia; KD: Klaas-Douwe B. Dijkstra, Congo, Ethiopia, Malawi, Uganda; KG: Karsten Grabow, Côte d'Ivoire; NMNW: National Museum of Namibia, Windhoek; RJ: Reinhard Jödicke, Namibia; VC: Viola Clausnitzer, Kenya, Tanzania; SG: Stephan Geschke, Zambia.

Family/genus	Specimens	Larval descriptions
Calopterygidae		
Phaon Selys, 1853	FS	Cammaerts 1967
Umma Kirby, 1890	KD	Legrand 1977
Chlorocyphidae		
Chlorocypha Fraser, 1928	KD	Pinhey 1959
Platycypha Fraser, 1949	FS, KD	Barnard 1937; Pinhey 1959
Synlestidae		
Chlorolestes Selys, 1862	–	Barnard 1921, 1937; Samways & Whiteley 1997
Lestidae		
Lestes Leach, 1815	FS, RJ	Cammaerts 1966; Pinhey 1959
Platycnemididae		
Elattoneura Cowley, 1935	–	Barnard 1937
Mesocnemis Karsch, 1891	AM, FS	Corbet 1956b (as *Metacnemis*)
Coenagrionidae		
Aciagrion Selys, 1891	–	–
Africallagma Kennedy, 1920	FS	Barnard 1937
Agriocnemis Selys, 1877	AM	Carchini et al. 1995
Azuragrion May, 2002	FS	Pinhey 1959a
Ceriagrion Selys, 1876	FS	Corbet 1956b
Ischnura Charpentier, 1840	FS	Barnard 1937; Pinhey 1959
Pinheyagrion May, 2002	–	–
Proischnura Kennedy, 1920	–	Barnard 1937
Pseudagrion Selys, 1876	FS	Chutter 1961, 1962
Gomphidae		
Ceratogomphus Selys, 1854	FS	Barnard 1937
Crenigomphus Selys, 1892	FS , NMNW, VC	Corbet 1957c
Gomphidia Selys, 1854	FS, KD, KG, VC	Fraser 1956; Müller et al. 2005
Ictinogomphus Cowley, 1834	FS, KD, KG,	Corbet 1956a; Corbet 1977
Lestinogomphus Martin, 1911	FS, KD, KG	Corbet 1956c
Mastigogomphus Cammaerts, 2004	FS, KD	–
Neurogomphus Karsch, 1890	FS, KD	Cammaerts 2004
Notogomphus Selys, 1858	AM, VC, KD	Pinhey 1959; Samways & Whiteley 1997
Onychogomphus Selys, 1854	AM, KD	Pinhey, 1959

Family/genus	Specimens	Larval descriptions
Paragomphus Cowley, 1934	AM, FS, KD, KG, VC	Barnard 1937; Corbet 1957c; Corbet, 1977
Phyllogomphus Selys, 1854	FS, KD, KG	Corbet 1956c; Corbet 1977; Di Domenico et al. 1994
Aeshnidae		
Anax Leach, 1815	FS, KD, KG	Chelmick 2001
Pinheyschna Peters & Theischinger, 2011	–	Barnard 1937; Chelmick 2001; Pinhey 1959; Samways et al. 1993a
Zosteraeschna Peters & Theischinger, 2011	AM, FS	Barnard 1937; Chelmick 2001; Pinhey 1959; Samways et al. 1993a
Gynacantha Rambur, 1842	KG	Pinhey 1959
Corduliidae s.l.		
Syncordulia Selys, 1882	–	Barnard 1937
Macromiidae		
Phyllomacromia Selys, 1878	FS, KD, KG,	Barnard 1937; Corbet 1957b; Pinhey 1959a
Libellulidae		
Acisoma Rambur, 1842	FS, KD	Pinhey 1961
Aethiothemis Martin, 1908	–	–
Aethriamantha Kirby, 1889	–	Fleck & Legrand 2005
Brachythemis Brauer, 1886	FS, KD	Corbet 1957a
Bradinopyga Kirby, 1893	AM	Pinhey 1959
Chalcostephia Kirby, 1889	–	Di Domenico et al. 2001
Crocothemis Brauer, 1886	FS, KG	Barnard 1937; Jödicke 1995
Diplacodes Kirby, 1889	AM, FS, NMNW	Hagen 1996; Jödicke 1995; Pinhey 1961
Hemistigma Kirby, 1889	–	Whiteley et al. 1999
Nesciothemis Longfield, 1955	FS	Suhling et al. 2004
Olpogastra Karsch, 1895	FS, KD, KG	Dijkstra et al. 2006
Orthetrum Newman, 1833	AM, FS, KD, KG	Butler 1993; plus several others cf. Appendix 2
Palpopleura Rambur, 1842	KG, NMNW	Fraser 1955; Pinhey 1959
Pantala Hagen, 1861	AM, FS, KD, NMNW	Barnard 1940; Lamb 1925a,b
Parazyxomma Pinhey, 1961	FS	Corbet 1957a
Rhyothemis Hagen, 1867	AM, JK	Samways et al. 1998
Sympetrum Newman, 1833	FS	Barnard 1937; Gardner 1951; Jödicke 1995
Tetrathemis Brauer, 1868	KG	Legrand 1977
Tholymis Hagen, 1867	AM, FS	Lieftinck 1962; Fraser 1919
Tramea Hagen, 1861	AM	Pinhey 1959; Lieftinck 1962; Fraser 1919
Trithemis Brauer, 1861	AM, FS, KD	Barnard 1937; Carchini et al. 1992a; Samways et al. 1993b; Brochard et al. 2013
Trithetrum Dijkstra & Pilgrim, 2007	–	–
Urothemis Brauer, 1868	FS, KG	Paulian 1947; Hassan 1977
Zygonoides Fraser, 1957	FS, KD, KG	Dijkstra et al. 2006
Zygonyx Hagen, 1867	AM, FS, KD, KG	Dijkstra et al. 2006

Appendix 2. List of species occurring in Namibia and adjacent regions. It is indicated whether descriptions or collected specimens were available. Collection abbreviations as in appendix 1; in brackets: the species identification is by presumption. * Species not found in Namibia.

Species	Specimens	Larva description
Phaon iridipennis (Burmeister, 1839)	AM, FS, KD	Cammaerts 1967
Umma femina Longfield, 1947*	–	–
Platycypha caligata (Selys, 1853)	AM, FS, KD	Barnard 1937; Pinhey 1959
Chlorocypha bamptoni Pinhey, 1975*	–	–
Aciagrion heterosticta Fraser, 1955	–	–
Aciagrion steeleae Kimmins, 1955*	–	–
Africallagma glaucum (Burmeister, 1839)	FS	Barnard 1937
Africallagma subtile (Ris, 1921)	–	–
Agriocnemis angolensis Longfield, 1947	–	–
Agriocnemis bumhilli Kipping et al. 2012.	–	–
Agriocnemis exilis Selys, 1872	AM	–
Agriocnemis gratiosa Gerstäcker, 1891	–	–
Agriocnemis ruberrima Balinsky, 1961	–	–
Agriocnemis victoria Fraser, 1928	–	–
Azuragrion nigridorsum (Selys, 1876)	FS	Pinhey 1959
Ceriagrion corallinum Campion, 1914	–	–
Ceriagrion glabrum (Burmeister, 1839)	AM, FS	Corbet 1956b
Ceriagrion katamborae Pinhey, 1961	–	–
Ceriagrion suave Ris, 1921	–	–
Ischnura senegalensis (Rambur, 1842)	AS, FS	Barnard 1937
Pinheyagrion angolicum (Pinhey, 1966)*	–	–
Pseudagrion (A) *angolense* Selys, 1876	–	–
Pseudagrion (A) *citricola* Barnard, 1937*	–	–
Pseudagrion (A) *fisheri* Pinhey, 1961*	–	–
Pseudagrion (A) *hageni* Karsch, 1893*	–	Chutter 1962
Pseudagrion (A) *kersteni* (Gerstäcker, 1869)	FS	Chutter 1961
Pseudagrion (A) *salisburyense* Ris, 1921	FS	Chutter 1961
Pseudagrion (B) *acaciae* Förster, 1906	FS	Chutter 1962
Pseudagrion (B) *assegaii* Pinhey, 1950	–	–
Pseudagrion (B) *coeleste* Longfield, 1947	FS	–
Pseudagrion (B) *commoniae* (Förster, 1902)	–	–
Pseudagrion (B) *deningi* Pinhey, 1961	FS	–
Pseudagrion (B) *glaucescens* Selys, 1876	–	–
Pseudagrion (B) *hamoni* Fraser, 1955	–	–
Pseudagrion (B) *helenae* Balinsky, 1964*	–	–
Pseudagrion (B) *massaicum* Sjöstedt, 1909	FS	Chutter 1961
Pseudagrion (B) *nubicum* Selys, 1876	–	–
Pseudagrion (B) *rufostigma* Longfield, 1947	FS	–

Species	Specimens	Larva description
Pseudagrion (B) *sjoestedti* Förster, 1906	–	–
Pseudagrion (B) *sublacteum* (Karsch, 1893)	FS	Chutter 1962 (as *P. pseudomassaicum*)
Pseudagrion (B) *sudanicum* Le Roi, 1915	–	–
Pseudagrion (B) *vaalense* Chutter, 1962	–	Chutter 1961 (as *P. pseudomassaicum*)
Mesocnemis singularis Karsch, 1891	AM, FS, KD	Corbet 1956b (as *Metacnemis valida*)
Elattoneura cellularis (Grünberg, 1902)	–	–
Elattoneura glauca (Selys, 1860)	–	–
Lestes dissimulans Fraser, 1955	–	–
Lestes pallidus Rambur, 1842	FS, RJ	Pinhey 1959
Lestes pinheyi Fraser, 1955	–	–
Lestes plagiatus (Burmeister, 1839)*	–	Cammaerts 1966
Lestes tridens (McLachlan, 1895)	–	Pinhey 1959
Lestes virgatus (Burmeister, 1839)*	–	Samways et al. 1992
Ceratogomphus pictus Hagen in Selys, 1854	FS	Barnard 1937
Crenigomphus cornutus Pinhey, 1956	(FS)	–
Crenigomphus hartmanni (Förster, 1898)	FS, VC	Pinhey 1959
Crenigomphus kavangoensis Suhling & Marais, 2010	FS	Suhling & Marais 2010
Gomphidia quarrei (Schouteden, 1934)	FS, KD, VC	Müller et al. 2006
Ictinogomphus dundoensis (Pinhey, 1961)	FS	–
Ictinogomphus ferox (Rambur, 1842)	FS, KD, KG, VC	Corbet 1956a
Lestinogomphus angustus Martin, 1911	FS, KD, KG, VC	Corbet 1956c; Pinhey 1959
Lestinogomphus silkeae Kipping, 2006	–	–
Mastigogomphus dissimilis (Cammaerts, 2004)	FS	–
Neurogomphus cocytius Cammaerts, 2004	FS	Cammaerts 2004
Neurogomphus zambeziensis Cammaerts, 2004	FS	Cammaerts 2004
Notogomphus praetorius (Selys, 1878)*	AM	Samways & Whiteley 1997
Onychogomphus rossi Pinhey, 1966*	–	–
Paragomphus cataractae Pinhey, 1963	FS	–
Paragomphus cognatus (Rambur, 1842)	AM, KD	Barnard 1937; Pinhey 1959
Paragomphus elpidius (Ris, 1921)	FS	–
Paragomphus genei (Selys, 1841)	FS	Corbet 1957c
Paragomphus sabicus Pinhey, 1950	FS, (KG)	–
Phyllogomphus selysi Schouteden, 1933	FS, KD, VC	Corbet 1956c; Di Domenico et al. 1994
Anax bangweuluensis Kimmins, 1955	FS	–
Anax ephippiger (Burmeister, 1839)	FS	de Marmels 1975; Chelmick 1999
Anax imperator Leach, 1815	FS	Barnard 1937; Chelmick 1999

Species	Specimens	Larva description
Anax speratus Hagen, 1867	FS	Pinhey 1959; Chelmick 1999**
Anax tristis Hagen, 1867	KG, SG, FS	Chelmick 1999
Gynacantha manderica Grünberg, 1902	(KG)	–
Gynacantha villosa Grünberg, 1902	–	–
Pinheyschna subpupillata McLachlan, 1895*	–	Chelmick 2001
Pinheyschna rileyi Calvert 1892*	–	Chelmick 2001
Zosteraeshna minuscula McLachlan, 1896	FS	Barnard 1937; Samways et al. 1993a; Chelmick 2001
Phyllomacromia contumax Selys, 1879	FS, KG	Corbet 1957b (as *Macromia sylvatica*)
Phyllomacromia kimminsi (Fraser, 1954)*	–	–
Phyllomacromia overlaeti (Schouteden, 1934)	FS	–
Phyllomacromia picta (Hagen in Selys, 1871)	FS	Barnard 1937; Corbet 1957b; Pinhey 1959a
Acisoma panorpoides Rambur, 1842	KG, FS	Pinhey 1961; Lieftinck 1962; Ishida et al. 1988
Acisoma trifidum Kirby, 1889*	KD	–
Aethiothemis solitaria Martin, 1908	–	–
Aethriamanta rezia Kirby, 1889	–	Fleck & Grand 2005
Brachythemis lacustris (Kirby, 1889)	FS, KD	Corbet 1957a
Brachythemis leucosticta (Burmeister, 1839)	FS	Corbet 1957a
Brachythemis wilsoni Pinhey, 1952	–	–
Bradinopyga cornuta Ris, 1911	FS	Pinhey 1959
Chalcostephia flavifrons Kirby, 1889	KG	Di Domenico et al. 2001
Crocothemis divisa Karsch, 1898	–	–
Crocothemis erythraea (Brullé, 1832)	FS	Barnard 1937; Jödicke 1995
Crocothemis sanguinolenta (Burmeister, 1839)	FS	Pinhey 1962
Diplacodes deminuta Lieftinck, 1969	–	–
Diplacodes lefebvrii (Rambur, 1842)	AM, FS	von Hagen 1996; Jödicke 1995
Diplacodes luminans (Karsch, 1893)	NMNW	Pinhey 1961
Hemistigma albipunctum (Rambur, 1842)	–	Whiteley et al. 1999
Nesciothemis farinosa (Förster, 1898)	FS	Suhling et al. 2004
Olpogastra lugubris Karsch, 1895	FS, KD, KG	Dijkstra et al. 2006.
Orthetrum abbotti Calvert, 1892	–	–
Orthetrum brachiale (Palisot de Beauvois, 1817)	FS	Pinhey 1961
Orthetrum caffrum (Burmeister, 1839)	–	Pinhey 1959
Orthetrum chrysostigma (Burmeister, 1839)	FS	Cammaerts 1975; Butler 1993
Orthetrum guineense Ris, 1910	–	–
Orthetrum hintzi Schmidt, 1951	–	Carchini & Di Domenico 1996
Orthetrum icteromelas Ris, 1910	–	–
Orthetrum julia Kirby, 1900	FS	–
Orthetrum machadoi Longfield, 1955	FS	–
Orthetrum robustum Balinsky, 1965	–	Carchini et al. 1992b

Species	Specimens	Larva description
Orthetrum stemmale (Burmeister, 1839)	–	–
Orthetrum trinacria (Selys, 1841)	FS, AM	Butler 1993
Palpopleura deceptor (Calvert, 1899)	KG	–
Palpopleura jucunda Rambur, 1842	NMNW, FS	Pinhey 1959
Palpopleura lucia (Drury, 1773)	AM, KG	Fraser 1955; Pinhey 1959
Palpopleura portia (Drury, 1773)	–	–
Pantala flavescens (Fabricius, 1798)	AM, FS, KG	Barnard 1940; Lamb 1925a, b
Parazyxomma flavicans (Martin, 1908)	FS	Corbet 1957a
Rhyothemis fenestrina (Rambur, 1842)	(FS)?	–
Rhyothemis mariposa Ris, 1913	–	–
Rhyothemis semihyalina (Desjardins, 1832)	AM, JK	Samways et al. 1998
Sympetrum fonscolombii (Selys, 1840)	FS	Barnard 1937; Gardner 1951; Jödicke 1995
Tetrathemis polleni (Selys, 1869)*	–	Samways et al. 1998
Tholymis tillarga (Fabricius, 1798)	AM, FS, KG	Fraser 1919; Lieftinck 1962
Tramea basilaris (Palisot de Beauvois, 1817)	KG	Pinhey 1962
Tramea limbata (Desjardins, 1832)	AM	Fraser 1919
Trithemis aconita Lieftinck, 1969	(FS)	–
Trithemis aequalis Lieftinck, 1969	–	–
Trithemis annulata (Palisot de Beauvois, 1807)	AM, FS	Samways et al. 1993b
Trithemis arteriosa (Burmeister, 1839)	FS	Barnard 1937; Carchini et al. 1992a; Samways et al. 1993b
Trithemis brydeni Pinhey, 1970	–	–
Trithemis donaldsoni (Calvert, 1899)	(FS), KG	–
Trithemis dorsalis (Rambur, 1842)*	–	Samways et al. 1993b
Trithemis furva Karsch, 1899	–	Carchini et al. 1992a; Samways et al. 1993b
Trithemis hecate Ris, 1912	(FS)	–
Trithemis kirbyi Selys, 1891	FS	Carchini et al. 1992a; Samways et al. 1993b
Trithemis monardi Ris, 1931	–	–
Trithemis morrisoni Damm & Hadrys, 2010	–	–
Trithemis palustris Damm & Hadrys, 2010	–	–
Trithemis stictica (Burmeister, 1839)	FS	Carchini et al. 1992a; Samways et al. 1993b
Trithemis werneri Ris, 1912	–	Samways et al. 1993b
Trithetrum navasi (Lacroix, 1921)	–	–
Urothemis assignata (Selys, 1872)	KG	Hassan 1977
Urothemis edwardsii (Selys, 1849)	(FS)	Paulian 1947 (only young instar larvae)
Zygonoides fuelleborni (Grünberg, 1902)	FS	Dijkstra et al. 2006
Zygonyx natalensis (Martin, 1900)	AM, FS	Pinhey 1959; Dijkstra et al. 2006
Zygonyx torridus (Kirby, 1889)	AM, FS	Barnard 1937; Pinhey 1959

** Chelmick (1999) probably described *A. rutherfordi*, which was then regarded as *A. speratus*.

Appendix 3. Overview of Plates and Figures

Plate 01. General morphology of odonate larvae

1-2 Dorsal view of odonate larvae with main body parts labelled. **1** Zygoptera (Coenagrionidae) and **2** Anisoptera (Gomphidae).
3 Zygoptera (Lestidae) larva in lateral view.
4 Anisoptera (Gomphidae) larva in dorso-lateral view.
5 Head of a libellulid larva (*Nesciothemis farinosa*) in dorsal view showing appearance with setae (left) and with setae removed for simplification.

Plate 02. Characters of the larval head and prothorax

1 Head of an anisopteran larvae (here Gomphidae) in dorsal view with eyes, antennae, posterior lobe and projections marked.
2-3 Head and prothorax of an aeshnid larva with forceps type labium in lateral view; labium shown **2** contracted and **3** ejected.
4 Head and prothorax of a libellulid larva with shovel type labium in lateral view.
5 Frontal view of a libellulid head showing the shovel-shaped labium covering parts of the face.
6 Comparison of gomphid antennae with 4 segments (upper drawing) with those of other Anisoptera having 7 segments (lower drawing).
7 Prementum and labial palps of a forceps type labium (here an aeshnid).
8 A single labial palp of a libellulid in frontal view showing crenations on the anterior margin.
9 Prementum and labial palps of a shovel type labium (here a libellulid), with setae depicted on one palp and on the prementum.
10 Prementum and labial palps of a spoon-shaped labium of a lestid, with setae depicted on the palps and on the prementum.

Plate 03. Characters of the larval abdomen

1-2 Abdomen in lateral view depicting different characters. **1** Libellulid abdomen with dorsal spines, segment numbering is shown; **2** libellulid abdomen without dorsal spines, setae cover is shown from segment 2 to segment 6.
3 Abdomen of a libellulid in ventral view showing lateral spines and segment numbering.
4 Abdomen of a libellulid in dorsal view with fully developed wing sheaths and lateral spines; one half depicted with setae the other without.
5 Close up of the anisopteran anal pyramid in lateral view showing epiproct (ep), one cercus (ce) and one paraproct (pp) as well as the short segment 10. Segment 9 and 10 depicted with long lateral spines.
6-8 Close ups of the anal pyramid in dorsal view depicting different lengths relations of epi- and paraprocts and cerci.
9 Rear end of a zygopteran (lestid) in lateral view with all three caudal lamellae visible, the central (upper) one being the epiproct, the two lateral (lower) ones the paraprocts.
10-11 Different shapes of single caudal lamellae in lateral view, **10** with a nodus (nd); **11** without a nodus, but with a sharp tip (tp).

Plate 04-05. Key to the sub-orders

1-2 Contrast of the general habitus of **1** Zygoptera (Coenagrionoidea: *Pseudagrion*) and **2** Anisoptera larva (Gomphidae: *Paragomphus*) in dorsal view.
3 Dorsal view of the larva of *Phaon* (Zygoptera: Calopterygidae).
4 Dorsal view of the larva of *Platycypha* (Zygoptera: Chlorocyphidae).
5 Dorsal view of the larva of *Mesocnemis* (Zygoptera: Coenagrionoidea).
6 Dorsal view of the larva of *Gomphidia* (Anisoptera: Gomphidae).
7 Dorsal view of the larva of *Trithemis* (Anisoptera: Libellulidae).
8 Dorsal view of the larva of *Anax* (Anisoptera: Aeshnidae).

Plate 06. Zygoptera – key to the families

1 Antenna of Calopterygidae and Chlorocyphidae (here Calopterygidae: *Phaon iridipennis*).
2 Antenna of other Zygoptera (here *Pseudagrion*).
3 Caudal lamellae in dorsal view of Calopterygidae (*Phaon iridipennis*).
4 Labium of Calopterygidae (*Phaon*).
5 Single lamella of *Phaon iridipennis* in lateral view.
6 Caudal lamellae in dorsal view of Chlorocyphidae (*Platycypha caligata*).
7 Labium of Chlorocyphidae (*Platycypha caligata*).
8 Single lamella of *Platycypha caligata* in lateral view.
9 Single lamella in lateral view Coenagrionoidea (*Pseudagrion*).
10 Labium of Lestidae (*Lestes pallidus*), with seate, dorsal view; note some lestidae have a shorter labium but still spoon-shaped.
11 Labium of Coenagrionoidea (*Pseudagrion*), with setae, dorsal view.
12 Caudal lamellae in lateral view of Synlestidae (*Chlorolestes* sp}.
13 Body shape of Lestidae (*Lestes pallidus*).
14 Body shape of Coenagrionoidea (*Pseudagrion massaicum*).

Plate 07. Anisoptera – key to the families

1 Flat labium in Aeshnidae and Gomphidae (here Aeshnidae).
2 Shovel-shaped labium in Macromiidae, Corduliidae, and Libellulidae (here Libellulidae).
3 Antenna of Gomphidae, with four segments, segments 3 and 4 marked.
4 Antenna of Aeshnidae, with seven segments, segments 3 and 7 marked.
5 Head of Macromiidae in frontal view, note the projection on the forehead.
6 Labial palp of a Macromiidae enlarged in frontal view; crenations about as wide as deep.
7 Head of Libellulidae and Corduliidae in frontal view, labium with shallow crenations (here Libellulidae: *Bradinopyga cornuta*).
8 One labial palp of *Bradinopyga cornuta*, crenations wider than deep.
9 Head of Libellulidae in frontal view, labium without crenations (*Zygonyx natalensis*).
10 One labial palp of *Zygonyx natalensis*, no crenations.
11 Anal pyramid of a Corduliidae.
12 Anal pyramid of a Libellulidae (*Orthetrum trinacria*).
13 Anal pyramid of a Libellulidae (*Acisoma panorpoides*).
14-15 View on the dorsal surface of the prementum of **14** Corduliidae with medio-dorsal groove and **15** Libellulidae without medio-dorsal groove.

Plate 08. Calopterygidae

1 Larva of *Phaon iridipennis* in dorsal view.
2 Antennae and head of *Phaon iridipennis* in dorsal view.
3 Antennae and head of *Umma* sp. in dorsal view.
4 Habitus of *Umma* spp. (here *Umma longistigma*) in dorsal view; note the lateral and dorsal spines (ls, ds) on the abdomen.
5 Caudal lamellae of *Umma mesostigma*.

Plate 09. Chlorocyphidae

1 Larva of *Platycypha caligata* in dorsal view.
2 Tip of the abdomen of *P. caligata* showing the spur (dl) replacing the central lamella.
3 Labium (anterior part) of *P. caligata*, note the gap (gp) in the prementum.
4 Caudal lamella of *P. caligata* in lateral view.

Plate 10. Lestidae

1 Larva of *Lestes pallidus* in dorsal view.
2-4 Labium in dorsal view. **2** *Lestes pallidus*, **3** *L. tridens*, **4** *L. virgatus* (3-4 after Samways et al. 1992).
5-7 Labial palp in dorsal view. **5** *L. pallidus*, **6** *L. tridens*, *L. virgatus* (**6-7** after Samways et al. 1992).

Plate 11. Coenagrionoidea – key to the genera

1-2 Length of prementum relative to position of the base of the legs, **1** *Mesocnemis singularis*, **2** other species, here *Pseudagrion massaicum*.
3-6 Examples of setae distribution in the labium: **3** No setae on prementum, two on each palpus, **4** three setae on each palpus, spiniform setae (one enlarged) along margin of prementum as in *Elattoneura*, **5** two setae on prementum, four on each palpus, **6** eigth setae on prementum, six on each palpus.
7-12 Shape of caudal lamellae: **7** *Mesocnemis singularis*, **8** *Elattoneura glauca,* **9** *Ceriagrion glabrum*, **10** *Pseudagrion*, **11** *Agriocnemis exilis*, **12** *Africallagma glaucum*, **13** *Ischnura senegalensis*.

Plate 12. *Mesocnemis*, *Elattoneura*, *Ceriagrion*

1 Larva of *Mesocnemis singularis* in dorsal view.
2 Labium of *M. singularis* in dorsal view without any setae on prementum and two setae on each palpus.
3 Shape of a caudal lamella of *M. singularis*.
4 Larva of *Ceriagrion glabrum* in dorsal view.
5 Labium of *C. glabrum* in dorsal view with two setae on the prementum and seven on each palpus.
6 Shape of a caudal lamella of *C. glabrum*.

Plate 13. *Pseudagrion*

1 Larva of *Pseudagrion massaicum* in dorsal view.
2 Setae distribution in the labium of *P. massaicum*.
3 Caudal lamella of *P. massaicum*.
4-5 Labial palps (lp) in dorsal view. **4** A-group *Pseudagrion*, **5** B-group *Pseudagrion* (redrawn from CHUTTER 1962).

Plate 14. *Pseudagrion*

1-10 Shape and colour patterns of the caudal lamellae of *Pseudagrion* species: **1** *P. hageni,* **2** *P. kersteni,* **3** *P. salisburyens* (all A-group), **4** *P. citricola*, **5** *P. acaciae,* **6** *P. massaicum*, **7** *P. sublacteum*, **8** *P. vaalense,* **9** *P. deningi*, **10** *P. rufostigma* (all B-group). The drawings are partly redrawn from CHUTTER (1961).

Plate 15. *Agriocnemis*, *Africallagma*, *Azuragrion*, *Ischnura*

1-3 Larva in dorsal view of **1** *Agriocnemis exilis*, **2** *Africallagma glaucum*, and **3** *Ischnura senegalensis.*
4 Thorax with wing-sheaths of *Ischnura* in dorsal view; dark spots at the wing sheaths visible in larvae.
5-7 Shape of caudal lamella of **5** *A. exilis*, **6** *A. glaucum*, and **7** *I. senegalensis*.

Plate 16. Body shapes of gomphid larvae

1 *Gomphidia*, **2** *Ictinogomphus*, **3** *Onychogomphus*, **4** *Notogomphus*, **5** *Paragomphus*, **6** *Lestinogomphus*, **7** *Phyllogomphus*, **8** *Neurogomphus.*

Plate 17. Gomphidae – key to the genera

1-2 Broad-shaped, rounded abdomen in **1** *Gomphidia*, **2** *Ictinogomphus*.
3 Two tarsal segments at the hind leg of *Ictinogomphus* and *Gomphidia*.
4 Abdomen with breathing tube (*Lestinogomphus*).
5 Elongate-shaped abdomen without breathing tube (*Onychogomphus*).
6 Three tarsal segments at the hind leg of other Gomphidae.
7 Hair-like projections at head anterior margin of *Gomphidia*.
8 Projections at head anterior margin of *Ictinogomphus*.

Plate 18. Gomphidae – key to the genera

1-2 Length of hind legs of **1** *Lestinogomphus* in comparison to **2** *Mastigogomphus* (and *Phyllogomphus* and *Neurogomphus*, cf. **4**). Hind legs of *Lestinogomphus* reach to end of S9, if stretched out beyond S9; in the others it is much shorter as depicted.
3-4 Relative length of breathing tube (S10) in comparison to S8 and S9: **3** in *Phyllogomphus* S10 about as long as S8 and S9 together, **4** in *Neurogomphus* (and *Mastigogomphus*, cf. **2**) S10 distinctly longer than S8 and S9 together.
5-6 Antennae shape: **5** with elongate (fathom-shaped) terminal segment in *Paragomphus* and *Crenigomphus*, **6** with short, often knob-like terminal segment in other Gomphidae.
7-9 Cross section through an abdominal segment: **7** without spine, **8** broad-based spine, **9** with keel-like spine.

Plate 19. *Gomphidia*, *Ictinogomphus*

1 Larva of *Gomphidia* in dorsal view.
2 Head of *Gomphidia* in lateral view showing projections (arrow).
3 Abdomen of *Gomphidia* in ventral view; note the kinked segment border between S8 and S9.
4 Larva of *Ictinogomphus ferox* in dorsal view.
5 Abdomen of *Ictinogomphus ferox* in ventral view.
6 No indentation of anterior border of prementum and prementum of *Ictinogomphus ferox*.
7 Indentation of anterior border of prementum and prementum of *Ictinogomphus dundoensis*.
8 Abdomen of *Ictinogomphus dundoensis* in ventral view.

Plate 20. *Lestinogomphus*, *Phyllogomphus*, *Mastigogomphus*, *Neurogomphus*

1-4 Larva in dorsal view of **1** *Lestinogomphus angustus*, **2** *Phyllogomphus selysii*, **3** *Mastigogomphus dissimilis*, **4** *Neurogomphus*.
5-7 Anterior margin of the prementum of **5** *Mastigogomphus dissimilis*, **6** *Neurogomphus cocytius*, **7** *N. zambeziensis*.

Plate 21. *Paragomphus*, *Crenigomphus*

1-2 Larva in dorsal view of **1** *Paragomphus genei*, **2** *Crenigomphus kavangoensis*.
3-4 Head in dorsal view of **3** *Paragomphus*, **4** *Crenigomphus*.
5-6 Anal pyramid in dorsal view of **5** *Paragomphus sabicus*, **6** other *Paragomphus*.

Plate 22. *Notogomphus*, *Ceratogomphus*, *Onychogomphus*

1-3 Larva in dorsal view of **1** *Notogomphus praetorius*, **2** *Ceratogomphus pictus,* **3** *Onychogomphus* (here *O. styx*).

Plate 23. Aeshnidae – habitus drawings of the genera

1-4 Larva in dorsal view of **1** *Anax* (*A. imperator*), **2** *Zosteraeschna* (*Z. minuscula*), **3** *Pinheyschna* (*P. subdilatata*), **4** *Gynacantha* (cf. *G. manderica*). **5** Head of *Anax.* **6** Prementum of *Anax.*

Plate 24. Aeshnidae – key to the genera

1-2 Head of **1** *Anax*, **2** other aeshnids than *Anax* (dorsal view).
3-6 Abdomen segments and anal pyramid of **3** *Anax imperator*, **4** *Pinheyschna subdilatata*, **5** *Zosteraeschna minuscula*, **6** *Gynacantha manderica* (all dorsal view).

Plate 25. *Anax*

1-4 Labial palp of **1** *Anax tristis,* **2** *A. ephippiger*, **3** *A. imperator*, **4** *A. speratus* (dorsal view).
5-9 Projections of prothorax of **5** *Anax bangweuluensis*, **6** *A. imperator*, **7** *A. speratus*, **8** *A. ephippiger*, **9** *A. tristis* (dorsal view, note that the position of the projections at the prothorax is indicated in the drawing the left).
10-12 Labium of **10** *Anax bangweuluensis*, **11** *A. imperator*, **12** *A. speratus* (ventral view).

Plate 26. *Phyllomacromia*

1 Larva of final instar larva of *Phyllomacromia contumax* in dorsal view.
2 Labial palp of *Phyllomacromia contumax* with three crenations.
3 Head and labium in frontal view of *Phyllomacromia contumax*.
4 Labial palp of *Phyllomacromia overlaeti* and *P. picta* with four crenations.
5-6 Head and labium in frontal view of **5** *Phyllomacromia overlaeti*, **6** *Phyllomacromia picta*.

Plate 27. Libellulidae – key to the genera

1-3 Head shape and size of the eyes relative to the head length (dorsal view): **1** *Orthetrum* and *Nesciothemis*, **2**, **3** other Libellulidae.
4-6 Dorsal abdominal spines: **4** Spines present on all segments (*Parazyxomma*), **5** dorsal abdominal spines present, but not on S9 (*Urothemis*), **6** no dorsal abdominal spines (*Crocothemis*).
7-9 Abdominal structures in ventral view: **7** *Olpogastra lugubris*, **8** *Zygonoides fuelleborni*, **9** *Zygonyx natalensis*. Note the kinked suture between S8 and S9 in *O. lugubris* and *Z. fuelleborni* and the difference in lenght of lateral spines.
10-11 Length of the labium (lateral view): labium reaching to coxa of frontlegs in *Zygonyx* (here *Z. natalensis*), **11** longer labium reaching to coxa of mid leg in other Libellulidae.

Plate 28. Libellulidae – key to the genera

1-3 Length and shape of lateral spines (abdomen in dorsal view): **1** *Brachythemis* and *Parazyxomma* with outward pointing and prominent lateral spines, **2**, **3** inconspicuous lateral spines as e.g. in *Tholymis* and *Trithemis*.
4, 6 Labial palps with **4** ragged edges crenations as in *Tetrathemis* and **6** with less distinct crenations.
5 Anal pyramid of *Tetrathemis*.
7-8 Shape of dorsal spines in cross section: **7** Keel-shaped dorsal spines, **8** dorsal spines with broader, more rounded base.
9-12 Rear end of abdomen with different shapes and lentgh of abdominal pyramid and lateral spines (dorsal view): **9** very short, inwards pointing lateral spines and short anal pyramid in *Rhyothemis semihyalina*, **10** long anal pyramid and rearwards pointing lateral spines of *Chalcostephia flavifrons* (redrawn from Di Domenico et al. 2001), **11** abdomen of *Aethrimantha* (redrawn from Fleck & Legrand 2005), **12** abdomen of *Urothemis* (here *U. assignata*, redrawn from Hassan 1979).

Plate 29. Libellulidae – key to the genera

1-3 Abdomen in dorsal view showing shape and length of lateral spines: **1** *Bradinopyga cornuta*, **2** *Pantala flavescens,* **3** *Tramea basilaris.*
4 Shape of anal pyramid of *Acisoma panorpoides* with short epi- and paraprocts (note also the size, which is drawn to scale with **1-3**).
5-8 Dorsal view of abdomen showing dark patterns **5** *Palpopleura lucia,* **6** *Sympetrum fonscolombii,* **7** *Diplacodes lefebvrii*, **8** *Crocothemis erythraea.*
9-10 Legs in relation to abdomen length in dorsal view. **9** *Nesciothemis farinosa*, **10** *Orthetrum julia falsum*.
11 Strong seta on hind leg tibia of *Nesciothemis farinosa*.

Plate 30. *Olpogastra*, *Zygonoides*, and *Zygonyx*

1-3 Larva in dorsal view, **1** *Olpogstra lugubris*, **2** *Zygonoides fuelleborni*, **3** *Zygonyx natalensis*, **4** *Z. torridus*.
5, 7 Rear end of abdomen in lateral view: **5** *Zygonyx torridus*, **7** *Z. natalensis*.
6, 8 Labium in ventral view: **6** *Z. torridus*, **8** *Z. natalensis*.

Plate 31. *Rhyothemis*, *Chalcostephia*, *Aethrimantha*, *Urothemis*

1-4 Larva in dorsal view, **1** *Rhyothemis semihyalina*, **2** *Chalcostephia flavifrons*, **3** *Aethriamantha rezia*, **4** *Urothemis assignata*.
5-6 Rear end of abdomen with lenght of dorsal and lateral spines (lateral view) of **5** *Urothemis edwardsii*, **6** *U. edwardsii.*

Plate 32. *Brachythemis*, *Parazyxomma*, *Tetrathemis*, *Tholymis*

1 Larva of *Parazyxomma flavicans* (dorsal view).
2-3 Abdomen in lateral view: **2** *P. flavicans,* **3** *B. lacustris.*
4-5 Abdomen in dorsal view: **4** *B. lacustris,* **5** *B. leucosticta.*
6 Larva of *Tetrathemis* (here *T. bifida*) in dorsal view.
7 Abdomen of *Tetrathemis* in lateral view; note the shape of dorsal spines and anal pyramid.
8 Larva of *Tholymis tillarga* in dorsal view.
9 Cross section of an abdominal segment of *T. tillarga*, showing the keel-like spine shape.
10 Larva of *T. tillarga* in lateral view.

Plate 33. *Trithemis*

1 Larva of *Trithemis stictica* (dorsal view).
2-3 Dorsal view of the last six abdominal segments of *Trithemis* showing abdomen shape and dorsal bands: **1** *T. stictica*, **2** other *Trithemis*.
4-10 Abdomen of *Trithemis* in lateral view and shape of the dorsal spine on abdominal segment 6: **4** *Trithemis stictica*, **5** *T. annulata*, **6** *T. kirbyi*, **7** *T. dorsalis*, **8** *T. werneri*, **9** *T. furva*, **10** *T. arteriosa* and *T. donaldsoni*.
11-12 Setae on the margin of the labial palps: **11** *Trithemis kirbyi*, **12** *T. dorsalis*.
13-14 Setae on the mesosternum between the coxae: **13** *Trithemis werneri*, **14** other *Trithemis*.

Plate 34. *Bradinopyga*, *Pantala*, *Tramea*

1 Larva in dorsal view of *Bradinopyga cornuta*, **2** *Pantala flavescens*, **3** *Tramea basilaris*.
2 Habitus in dorsal view of *Pantala flavescens.*
3, 5 Length of lateral spine on S8: **3** *Pantala flavescens*, **5** *Tramea* spp.
4 Habitus in dorsal view of *Tramea basilaris.*
6-7 Shape of the anal pyramid. **6** *Tramea basilaris*, **7** *T. limbata*.

Plate 35. *Acisoma, Sympetrum, Hemistigma, Palpopleura*

1-3 Larva in dorsal view: **1** *Acisoma panorpoides*, **2** *Sympetrum fonscolombii*, **3** *Palpopleura lucia*.
4-5 Length of lateral spines of *Palpopleura*: **4** *P. jucunda*, **5** other *Palpopleura*.
6-7 Extend of mid-dorsal white band of *Palpopleura*: **6** *P. jucunda*, **7** other *Palpopleura*.
8-9 Anal pyramid-length of cerci in relation to epiproct: **8** *Palpopleura lucia*, **9** *P. deceptor*.

Plate 36. *Diplacodes, Crocothemis*

1 Larva of *Diplacodes lefebvrii* in dorsal view.
2-3 Shape of rear end of abdomen: **2** *Diplacodes luminans*, **3** *D. lefebvrii*.
4 Larva of *Crocothemis erythraea* in dorsal view.
5-6 Abdominal pattern and length of lateral spines (ventral view) of *Crocothemis*: **5** *C. erythraea*, **6** *C. sanguinolenta*.
7 Posterior margin of S7 sternite of *C. erythraea* with distinct row of short setae in ventral view.

Plate 37. *Nesciothemis*, *Orthetrum*

1 Larva in dorsal view of *Nesciothemis farinosa*.
2 Spine on tibia of *N. farinosa*.
3 Abdomen with dorsal spines on S4-7 of *N. farinosa* in lateral view; note that populations from NE Namibia have also a spine on S8.
4-5 Anal pyramid in dorsal view: **4** *Orthetrum trinacria,* **5** *Orthetrum chrysostigma*.
6 Larva in dorsal view of *Orthetrum julia falsum*.
7 Ventral view of abdomen of *O. chrysostigma*; magnified view of one of the small lateral spines covered by setae.