

## Critical species of Odonata in eastern Africa

**Viola Clausnitzer**

Liebenauer Straße 180, D-06110 Halle/Saale, Germany. <violacl@gmx.de>

Key words: Odonata, dragonfly, IUCN, critical species, conservation, eastern Africa.

### ABSTRACT

From eastern Africa, ranging from Somalia and Ethiopia south to Mozambique and Zimbabwe and west to eastern Democratic Republic of Congo and Botswana, ca 500 species of Odonata are known. Comments on species and sites of conservation concern are given as well as recommendations for future research and conservation activities. Due to the rapid and ongoing destruction of forests, especially of coastal, Guineo-Congolian and Eastern Arc forests, species confined to these habitats are the most threatened.

### REGIONAL DEFINITION

Eastern Africa is not a fixed political or geographical description for a specific area. Here the term is used for the region comprising the Rift Valley from Ethiopia southward to Mozambique and northern Botswana and westward to eastern Democratic Republic of Congo and eastern Angola. The neighbouring regions are covered to the south by Samways (2004), to the southwest by Suhling et al. (2004), to the west by Dijkstra & Vick (2004) and to the north by Jödicke et al. (2004). As biogeography and faunistic distributions do not follow political borders, there may be overlaps with neighbouring regions.

The area considered here covers some of the most important centres for endemism and regions of high biodiversity in Africa, namely forested mountain chains along the Albertine Rift and the Eastern Arc and coastal forests (e.g. Kingdon 1989; Fjeldså & Lovett 1997; Burgess et al. 1998; Burgess & Clarke 2000). Tanzania is often considered as one of the “richest and most diverse countries in Africa in terms of both species and habitats” (Stuart et al. 1990: 204).

The dominating landscapes in eastern Africa are dry thornbush (Ethiopia, Kenya, Tanzania), montane forests of highlands, isolated volcanoes and mountain chains (Burundi, Ethiopia, Kenya, Rwanda, Tanzania), montane grasslands (Malawi, Tanzania), Guineo-Congolian rain forest (Democratic Republic of Congo [DRC], Uganda, western Kenya), coastal forest (Kenya, Tanzania, Mozambique) and miombo woodlands and savanna (Malawi, Mozambique, Tanzania, Zimbabwe, Zambia).

Wetlands, mainly as lakes, swamps and floodplains, cover large areas of Uganda and Tanzania. Lakes Victoria and Kyoga in Uganda, the Sudd region of southern Sudan and swamps of western Tanzania, southern Democratic Republic of Congo and Zambia are listed as centres of endemism in Stuart et al. (1990).

## STATE OF THE ART

### Studies on taxonomy, ecology and biodiversity

A lot of taxonomic work on Odonata in eastern Africa has been done by Elliot Pinhey, which is more than can be listed here; for Pinhey's bibliography see Martens in Vick et al. (2001). An identification manual for the dragonflies of eastern Africa is being prepared for publication by V. Clausnitzer & K.-D.B. Dijkstra. For this work all existing keys, checklists and most museum collections have been checked. Changes in taxonomy and critical checklists of all eastern African countries are being prepared by K.-D.B. Dijkstra & V. Clausnitzer. The identification manual and the critical checklists will cover all ca 500 species, ranging from Sudan to Somalia and south to Zimbabwe and Mozambique, including most of the DRC and parts of Angola.

Recently, mainly in the course of the work on the identification manual mentioned above, a number of new species have been found in the field and/or in museums, belonging to the genera *Platycnemis*, *Notogomphus*, *Phyllogomphus*, *Hemicordulia*, *Neodythemis*, *Trithemis* and *Porpax*, which are still waiting description. Quite a number of synonymies and taxonomic mistakes have been identified (e.g. Clausnitzer 2003c; Dijkstra 2003), most of which will be addressed in the identification manual and in the critical checklists, which are in preparation (see above).

Studies on ecology and/or behaviour are very rare and often only from shortterm projects (e.g. Miller 1985, 1995; Miller & Miller 1985; Clausnitzer 1998, 2003b, 2003d; Dijkstra 2004). Very detailed descriptions of the ecology of selected species are given in Miller & Miller (2003). Studies on biodiversity and conservation issues with respect to Odonata are hardly existent (Clausnitzer 2003a). Recently a study on population genetics of some zygopteran species was carried out in Kenya and Tanzania (Groeneveld 2003).

### Identification guides

The most up to date identification guide, concerning distribution and taxonomy and covering the whole range of eastern Africa, will be the manual mentioned above. Other keys with an often countrywide focus are by Pinhey (1961, 1981, 1984) and Miller & Miller (2003). For some families and genera an Africa-wide monograph exists: Chlorocyphidae (Pinhey 1967), Lestidae (Pinhey 1980b), *Aciagrion* (Pinhey 1972), *Agriocnemis* (Pinhey 1974), *Pseudagrion* (Pinhey 1964), *Metacnemis* (Pinhey 1980a), *Chlorocnemis* (Pinhey 1969), *Neurogomphus* (Cammaerts 2004), *Orthetrum* (Pinhey 1970a), and *Trithemis* (Pinhey 1970b).

Africa-wide revisions are currently under preparation and will be published within the next few years by K.-D.B. Dijkstra for the genera *Gynacantha*, *Heliaeschna*, *Hemicordulia*, *Atoconeura* and *Diplacodes*.

#### Faunal lists

Critical and updated checklists for eastern Africa south of 22°N, east of 22°E and north of South Africa and Botswana and detailed country checklists for Ethiopia, Kenya, Tanzania, Malawi and Uganda will be provided shortly by K.-D.B. Dijkstra & V. Clausnitzer (see above). Faunal lists are also available for Ethiopia (Consiglio 1978; Pinhey 1981b), Malawi (Pinhey 1966, 1979; Barlow 1996), Mozambique (Pinhey 1981a), Somalia (Carfi 1974), Zambia and Zimbabwe (Pinhey 1984). Most of these publications are check-lists only and reflect the lack of field surveys for most countries. Details on distribution, ecology, habitat requirements, etc. for the species are often not present or only shortly outlined.

### CRITICAL SPECIES

#### Notes on the species previously listed by IUCN

For eastern Africa 10 species have been listed in 2003 Red Lists of threatened species (Moore 1997; IUCN 2003):

as endangered [EN]:

*Amanipodagrion gilliesi* and *Aeshna meruensis* Sjöstedt, 1909, (both Tanzania)

as vulnerable [VU]:

*Monardithemis flava* (Zambia and Angola) and *Teinobasis alluaudi* (Seychelles only, but see Clausnitzer 2003d, 2003e)

as data deficient [DD]:

*Aciagrion rarum* (Angola and Zambia), *Ceriagrion mourae* (Mozambique), *Pseudagrion quadrioculatum* Pinhey, 1964, *Aethiothemis watulikii* Pinhey, 1962 (DRC), *Eleuthemis buettikoferi quadrigutta* Pinhey, 1974 (Zimbabwe), and *Urothemis thomasi* (Somalia and Ethiopia)

Additionally four species were listed as priority species for the eastern African region by Moore (1997):

as monotypic genera confined to one country only:

*Thermagrion webbianum* (Ethiopia), *Oreocnemis phoenix* (Malawi) and *Nepogomphoides stuhlmanni* (Tanzania)

as taxonomically isolated species:

*Coryphagrion grandis* (Kenya, Tanzania, ?Mozambique, Uganda)

Concerning the listed species by the IUCN (2003) and Moore (1997) it has to be noted that:

*Aeshna meruensis* does not qualify for any threat status (Clausnitzer & Peters 2003); *Aethiothemis watulikii* and *A. basilewskyi* Fraser, 1954 (Musée Royal de l'Afrique

Centrale, Tervuren, Belgique) pertain to a small, dark *Aethiothemis* species known only from a holotype each collected in the Congo basin. Their descriptions reveal no distinct differences in build, markings, venation and genitalia, and *A. watulikii* is treated as a synonym to *A. basilewskyi* (K.-D.B. Dijkstra & V. Clausnitzer unpubl.);

*Coryphagrion grandis* does not occur in Uganda; this locality is a misinterpretation made by Kimmins (1931) of the locality “Rabai”, which is located near Mombasa; the Mozambique record (Pinhey 1981) has not been confirmed. Recent studies showed that *C. grandis* belongs to the Pseudostigmatidae, an otherwise entire neotropical family (Clausnitzer & Lindeboom 2002; Clausnitzer 2003e; Groeneveld 2003);

*Eleuthemis buettikoferi quadrigutta* is based on one female only (Zimbabwe, Vumba Mountains). The subspecies status is contentious and should be treated as *E. buettikoferi* Ris, 1910 (K.-D.B. Dijkstra & V. Clausnitzer unpubl.), which is a very widespread species and thus does not qualify for any threat status;

*Monardithemis flava* belongs to the genus *Micromacromia* (K.-D.B. Dijkstra & V. Clausnitzer unpubl.);

*Pseudagrion quadrioculatum* is a synonym of *P. superbum* (K.-D.B. Dijkstra & V. Clausnitzer unpubl.);

*Teinobasis alluaudi* has a wider distribution than assumed (Clausnitzer 2003d, 2003e);

*Thermagrion webbianum*, which is known from one female only, was placed by Pinhey (1962a) in *Enallagma*; the identity of this species needs clarification, and the type seems to be lost (Pinhey 1962a);

*Urothemis thomasi* has not been recorded from Ethiopia (Schneider 1988 and W. Schneider pers. comm.).

Table 1. Odonata endemic or mainly confined to the countries considered and their range of distribution in the region. DD: data deficient – might have to be deleted from list with increasing survey efforts; RR: range restricted; IC: identity of species needs clarification; A: action recommended, because of habitat destruction. The countries are abbreviated by their first three letters, except DRC for Democratic Republic of Congo.

Family/species	DD	RR	IC	A	Known distribution and notes
Calopterygidae					
<i>Umma declivium</i> Förster, 1906	○	●	○	●	Tan, nMal (Eastern Arc Mts)
<i>electa</i> Longfield, 1933	●	○	○	○	Ang, Zam, sDRC
Chlorocyphidae					
<i>Chlorocypha hasta</i> Pinhey, 1960	●	●	●	?	wTan (highlands)
<i>jacksoni</i> Pinhey, 1952	●	●	○	●	swUga (Bwindi), eDRC (Kivu)
<i>molindica</i> Fraser, 1948	●	●	○	●	swUga, eDRC, ?Rwa, ?Bur
<i>schmidtii</i> Pinhey, 1967	●	?	●	?	nwTan, eDRC
<i>tenuis</i> Longfield, 1936	○	●	●	○	wKen, Uga, eDRC
<i>trifaria</i> (Karsch, 1899)	○	●	○	○	Uga, eDRC, ?Sud
<i>victoriae</i> (Förster, 1914)	●	?	●	?	Uga, eDRC

Family/species	DD	RR	IC	A	Known distribution and notes
<i>Chlorocypha wittei</i> Fraser, 1958	●	●	○	?	Ang, Zam, sDRC
sp. nov.	●	●	○	●	wUga
<i>Platycypha amboniensis</i> (Martin, 1915)	○	●	○	●	Ken (Mt Kenya, Aberdare Mts)
<i>auripes</i> (Förster, 1906)	○	●	○	●	Tan (Eastern Arc Mts)
<i>fitsimensi inyangae</i> Pinhey, 1958	●	●	○	●	Zim (Inyanga Mts)
<i>lacustris</i> (Förster, 1914)	○	●	○	○	wKen (Kakamega Forest), Uga
<i>pinheyi</i> Fraser, 1950	●	●	○	?	nwTan (Mwangongo River)
sp. nov.	○	●	○	○	Mal (L. Malawi)
Synlestidae					
<i>Chlorolestes elegans</i> Pinhey, 1950	○	○	○	●	nSAfr, Mal, Zim, Moc
Megapodagrionidae					
<i>Amanipodagrion gilliesi</i> Pinhey, 1962	○	●	○	●	neTan (Amani Sigi Forest, East Usambara Mts)
Coenagrionidae					
<i>Aciagrion heterosticta</i> Fraser, 1955	●	?	●	○	Zam, sDRC, ?nUga (swamps)
<i>macrootithenae</i> Pinhey, 1972	●	●	○	?	eAng, nwZam, sDRC
<i>nodosum</i> (Pinhey, 1964)	●	●	○	?	nwZam
<i>rarum</i> (Longfield, 1947)	●	●	○	?	eAng, ?cZam
<i>Africallagma cuneistigma</i> (Pinhey, 1969)	●	?	○	?	Zim (Chimanimani Mts)
<i>Agriocnemis angolensis</i> Longfield, 1947	●	?	○	?	Ang, nZam, neNam
<i>palaeforma</i> Pinhey, 1959	●	●	○	?	sUga (Jinja)
<i>Ceriagrion katamborae</i> Pinhey, 1961	●	?	○	?	nBot, Zam (swamps)
<i>mourae</i> Pinhey, 1969	●	●	○	?	Moc, Tan
<i>sakejii</i> Pinhey, 1963	●	●	○	?	nZam, sDRC
<i>Ischnura abyssinica</i> Martin, 1907	●	●	●	?	Eth (lake shores)
<i>Pinheyagrion angolicum</i> (Pinhey, 1966)	●	●	○	○	Bot, nZam, nAng
<i>Pseudagrion bicoerulans</i> Martin, 1907	○	●	○	○	nTan, Ken, wUga (montane to afroalpine)
<i>coeruleipunctum</i> Pinhey, 1964	●	●	○	?	eAng, nZam
<i>fisheri</i> Pinhey, 1961	●	●	○	?	nBot, Zam, eAng (Zambesi basin)
<i>greeni</i> Pinhey, 1961	●	●	○	?	sDRC, Zamb
<i>guichardi</i> Kimmins, 1958	●	●	○	?	Eth
<i>kaffinum</i> Consiglio, 1978	●	?	●	?	Eth (Kaffa)
<i>rufocinctum</i> Pinhey, 1956	●	●	○	?	Uga, nwTan, eDRC
<i>superbum</i> Fraser, 1956	●	?	●	?	neDRC
<i>symoensii</i> Pinhey, 1967	●	?	○	?	sDRC (Kundulunge Plateau)
<i>vumbaense</i> Balinsky, 1963	●	●	○	?	eZim (Vumba Mts)
<i>Teinobasis alluaudi</i> (Martin, 1896)	●	●	●	●	Mal (Mkudwazi Forest), seKen (Buda Forest), eTan
<i>Thermagrion webbianum</i> Förster, 1906	●	?	●	?	Eth (1 ♀ from Webbi River only, might belong to " <i>Enallagma</i> ", type seems to be lost)
Platycnemididae					
<i>Allocnemis mitwabae</i> Pinhey, 1961	●	?	○	?	seDRC (Mitwaba Escarpment)
<i>Oreocnemis phoenix</i> Pinhey, 1971	○	●	○	○	Mal (Mt Mulanje)
<i>Platycnemis</i> sp. nov.	○	●	○	●	Tan (Pemba Island)
Protoneuridae					
<i>Chlorocnemis abbotti</i> (Calvert, 1892)	○	●	○	●	Ken, Tan (Eastern Arc, Mt Kili)

Family/species	DD	RR	IC	A	Known distribution and notes
Protoneuridae (continued)					
<i>Chlorocnemis cellularis</i> (Grünberg, 1902)	●	●	●	●	Tan (L. Malawi)
<i>macleeryi</i> Pinhey, 1969	●	●	○	●	Mal (Mt Ntchisi)
<i>marshalli</i> Ris, 1921	○	●	○	?	Mal, Zam, Zim (montane)
<i>montana</i> St. Quentin, 1942	○	●	○	?	nMal, sTan
<i>pauli</i> Longfield, 1936	○	●	○	○	wKen, Uga, eDRC
<i>superba</i> Schmidt, 1951	○	●	○	○	wUga, wTan, eDRC
<i>Elatoneura pasquinii</i> Consiglio, 1978	●	●	●	?	Eth (Kaffa)
<i>Prodasineura flavifacies</i> Pinhey, 1981	●	?	○	?	nwZam (Mwinilunga)
Pseudostigmatidae					
<i>Coryphagrion grandis</i> Morton, 1924	○	●	○	●	Ken, Tan (coastal forest)
Aeshnidae					
<i>Gynacantha immaculifrons</i> Fraser, 1956	●	●	○	●	Mal, Tan, DRC
Gomphidae					
<i>Crenigomphus abyssinicus</i> (Sélys, 1878)	●	●	○	?	Eth
<i>denticulatus</i> Sélys, 1892	●	●	○	?	Eth
<i>Ictinogomphus dundoensis</i> Pinhey, 1961	●	○	●	○	nAng, Bot, nZam, sDRC
<i>Lestinogomphus</i> sp. nov. 1	●	●	○	?	nBot
sp. nov. 2	●	?	○	?	nUga, Nig
<i>Microgomphus mozambicensis</i> Pinhey, 1959	●	●	○	●	Zim-Moc border (mountains)
<i>Nepogomphoides stuhlmanni</i> (Karsch, 1899)	○	●	○	●	Tan (Eastern Arc), Mal, Moc
<i>Neurogomphus cocytius</i> Cammaerts, 2004	●	?	○	?	Zam, Zim
<i>dissimilis</i> Cammaerts, 2004	●	?	○	?	Zam, Zim, Mal
<i>pinheyi</i> Cammaerts, 1968	●	?	○	?	wKen (Kakamega Forest), Uga
<i>zambesiensis</i> Cammaerts, 2004	●	?	○	?	Zam, Zim, Moc
<i>Notogomphus cottarellii</i> Consiglio, 1978	●	?	●	?	Kaffa, Eth
<i>flavifrons</i> Fraser, 1952	●	?	?	?	swUga (Mafuga Forest)
<i>meruensis</i> (Sjöstedt, 1909)	●	●	●	?	nTan (Mt. Meru)
<i>rueppeli</i> (Sélys, 1857)	○	?	●	?	Eth
sp. nov. 1	●	●	○	●	swUga
sp. nov. 2	●	●	○	●	w&cKen
<i>Onychogomphus bwambae</i> Pinhey, 1961	●	●	●	?	wUga (Bwamba Forest)
<i>kitchingmani</i> Pinhey, 1961	●	?	●	?	Zambia
<i>pilosus</i> (Martin, 1912)	●	●	●	?	Tan
<i>Paragomphus alluaudi</i> (Martin, 1915)	○	●	○	○	nTan, sKen (Rift Valley)
<i>catractae</i> Pinhey, 1963	●	?	○	?	Zam, Zim
<i>lacustris</i> Karsch, 1890	●	●	●	?	Tan (L Tanganyica)
<i>nyasicus</i> Kimmins, 1955	●	●	○	?	Mal (L. Malawi), 1 record from Victoria Falls
<i>zambeziensis</i> Pinhey, 1961	●	●	○	?	Zim (middle Zambesi River)
<i>Phyllogomphus schoutedeni</i> Fraser, 1957	●	?	○	?	DRC
Corduliidae					
<i>Heliaeschna libyana</i> (Fraser, 1928)	?	●	●	●	Uga (central forests)
<i>Idomacromia jilliana</i> Dijkstra & Kisakye (2004)	●	●	●	?	Uga (Bwindi NP)
<i>Phyllomacromia flavimitella</i> (Pinhey, 1966)	●	?	○	?	Uga, DRC
<i>pallidinervis</i> (Förster, 1906)	●	?	○	?	Ken, Eth

Family/species	DD	RR	IC	A	Known distribution and notes
<i>Phyllomacromia sylvatica</i> (Fraser, 1954)	●	●	○	●	nwTan, wKen (Kakamega Forest)
<i>unifasciata</i> Fraser, 1954	●	○	○	○	Ang, DRC, Zam
<b>Libellulidae</b>					
<i>Aethiothemis basilewskyi</i> Fraser, 1954	●	●	●	?	DRC
<i>Atoconeura aethiopica</i> Kimmins, 1958	●	●	○	?	Eth (highland streams)
<i>eudoxia</i> (Kirby, 1909)	○	●	○	?	Uga, wKen
<i>kenya</i> Longfield, 1953	○	●	○	○	Ken, Uga, nTan
<i>pseudeudoxia</i> Longfield, 1953	○	●	○	●	wUga
<i>Congothemis leakyi</i> (Pinhey, 1956)	○	●	○	?	nZam
<i>Crocothemis brevistigma</i> Pinhey, 1961	○	●	○	?	nZam
<i>Hadrothemis scabrifrons</i> Ris, 1910	○	●	○	○	Tan, Ken, Mal, Moc (coastal forests)
<i>Lokia coryndoni</i> Fraser, 1953	●	?	○	●	Uga (Zika and Budongo Forest)
<i>elliotti</i> Lieftinck, 1969	○	●	○	?	swamps, Zam, sDRC
<i>gamblesi</i> Lieftinck, 1969	●	?	○	?	Zam (Bangweulu Basin, 1 male only)
<i>Malgassophebia bispina longistipes</i> Pinhey, 1964	●	?	○	●	nwZam
<i>Micromacromia flava</i> (Longfield, 1945)	●	?	○	?	sAng, Zam (Mwinilunga)
<i>miraculosa</i> (Förster, 1906)	○	●	○	●	Tan (Amani Forest, East Usambara Mts)
<i>Neodythemis fitzgeraldi</i> Pinhey, 1961	○	●	○	●	nZam (swamp forest)
<i>gorillae</i> Pinhey, 1961	●	?	●	?	swUga, wNig, ?Cam
<i>Nesciothemis fitzgeraldi</i> Pinhey, 1955	○	●	○	?	nZam (local)
<i>Orthetrum kristenseni</i> Ris, 1911	●	●	○	?	highlands of Eth
<i>Porpax risi</i> Pinhey, 1958	●	○	●	○	Ang, Zam, Zim, ?Moc
<i>Tetrathemis corduliformis</i> Longfield, 1936-	●	○	●		Uga, wKen(Kakamega Forest)
<i>denticauda</i> Fraser, 1955	●	?	○	?	Uga (Fort Portal, 1 male only)
<i>ruwensoriensis</i> Fraser, 1945	●	●	○	?	Uga (Ruwenzori)
<i>Thermochoria jeanneli</i> (Martin, 1915)	○	●	○	●	eTan, seKen (coastal swamp forests), DRC (Katanga)
<i>Trithemis anomala</i> Pinhey, 1955	○	●	○	?	nZam (swamps)
<i>brydeni</i> Pinhey, 1970	●	?	○	●	Bot (Okavango), Zam (L. Bangweulu)
<i>ellenbecki</i> Förster, 1906	●	●	○	?	Eth
sp. nov.	●	●	○	?	Uga, wTan, eDRC
<i>Urothemis thomasi</i> Longfield, 1932	○	●	○	?	Som, sArabia
<i>Zygonyx atritibiae</i> Pinhey, 1961	●	?	●	○	DRC, Ang, Zam
<i>eusebia</i> (Ris, 1912)	●	?	○	?	Ang, DRC, Zam
<i>flavicosta</i> (Sjöstedt, 1900)	●	?	●	?	Uga, DRC, ?Nig

### Species to be considered

A high number of odonates can be listed as 'data deficient'. Usually this reflects the need for more research, but until studies on distribution, habitat requirements and systematic identity clarify the need for special conservation measures, such species require attention. Species listed in Table 1 are therefore either 'range restricted', where necessary measures can be at least roughly outlined, or 'data deficient', where research should have priority. Table 2 lists the species suggested for inclusion in the global Red List.

It is difficult to estimate whether the distribution of certain species is a result of restricted range or data deficiency. Species recorded from Ugandan rain forests only are likely to have a wider distribution range westward in the central African rain forest areas. Similarly, species recorded only from one locality in the Democratic Republic of Congo, can be expected to have a wider range in the Congo basin. There are also several species recorded locally from Zambia but nowhere else. In these cases more surveys are needed to prove if the species are really range restricted or if this pattern reflects only that Zambia has been comparatively well studied by Pinhey (e.g. Pinhey 1984).

The distribution given in Table 1 is for some species the type locality only, without any further records. Other species included in Table 1 have a highly disjunct distribution, e.g. species inhabiting montane forests of the Eastern Arc Mountains.

### CRITICAL SITES AND THREATS

Generally deforestation is the major threat to Odonata in eastern Africa. Any type of forest – e.g. montane forest, coastal forest, Guineo-Congolian rain forests or riverine forest – requires urgent conservation measures, especially in countries like Ethiopia, Burundi, Rwanda and Kenya, where forests are already restricted to tiny and highly disjunct patches. Growing human populations and stagnating economies put enormous pressures on the last remaining forests. Forest sites and wetlands are not adequately represented in protected areas in eastern Africa, which cover mainly the savanna and thornbush habitats.

One big problem for all kind of habitats in eastern Africa is uncontrolled fires, which is typical of all Africa. Fires hinder any kind of natural regeneration, even on otherwise unused land, and they frequently destroy huge areas in national Parks and reserves. Since many areas burn annually, the vegetation structure of habitats may be changed on a large scale, often resulting in a species composition change within odonate communities.

As a reflection of security and political problems, critical sites for biodiversity conservation in Mozambique, Rwanda and Burundi are suspected to be under severe threat. The current situation is not known to the author. Owing to high population densities, most of the natural habitats of Rwanda and Burundi are reported to have been converted into farmland (Stuart et al. 1990), except some montane forest areas at the Virunga Volcanoes.

#### Coastal forests and Eastern Arc Mountains

Coastal forests of Kenya, Tanzania and Mozambique are centres of endemism, hardly protected and in need of priority status for conservation measures. Further destruction of the remaining coastal forests will threaten a high number of species, including odonates, with extinction. Once the eastern African coastal forests covered most of the coast from north Mozambique to south Somalia. Now this belt is reduced to over 250 small to very small separated forest patches, often of less than 500 ha in size (Burgess & Clarke 2000). All these remaining forest patches share common characteristics. They are small and highly fragmented, have an exceptionally high

degree of localised endemism, differ in structure and species composition due to physical conditions, and are extremely vulnerable and rapidly being degraded. From eight biological groups which have been studied extensively, 786 known species are strictly endemic to the East African coastal forests; unfortunately, Odonata were not included in this survey (Burgess 2000). Kenya's remaining coastal forests are listed as "critical sites" by the IUCN and are not adequately represented in Kenya's protected area system (Stuart et al. 1990).

The Eastern Arc forests of Tanzania have been classified amongst the 14 most threatened tropical forest diversity centres (Myers 1988, 1990) and amongst the 25 diversity centres world-wide (Myers et al. 2000). Still most of the forests of Eastern Arc Mountains have no or only very weak protection status, and pressure on the remaining forests is very high.

At least nine odonate species are endemic to coastal forests and/or forests of the Eastern Arc Mountains. The differentiation between these two habitats is not always clear, since they merge, e.g. in the Usambara Mountains.

Table 2. Table of species from eastern Africa suggested for inclusion in the global Red List and likely to be considered for inclusion, once the taxonomy is solved. Species which had been erroneously included on the Red List up to 2003 are not listed again. — RL 2003: rating in the Red List 2003; rRL: recent Red List rating; not all species had been assessed at the finalisation of this manuscript, and for these the space remains blank. CR: critically endangered; EN: endangered; VU: vulnerable; NT: near threatened; DD: data deficient; TAX: taxonomy not clear.

Family/species	RL 2003	rRL
Calopterygidae		
<i>Umma declivium</i> Förster, 1906	-	VU
Chlorocyphidae		
<i>Chlorocypha hasta</i> Pinhey, 1960	-	DD
<i>jacksoni</i> Pinhey, 1952	-	VU
<i>molindica</i> Fraser, 1948	-	EN
<i>schmidti</i> Pinhey, 1967	-	EN
<i>victoriae</i> (Förster, 1914)	-	DD
sp. nov.	-	TAX
<i>Platycypha amboniensis</i> (Martin, 1915)	-	CR
<i>auripes</i> (Förster, 1906)	-	EN
<i>fitzsimonsi inyangae</i> Pinhey, 1958	-	
<i>pinheyi</i> Fraser, 1950	-	CR
sp. nov.	-	TAX
Synlestidae		
<i>Chlorolestes elegans</i> Pinhey, 1950	-	NT
Megapodagrionidae		
<i>Amanipodagrion gilliesi</i> Pinhey, 1962	EN	CR

Family/species	RL 2003	rRL
<b>Coenagrionidae</b>		
<i>Aciagrion heterosticta</i> Fraser, 1955	-	TAX
<i>macrootithenae</i> Pinhey, 1972	-	
<i>nodosum</i> Pinhey, 1964	-	
<i>rarum</i> (Longfield, 1947)	DD	
<i>Africallagma cuneistigma</i> (Pinhey, 1969)	-	
<i>Agriocnemis angolensis</i> Longfield, 1947	-	
<i>palaeforma</i> Pinhey, 1959	-	NT
<i>ruberrima</i> Balinsky, 1961	-	
<i>Ceriagrion katamborae</i> Pinhey, 1961	-	
<i>mourae</i> Pinhey, 1969	DD	DD
<i>Ischnura abyssinica</i> Martin, 1907	-	
<i>Pinheyagrion angolicum</i> (Pinhey, 1966)	-	
<i>Pseudagrion bicoerulans</i> Martin, 1907	-	VU
<i>coeruleipunctum</i> Pinhey, 1964	-	
<i>fisheri</i> Pinhey, 1961	-	
<i>greeni</i> Pinhey, 1961	-	
<i>guichardi</i> Kimmins, 1958	-	-
<i>kaffinum</i> Consiglio, 1978	-	
<i>rufocinctum</i> Pinhey, 1956	-	VU
<i>symoensii</i> Pinhey, 1967	-	
<i>vumbaense</i> Balinsky, 1963	-	
<i>Teinobasis alluaudi</i> (Martin, 1896)	-	VU
<i>Thermagrion webbianum</i> Förster, 1906	-	TAX
<b>Platycnemididae</b>		
<i>Allocnemis mitwabae</i> Pinhey, 1961	-	
<i>Oreocnemis phoenix</i> Pinhey, 1971	-	CR
<i>Platycnemis</i> sp. nov.	-	CR
<b>Protoneuridae</b>		
<i>Chlorocnemis abbotti</i> (Calvert, 1892)	-	NT
<i>cellularis</i> (Grünberg, 1902)	-	TAX
<i>macleeryi</i> Pinhey, 1969	-	CR
<i>montana</i> St. Quentin, 1942	-	EN
<i>pauli</i> Longfield, 1936	-	NT
<i>Elatoneura pasquinii</i> Consiglio, 1978	-	
<i>Prodasineura flavifacies</i> Pinhey, 1981	-	
<b>Pseudostigmatidae</b>		
<i>Coryphagrion grandis</i> Morton, 1924	-	VU
<b>Aeshnidae</b>		
<i>Gynacantha immaculifrons</i> Fraser, 1956	-	DD
<b>Gomphidae</b>		
<i>Crenigomphus abyssinicus</i> (Selys, 1878)	-	
<i>denticulatus</i> Selys, 1892	-	
<i>Lestinogomphus</i> sp. nov. 1	-	TAX
sp. nov. 2	-	TAX

Family/species	RL 2003	rRL
Gomphidae (continued)		
<i>Microgomphus mozambicensis</i> Pinhey, 1959	-	
<i>Nepogomphoides stuhlmanni</i> (Karsch, 1899)	-	NT
<i>Neurogomphus pinheyi</i> Cammaerts, 1968	-	DD
<i>Notogomphus cottarellii</i> Consiglio, 1978	-	
<i>flavifrons</i> Fraser, 1952	-	CR
<i>meruensis</i> (Sjöstedt, 1909)	-	TAX
<i>rueppeli</i> (Selys, 1857)	-	
sp. nov. 1	-	TAX
sp. nov. 2	-	EN
<i>Onychogomphus bwambae</i> Pinhey, 1961	-	TAX
<i>kitchingmani</i> Pinhey, 1961	-	TAX
<i>pilosus</i> (Martin, 1912)	-	TAX
<i>Paragomphus alluaudi</i> (Martin, 1915)	-	NT
<i>cataractae</i> Pinhey, 1963	-	
<i>lacustris</i> Karsch, 1890	-	DD
<i>nyasicus</i> Kimmins, 1955	-	NT
<i>zambeziensis</i> Pinhey, 1961	-	
<i>Phyllogomphus schoutedeni</i> Fraser, 1957	-	
Corduliidae		
<i>Heliaeschna libyana</i> (Fraser, 1928)	-	TAX
<i>Idomacromia jillianae</i> Dijkstra & Kisakye (2004)	-	VU
Libellulidae		
<i>Aethiothemis basilewskyi</i> Fraser, 1954	DD <sup>1</sup>	
<i>Atoconeura aethiopica</i> Kimmins, 1958	-	
<i>Congothemis leakeyi</i> (Pinhey, 1956)	-	
<i>Crocothemis brevistigma</i> Pinhey, 1961	-	
<i>Hadrothemis scabrifrons</i> Ris, 1910	-	NT
<i>Lokia coryndoni</i> Fraser, 1953	-	EN
<i>elliotti</i> Lieftinck, 1969	-	
<i>gamblesi</i> Lieftinck, 1969	-	
<i>Micromacromia miraculosa</i> (Förster, 1906)	-	CR
<i>Neodythemis fitzgeraldi</i> Pinhey, 1961	-	
<i>gorillae</i> Pinhey, 1961	-	TAX
<i>Nesciothemis fitzgeraldi</i> Longfield, 1955	-	
<i>Orthetrum kristenseni</i> Ris, 1911	-	
<i>Tetrathemis denticauda</i> Fraser, 1955	-	EN
<i>ruwensoriensis</i> Fraser, 1945	-	CR
<i>Thermochoria jeanneli</i> (Martin, 1915)	-	VU
<i>Trithemis anomala</i> Pinhey, 1956	-	
<i>brydeni</i> Pinhey, 1970	-	
<i>ellenbecki</i> Förster, 1906	-	
sp. nov.	-	NT
<i>Zygonyx atritibiae</i> Pinhey, 1964	-	
<i>eusebia</i> (Ris, 1912)	-	

<sup>1</sup>as *A. watulikii*

## Guineo-Congolian rain forests

The Kakamega Forest in Kenya is of regional importance and listed as “priority biodiversity conservation area” for Kenya (Wass 1995). On a larger scale, Guineo-Congolian rain forest areas are still found in large areas in Uganda, most of them protected as forest reserve or national park. At the moment there seems to be no immediate danger to these forests in Uganda, although illegal encroachment and logging is present everywhere.

## Wetlands

Wetlands are usually poorly protected, and the important biological resources in these ecosystems are easily lost through clearance and overuse. Only in Tanzania, where almost 10% of the country’s surface is estimated to be covered by wetlands (Kamukala & Crafter 1993), are wetland areas conserved in reserves. In Rwanda the Akagera National Park includes large swamps as well but suffers heavy pressure from the high human population density in the country. Kenya has very few wetlands, which are mainly of national importance (Crafter et al. 1993).

Major threats to wetlands are excessive exploitation, changes in water quality due to industrial effluent, agricultural pesticides, siltation and the introduction of foreign species, e.g. Nile Perch *Lates niloticus* or Water Hyacinth *Eichhornia crassipes*. Effects of chemical pollution on macroinvertebrates (including Odonata) in aquatic systems have been reported from a study conducted in Uganda (e.g. Matagi 1996). Chemical pollution is already a huge problem in and around cities but will drastically increase with increasing wealth and industrialisation of the countries.

## CONSERVATION PRIORITIES AND RECOMMENDATIONS

There is no doubt that much more research on afrotropical Odonata is urgently needed, i.e. surveys, systematic work, revisions of whole genera, and ecological work. The list in Table 1 is mainly based on data deficiency. Only for a few species, e.g. the ones rated in Table 2 according to the IUCN criteria other than DD, is there enough information available to specify habitat requirements and therefore conservation measures. But, before all the required data can be collected and analysed satisfactorily, a number of these species will be already extinct, due to rapid deforestation and habitat change in eastern Africa. Therefore the suggested measures in this chapter are not species specific but concentrated on those areas which, at the present state of knowledge, contain endangered species.

## Forest

Forest areas are important sites for Odonata, and swamp forests especially contain a high number of range restricted and rare species (Clausnitzer 2003f). In all countries in eastern Africa appropriate management plans are urgently needed to be implemented on the ground with effective protection, especially coastal forests

and Eastern Arc forests, which are considered as ecologically stable regions (Fjeldså et al. 1997) under serious threat and in need of immediate conservation measures.

Although the importance of the Eastern Arc Mountains is widely acknowledged by the scientific community (e.g. Burgess et al. 1998; Lovett 1998b), and measures for their conservation discussed (e.g. Newmark 1998, 1999), implementation on the ground remains a political and financial issue in the end. Maybe the suggestion to give the Eastern Arc Mountains World Heritage status (Lovett 1998a) might add enough financial, political and public power to succeed in conserving these remaining forests.

Efforts which should be undertaken are:

(1) prevention of any further deforestation.

This needs publicity work in local communities to stop illegal and uncontrolled logging and also measures from the highest political level. Forests should be regarded as a natural resource with high conservation priority;

(2) afforestation with indigenous trees.

This is not only of conservation interest for odonates, biodiversity and/or centres of endemism, but also resource management and prevention of flooding, landslides, etc. Afforestation programmes should focus on the local community level as well as on a largescale governmental level;

(3) fire control.

Frequent and uncontrolled fires prevent any kind of regeneration. For example, large areas in southern Kenya have been cleared and cultivated some time ago but lie fallow nowadays. Isolated patches of *Raphia* palm trees and a very high groundwater level indicate that this area had been previously covered by extensive coastal swamp forest. A natural regeneration of these areas into dense bushland and eventually forest is hindered by frequent burning. Fires are deliberately lit under cashewnut and coconut palm plantations and not controlled. Most areas burn yearly and leave a very impoverished vegetation with doom palms, which profit from the fires. A firecontrol programme in this area would be quite effective, allowing natural succession; and

(4) leaving a strip of natural riparian vegetation of at least 20 m on either side of the stream in cultivated landscapes.

This would increase landscape heterogeneity, decrease the destructive impact of flooding and increase biodiversity. Not only heliophobic odonate species of the streams would benefit from such measures, but also forest species, which are highly isolated at the moment, could use such corridors for dispersal between forest patches.

#### Aquatic sites in general

Water management is becoming a big issue in sub-Saharan Africa and not only for ecological reasons (Acreman & Hollis 1996). In Kenya surface water is still the major contributor to water reserves (Keter 1993). Human activities in the catchment areas are a major influence on water quality and quantity. Pollution of water and the conservation of watercatchment areas are widely discussed in tropical Africa, although the implementation of solutions is often difficult.

Water pollution control measures, e.g. sewage works and factory effluent treatment, should be undertaken before the rivers and streams become unusable, as has already happened with rivers around Nairobi and the bay of Lake Victoria at Kisumu. The amount of insecticides and pesticides used on farmlands, especially in rice fields and on the booming flower farms, need restrictive laws and controls. Floodplains, water retention sites, swamps, etc., should be protected and not turned into farmland or burned with the aim of getting grazing ground. These areas are important to prevent flooding and function as watercatchment areas.

#### Publicity work

Together with the control of illegal activities, public awareness of the importance of such forests has to be increased. This should not only emphasise biodiversity and uniqueness but also the importance of forests and wetlands for water catchment, flood protection and natural resources. The importance of forests in watercatchment areas has become quite obvious recently in Kenya during several years of heavy drought, and conservation efforts should strongly focus on this fact. Information boards on Odonata should be prepared and supplied to schools and information centres of protected areas.

One good example for the conservation of a small swamp area within an otherwise densely populated agricultural area is the Saiwa Swamp National Park in western Kenya. This national park, although still viewed critically by the local community, is frequently visited by schools and private persons from the neighbourhood. A recent inventory of the odonates there has resulted in one new record for Kenya.

### RESEARCH PRIORITIES

The most important problem concerning Odonata diversity assessment in eastern Africa is data deficiency, equally for species distribution, ecology and systematics. Often political instability, for example in Sudan, Somalia or Mozambique, hinders any kind of field work. Inventories in the rain forest areas of Central Africa, also a politically unstable region, are urgently needed to get more distribution data and to solve taxonomic problems. Approaches suggested by Ponder et al. (2001) should be used to specify high priority areas for surveys.

The research needed is probably the same all over Africa:

- systematic revisions;
- inventories;
- publication and allocation of data since Pinhey (1962a, 1962b);
- collection of ecological data from rangerrestricted species.

Species listed as data deficient in Table 1 should receive priority in future research on Odonata in eastern Africa.

## CURRENT ACTIVITIES

Recently some projects in eastern Africa have started to work exclusively on odonates or to include them in projects working on several taxa. Within a project funded by the German Ministry of Science (BMBF) "Diversity and species composition of Odonata as indicators of biotope quality of East African rain forests and their replacement communities" a key has been prepared by V. Clausnitzer & K.-D.B. Dijkstra entitled, "The dragonflies of eastern Africa – an identification key", and the status and taxonomy of about 450 odonate species has been revised in another publication, under preparation by K.-D.B. Dijkstra & V. Clausnitzer, entitled, "An annotated checklist of the dragonflies (Odonata) of eastern Africa, with critical lists for Ethiopia, Kenya, Malawi, Tanzania and Uganda, new records, taxonomic notes and descriptions of new species". Data on distribution and ecology of odonates of the East African countries is being collected. Odonata are included in a WCS (Wildlife Conservation Society) project in Tanzania "Southern Highlands Conservation Programme" and in an inventory of Uganda's openland IBAs (Important Bird Areas). As part of all of these projects, national reference collections are built up and local scientists trained.

Odonata are also included in a "Wetland Biodiversity Assessment" project by the IUCN, during which information on all odonate species of Kenya, Uganda, Tanzania, Malawi and Burundi has been fed into the "Global Biodiversity Assessment" (GBA) database.

A first dragonfly workshop was held in the National Museums of Kenya in Nairobi in September 2003, to train students and scientists from eastern Africa on general aspects, identification and field skills related to odonatology. Additionally, odonates will, hopefully, be included in the field courses of the Tropical Biological Association in 2005.

Odonatologists working in Africa are linked through the recently started PHAON (Pinhey's Heritage African Odonata Network), which proves to be an excellent tool to exchange views and data, discuss results and present projects; for more information contact K.-D.B. Dijkstra <kddijkstra@hetnet.nl>.

## REFERENCES

- Acreman, M.C. & G.E. Hollis, 1996. Water management and wetlands in sub-Saharan Africa. IUCN, Gland & Cambridge.
- Barlow, A., 1996. Additions to the checklist of Odonata from Malawi, with taxonomic notes. *Odonatologica* 25: 221-230.
- Burgess, N.D., 2000. Global importance and patterns in the distribution of coastal forest species. In: Burgess, N.D. & G.P. Clarke (eds) "Coastal forests of eastern Africa", IUCN, Gland & Cambridge, pp. 235-248.
- Burgess, N.D. & G.P. Clarke, 2000. Coastal forests of eastern Africa. IUCN, Gland & Cambridge.
- Burgess, N.D., J. Fjeldså & R. Botterweg, 1998. Faunal importance of the Eastern Arc Mountains of Kenya and Tanzania. *Journal of the East African Natural History Society* 87: 37-58.

- Cammaerts, R., 2004. Taxonomic studies on African Gomphidae (Odonata, Anisoptera). 2. A revision of the genus *Neurogomphus* Karsch, with the description of some larvae. Belgian Journal of Entomology 6: 91-239.
- Carfi, S., 1974. Contribution to the knowledge of Somalian Odonata. *Monitore Zoologico Italiano* (N.S.), Supplemento 13: 147-181.
- Clausnitzer, V., 1998. Territorial behaviour of the rain forest dragonfly *Notiothemis robertsi* Fraser, 1944: proposed functions of specific behavioural patterns (Odonata: Libellulidae). *Journal of Zoology*, London 245: 121-127.
- Clausnitzer, V., 2001. Notes on the species diversity of East African Odonata, with a checklist of species. *Odonatologica* 30: 49-66.
- Clausnitzer, V., 2003a. Dragonfly communities in coastal habitats of Kenya: indication of biotope quality and the need of conservation measures. *Biodiversity and Conservation* 12: 333-356.
- Clausnitzer, V., 2003b. Rediscovery of *Amanipodagrion gilliesi*, with notes on habitat, behaviour and conservation (Odonata: Megapodagrionidae). *International Journal of Odonatology* 6: 1-8.
- Clausnitzer, V., 2003c. The identity of the East African *Notogomphus lecythus*, *N. cataractae* and *N. immicericors* (Odonata: Gomphidae). *Odonatologica* 32: 85-87.
- Clausnitzer, V., 2003d. *Teinobasis alluaudi* Martin, 1896 from mainland Africa: notes on ecology and biogeography. *Odonatologica* 32: 321-334.
- Clausnitzer, V., 2003e. Dragonflies of the Rufiji Delta. Rufiji Environment Management Project Report (REMP), Utete.
- Clausnitzer, V., 2003f. Odonata of African forests. *Cimbebasia* 28: 173-190.
- Clausnitzer, V. & M. Lindeboom, 2002. Natural history and description of the dendrolimnetic larvae of *Coryphagrion grandis* (Odonata). *International Journal of Odonatology* 5: 29-44.
- Clausnitzer, V. & G. Peters, 2003. Identity and distribution of the little known *Aeshna meruensis* (Odonata: Aeshnidae). *International Journal of Odonatology* 6: 9-15.
- Consiglio, C., 1978. Odonata collected in Ethiopia by the expeditions of the Accademia Nazionale dei Lincei. I. Introduction and the Zygoptera. *Problemi Attuali di Scienza e di Cultura* 243: 27-51.
- Crafter, S.A., S.G. Njuguna & G.W. Howard, 1993. Wetlands of Kenya. Proceedings of the KWWG Seminar on wetlands of Kenya, National Museums of Kenya, Nairobi, Kenya. IUCN, Gland & Cambridge.
- Dijkstra, K.-D.B., 2003. Fooled by the double: *Brachythemis liberiensis* is *Parazyxomma flavicans*, with a note on the *Zyxommatini* (Odonata: Libellulidae). *International Journal of Odonatology* 6: 109-126.
- Dijkstra, K.-D.B., 2004. Distribution, status, habitat and behaviour of Malawi's Mulanje Damselfly *Oreocnemis phoenix* (Odonata: Platycnemididae). IDF-Report 6: in press.
- Dijkstra, K.-D.B. & J.J. Kisakye (2004) *Idomacromia jillianae* sp. nov. from Uganda (Odonata: Corduliidae). *International Journal of Odonatology* 7: in press.
- Dijkstra, K.-D.B. & G. Vick, 2004. Critical species of Odonata in western Africa. In: Clausnitzer, V. & R. Jödicke (eds) "Guardians of the watershed. Global status of dragonflies: critical species, threat and conservation". *International Journal of Odonatology* 7: 229-238.
- Fjeldså, J., & J.C. Lovett, 1997. Geographical patterns of old and young species in African forest biota: the significance of specific montane areas as evolutionary centres. *Biodiversity and Conservation* 6: 325-346.
- Fjeldså, J., D. Ehrlich, E. Lambin & E. Prins, 1997. Are biodiversity "hotspots" correlated with current ecoclimatic stability? A pilot study using the NOAA-AVHRR remote sensing data. *Biodiversity and Conservation* 6: 401-422.

- Groeneveld, L., 2003. Molecular approaches to systematics, speciation, and population genetics of four African damselfly species. Diplomarbeit, Fachbereich Biologie der Universität Hannover.
- IUCN, 2003. 2003 IUCN Red List of threatened species. <[www.redlist.org/](http://www.redlist.org/)>.
- Jödicke, R., J.-P. Boudot, G. Jacquemin, B. Samraoui & W. Schneider, 2004. Critical species of Odonata in North Africa and the Arabian Peninsula. In: Clausnitzer, V. & R. Jödicke (eds) "Guardians of the watershed. Global status of dragonflies: critical species, threat and conservation". International Journal of Odonatology 7: 239-253.
- Kamukala, G.L. & S.A. Crafter, 1993. Wetlands of Tanzania. IUCN, Gland & Cambridge.
- Keter, J.K., 1993. Wetlands and water supply in Kenya. In: Crafter, S.A., S.G. Njuguna & G.W. Howard (eds) "Wetlands of Kenya", Proceedings of the KWWG Seminar on Wetlands of Kenya, National Museums of Kenya, Nairobi, Kenya. IUCN, Gland & Cambridge, pp. 155-160.
- Kimmins, D.E., 1931. Description of the male of *Coryphagrion grandis*, Morton (Odonata). Annals and Magazine of Natural History 8: 215-217.
- Kingdon, J., 1989. Island Africa. Princetown University Press, Princetown.
- Lovett, J.C., 1998a. Eastern Tropical African Centre of Endemism: a candidate for World Heritage status? Journal of East African Natural History 87: 359-366.
- Lovett, J.C., 1998b. Importance of the Eastern Arc mountains for vascular plants. Journal of East African Natural History 87: 59-74.
- Matagi, S.V., 1996. The effect of pollution on benthic macroinvertebrates in a Ugandan stream. Archiv für Hydrobiologie 137: 537-549.
- Miller, P.L., 1985. Oviposition by *Phaon iridipennis* (Burmeister) in Kenya (Zygoptera: Calopterygidae). Odonatologica 14: 251-256.
- Miller, P.L., 1995. Some dragonflies of forests near Kampala, Uganda, with notes on their ecology and behaviour (Odonata). Opuscula Zoologica Fluminensia 136: 1-19.
- Miller, P.L. & A.K. Miller, 1985. Rates of oviposition and some other aspects of reproductive behaviour in *Tholymis tillarga* (Fabricius) in Kenya (Anisoptera: Libellulidae). Odonatologica 14: 287-299.
- Miller, P.L. & K. Miller, 2003. East African dragonflies. Nature Kenya, Nairobi.
- Moore, N.W., 1997. Dragonflies – status survey and conservation action plan. IUCN/SSC Odonata Specialist Group. IUCN, Gland & Cambridge.
- Myers, N., 1988. Threatened biotas: "hot spots" in tropical forests. Environmentalist 8: 187-208.
- Myers, N., 1990. The biodiversity challenge: expanded hotspot analysis. Environmentalist 10: 243-256.
- Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. Fonseca & J. Kent, 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853-858.
- Newmark, W.D. 1998. Forest area, fragmentation, and loss in the Eastern Arc Mountains: implications for the conservation of biological diversity. Journal of East African Natural History 87: 29-36.
- Newmark, W.D., 1999. Ecological monitoring: its importance for the conservation of biological diversity in the Eastern Arc forests. East African Natural History Society Bulletin 29: 4-6.
- Pinhey, E., 1961. A survey of the dragonflies (order Odonata) of eastern Africa. British Museum (Natural History), London.
- Pinhey, E., 1962a. A descriptive catalogue of the Odonata of the African continent (up to December 1959). (Part I). Publicações Culturais Companhia de Diamantes de Angola 59: 11-161.
- Pinhey, E., 1962b. A descriptive catalogue of the Odonata of the African continent (up to December 1959). (Part II). Publicações Culturais Companhia de Diamantes de Angola 59: 163-322.

- Pinhey, E., 1964. A revision of the African members of the genus *Pseudagrion* Selys (Odonata). *Revista de Entomologia de Mocambique* 7: 5-196.
- Pinhey, E., 1966. Check-list of dragonflies (Odonata) from Malawi, with description of a new *Teinobasis* Kirby. *Arnoldia Rhodesia* 2 (33): 1-24.
- Pinhey, E., 1967. African Chlorocyphidae (Odonata). *Journal of the Entomological Society of South Africa* 29: 161-197.
- Pinhey, E., 1969. A revision of the genus *Chlorocnemis* Selys (Odonata). *Occasional Papers of the National Museums of Rhodesia (B)* 4 (29): 209-260.
- Pinhey, E., 1970a. A new approach to African *Orthetrum* (Odonata). *Occasional Papers of the National Museums of Rhodesia (B)* 4 (30): 261-321.
- Pinhey, E., 1970b. Monographic study of the genus *Trithemis* Brauer (Odonata: Libellulidae). *Memoirs of the Entomological Society of Southern Africa* 11: 1-159.
- Pinhey, E., 1972. The genus *Aciagrion* Selys (Odonata). *Occasional Papers of the National Museums of Rhodesia (B)* 5: 1-59.
- Pinhey, E., 1974. A revision of the African *Agriocnemis* Selys and *Mortonagrion* Fraser (Odonata: Coenagrionidae). *Occasional Papers of the National Museums and Monuments of Rhodesia (B)* 5: 171-278.
- Pinhey, E., 1979. Additions and corrections to the 1966 check-list of dragonflies (Odonata) from Malawi. *Arnoldia Zimbabwe* 8: 1-14.
- Pinhey, E., 1980a. A review of the *Metacnemis* group (Odonata: Platycnemididae). *Arnoldia Zimbabwe* 9 (2): 1-13.
- Pinhey, E., 1980b. A revision of African Lestidae (Odonata). *Occasional Papers of the National Museums and Monuments of Rhodesia (B)* 6: 327-479.
- Pinhey, E., 1981a. Checklist of the Odonata of Moçambique. *Occasional Papers of the National Museums and Monuments of Rhodesia (Natural Sciences) (B)* 6: 556-631.
- Pinhey, E., 1981. Odonata collected in Ethiopia. III. Anisoptera. In: "Zoological researches in Ethiopia. Part II. Some results of the first and second Italian zoological mission to Ethiopia, sponsored by the National Academy of Lincei (1973 and 1975)." *Problemi Attuali di Scienza e di Cultura* 252: 5-56, pl. I.
- Pinhey, E., 1984. A checklist of the Odonata of Zimbabwe and Zambia. *Smithersia* 3: 1-64.
- Pinhey, E. & N. Pinhey, 1984. A preliminary list of the Odonata collected by Dr. J. Kielland in Tanzania for Dr. M.A. Lieftnick. *Odonatologica* 13: 129-138.
- Ponder, W.F., G.A. Carter, P. Flemons & R.R. Chapman, 2001. Evaluation of museum collection data for use in biodiversity assessment. *Conservation Biology* 15: 648-657.
- Samways, M.J., 2004. Critical species of Odonata in southern Africa. In: Clausnitzer, V. & R. Jödicke (eds) "Guardians of the watershed. Global status of dragonflies: critical species, threat and conservation". *International Journal of Odonatology* 7: 255-262.
- Schneider, W., 1988. Dragonflies (Odonata) of the Wahiba Sands and adjacent areas, eastern Oman. *Journal of Oman Studies, Special Report* 3: 377-388.
- Stuart, S.N., R.J. Adams & M.S. Jenkins, 1990. Biodiversity in sub-saharan Africa and its islands – conservation, management and sustainable use. IUCN, Gland & Cambridge.
- Suhling, F., A. Martens & E. Marais, 2004. Critical species of Odonata in southwest Africa. In: Clausnitzer, V. & R. Jödicke (eds) "Guardians of the watershed. Global status of dragonflies: critical species, threat and conservation". *International Journal of Odonatology* 7: 263-277.
- Vick, G.S., D.G. Chelmick & A. Martens, 2001. In memory of Elliot Charles Gordon Pinhey (10 July 1910 - 7 May 1999). *Odonatologica* 30: 1-11.
- Wass, P., 1995. Kenya's indigenous forests: status, management and conservation. IUCN, Gland & Cambridge.