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DRAGONFLY CONSERVATION IN SOUTH AFRICA: A BIOGEOGRAPHICAL PERSPECTIVE

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Most of the 153 South African odon. spp. (the taxonomic status of 2 of which is uncertain) are widespread African elements, whose ranges extend into the southern tip of the continent especially along the eastern seaboard, where there are suitable warm and moist climatic conditions. The endemics make up only 18% of the total (14% Zygoptera, 4% Anisoptera).

The Cape, which is well-known for its high level of endemicity in many plant and animal groups, makes up only 9% of the total odon. fauna. 4 zygopteran and 1 anisopteran Cape endemics are listed in the 1990 IUCN Red List. Also listed is 1 montane Natal Drakensberg endemic zygopteran and 1 highly localized coastal Natal anisopteran. Many of the endemics occur in water catchment wilderness areas or nature reserves, and are not immediately threatened with extinction, although the long--term global changes are of particular concern for southern African spp. Much further research is required on the exact distribution and abundance of all spp., especially the IUCN-catagorized ones. Although loss of wetlands has been severe in South Africa, farm dams have, on the contrary, benefitted many spp. A pilot scheme to develop a dragonfly reserve in a botanic garden is also underway.

INTRODUCTION

South Africa is the southern tip of the large continent of Africa. This southern tip has been isolated from neighbouring continents for many tens of millions of years and has undergone important mountain building. These points have an important historical and geographical bearing on the conservation biology of South African Odonata. Firstly, the Cape of Good Hope, and to a lesser extent the high Natal Drakensberg mountains, are characterized by high levels of endemism in much of the fauna and flora (HUNTLEY, 1989; KINGDON, 1990). Secondly, on the eastern seaboard in particular, a combination of high rainfall

and warm sea currents has enabled many tropical species to extend their ranges southwards. These may be either widespread in this eastern sector or highly restricted to specific biotopes. Principally however, it is the Cape and Natal endemics that are truly worthy of conservation status.

This paper reviews South African geology and geography as a background to species richness and overall distributions. Finally, the paper focusses on the endemic, threatened species, indicating gaps in our knowledge, and ongoing management. The basic biogeographical data gathered here are from PINHEY (1984, 1985), from various museum collections and from the unpublished records of the Odonata programme in the Department of Zoology and Entomology, University of Natal, over the past five years.

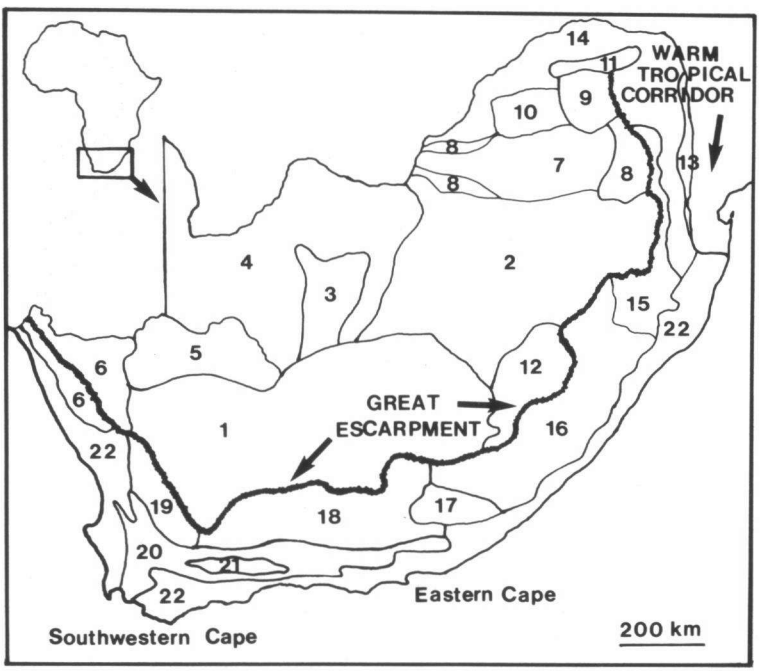

Fig. 1. The 22 physiographic regions of South Africa: (1) Upper Karoo, – (2) Highveld, – (3) Kaap Plateau, – (4) Southern Kalahari, – (5) Bushmanland, – (6) Namaqualand Highlands, – (7) Bushveld Basin, – (8) Bankeveld, – (9) Pietersburg Plateau, – (10) Waterberg Plateau, – (11) Soutpansberg, – (12) Lesotho Highlands, – (13) Lebombo Hills, – (14) Lowveld, – (15) Middelveld, – (16) Eastern Midlands, – (17) Winterberg Mountains, – (18) Great Karoo, – (19) Doring Karoo, – (20) Cape Folded Mountains, – (21) Little Karoo, – (22) Coastal Belt with sub-regions running from northern Natal in the North-East, down through southern Natal, the Transkei, Eastern and Southern Cape, and the Western Cape in the South-West.

SOUTH AFRICAN GEOLOGY AND GEOGRAPHY

In the Triassic, about 200 million years ago, the African landmass formed the central area of the single giant supercontinent Pangea. Then, about 180 m. y. B.P., Pangea split into the northern continent of Laurasia and the southern continent of Gondwanaland. Simultaneously, the southern landmass also split, and by 135 m.y. B.P., the beginning of the Cretaceous, the Indian and the Antarctic/ Australian tectonic plates and moved these landmasses away from Africa, which remained fairly central. Also, at the same time, the split between Africa and South America had started, with the outline of Southern Africa very much as it is today.

Fig. 2. The Drakensberg Mountains of Natal form part of the Great Escarpment, which, because of its size and extent has a major modifying effect on the odonatan fauna in southern Africa.

Since the early Cretaceous, uplifting and erosion has led to the appearance of 22 topographically distinct physiographic regions (Fig. 1). These fall into two distinct groups: the Interior Plateau of 12 regions, and the Marginal Zone of 10 regions. These two groups are divided by the Great escarpment, which is clearly seen in some areas as a majestic wall of rock making up the Drakensberg (Fig. 2).

The Interior Plateau, the southern tip of the much greater African Plateau, is a tableland varying in elevation from about 900 m a.s.l. in the Kalahari desert to 3500 m a.s.l. in the Lesotho Highlands. The thick Karoo sediments of the Carboniferous to Triassic Periods were covered in the Jurassic by thick lava flows, which, on cooling to a hard layer of basalt, protected the underlying softer rocks from weathering, giving rise to the high escarpment and mountains of southern Africa.

The Marginal Zone between the Great Escarpment and the coast varies in width from 60 km in the west to 240 km in the east. Its elevation varies from sea-level to a maximum of 2300 m a.s.l. among the peaks of the Swartberg range in the southern tip of the Cape.

Off the eastern shores, the warm southward-flowing Agulhas Current brings an almost tropical climate to the eastern seaboard. Off the west coast, the Benguela Current flows northwards bringing cold conditions, particularly in winter, to the Cape of Good Hope and the western shores.

These sea currents, along with the topography and global wind patterns, influence the area's rainfall patterns. There are three distinct rainfall regions in southern Africa: summer, winter and all-season rainfall areas. The varied topography and climate has resulted in nine climatic zones.

SPECIES RICHNESS

Below are listed the 153 species recorded to date south of the Limpopo River, excluding Namibia, but including Lesotho and Swaziland, as well as South Africa. All these records are confirmed with specimens. There are three taxonomically doubtful records. Firstly, *Neurogomphus ? vicinus*, the genus of which requires revision, is known to date only from the Kruger National Park, although it does have a wider distribution. Secondly, *Paragomphus dicksoni* is known only from the single female holotype. This is a Cape endemic but may only be a subspecies of the relatively widespread and common *Paragomphus cognatus* (PINHEY, 1985). The third species, *Metacnemis angusta*, is known from only two female specimens, and although probably a good species, could eventually be found to be a form or subspecies of *M. valida*.

Species listed by PINHEY (1984, 1985) as South African, but not yet confirmed south of the Limpopo, include *Lestes ochraceus* Selys (Zimbabwe), *L. pinheyi* Fraser (Botswana), *Chlorocnemis marshalli* Ris (Zimbabwe), *P. sudanicum rubroviride* Pinhey (Zimbabwe), *Enallagma subtile* Ris (Namibia), *Agriocnemis a. angolensis* Longfield (Namibia), *Paragomphus sabicus* Pinhey (Zimbabwe), *Sympetrum navasi* Lacroix (Namibia), *Trithemis monardi* Ris (Namibia), *Rhyothemis notata fenestrina* (Rambur) (Namibia), and *R. mariposa* Ris (Namibia). With further records, any of these could be recorded in the South African area. A few new species may also await discovery. In our collection are specimens of *Agriocnemis* and *Enallagma* that do not agree with any of the published descriptions. Additionally, with few exceptions (e.g. CHUTTER, 1961; CARCHINI et al., 1991), few of the larvae of South African species are adequately described, although a key to the genera is in preparation (B. Wilmot, in preparation).

SPECIES RECORDED IN SOUTH AFRICA TO DATE

Zygoptera

CHLOROLESTIDAE
Chlorolestes apricans Wilmot
C. conspicuus Selys
C. draconicus Balinsky
C. elegans Pinhey
C. fasciatus (Burmeister)
C. tessellatus (Burmeister)
C. umbratus Selys
Ecchlorolestes nylephtha Barnard
E. peringueyi (Ris)

LESTIDAE
Lestes dissimulans Fraser
L. ictericus Gerstaecker
L. pallidus Rambur
L. plagiatus (Burmeister)
L. tridens McLachlan
L. uncifer Karsch
L. virgatus (Burmeister)

PROTONEURIDAE
Elattoneura frenulata (Hagen)
E. glauca (Selys)

PLATYCNEMIDIDAE
Metacnemis valida Selys

M. angusta Selys
Allocnemis leucosticta Selys
Mesocnemis singularis Karsch

COENAGRIONIDAE
Ceriagrion glabrum (Burmeister)
C. suave Ris
Pseudagrion acaciae (Förster)
P. assegaii Pinhey
P. caffrum (Burmeister)
P. citricola Barnard
P. commoniae (Förster)
P. draconis Barnard
P. furcigerum (Rambur)
P. gamblesi Pinhey
P. hageni Karsch
P. hamoni Fraser
P. inconspicuum Ris
P. inopinatum Balinsky
P. kersteni (Gerstaecker)
P. makabusiense Pinhey
P. massaicum Sjöstedt
P. newtoni Pinhey
P. salisburyense Ris
P. spernatum natalense Ris
P. sublacteum (Karsch)
P. umsingaziense Balinsky
P. vaalense Chutter
Ischnura senegalensis (Rambur)
Enallagma elongatum (Martin)
E. glaucum (Burmeister)
E. nigridorsum Selys
E. polychromaticum Barnard
E. rotundipennis Ris
E. sapphirinum Pinhey
E. sinuatum Ris
E. subfurcatum Selys
Agriocnemis exilis Selys
A. falcifera Pinhey
A. gratiosa Gerstaecker
A. pinheyi Balinsky
A. ruberrima ruberrima Balinsky

CALOPTERYGIDAE
Phaon iridipennis (Burmeister)

CHLOROCYPHIDAE
Chlorocypha consueta (Karsch)
Platycypha caligata (Selys)
P. fitzsimonsi (Pinhey)

Anisoptera

GOMPHIDAE
Ictinogomphus ferox Rambur
Gomphidia quarrei (Schouteden)
Lestinogomphus angustus Martin
Notogomphus praetorius (Selys)
Neurogomphus ? vicinus Schouteden
Paragomphus cognatus (Rambur)
P. dicksoni Pinhey
P. elpidius (Ris)
P. genei (Selys)
Onychogomphus supinus Hagen
Crenigomphus cornutus Pinhey
C. hartmanni (Förster)
Ceratogomphus pictus Hagen
C. triceraticus Balinsky
Phyllogomphus brunneus Pinhey

AESHNIDAE
Aeshna ellioti usambarica Förster
A. minuscula McLachlan
A. subpupillata McLachlan
Anaciaeshna triangulifera McLachlan
Anax imperator mauricianus Rambur
A. speratus Hagen
A. tristis Hagen
Hemianax ephippiger (Burmeister)
Gynacantha manderica Grünberg
G. villosa Grünberg
G. zuluensis (Balinsky)

CORDULIIDAE
Syncordulia venator (Barnard)
S. gracilis (Burmeister)
Macromia bifasciata (Martin)
M. monoceros (Förster)
M. picta Hagen
Hemicordulia asiatica Selys

LIBELLULIDAE
Tetrathemis polleni (Selys)
Notiothemis jonesi Ris
Orthetrum abbotti Calvert

O. brachiale (Palisot de Beauvois)
O. caffrum (Burmeister)
O. chrysostigma (Burmeister)
O. guineense Ris
O. hintzi Schmidt
O. icteromelan cinctifrons Pinhey
O. julia falsum Longfield
O. machadoi Longfield
O. robustum Balinsky
O. rubens Barnard
O. trinacria Selys
Nesciothemis farinosa (Förster)
Palpopleura deceptor (Calvert)
P. jucunda Rambur
P. lucia (Drury)
Chalcostephia flavifrons Kirby
Hemistigma albipuncta (Rambur)
Acisoma panorpoides ascalaphoides Rambur
Diplacodes deminuta Lieftinck
D. lefebvrei (Rambur)
Crocothemis divisa Karsch
C. erythraea (Brullé)
C. sanguinolenta (Burmeister)
Bradinopyga cornuta Ris
Brachythemis lacustris (Kirby)
B. leucosticta (Burmeister)
Philonomon luminans (Karsch)
Sympetrum fonscolombei (Selys)
Trithemis aconita Lieftinck
T. annulata (Palisot de Beauvois)
T. arteriosa (Burmeister)
T. donaldsoni (Calvert)
T. dorsalis (Rambur)
T. furva Karsch
T. hecate Ris
T. kirbyi ardens Gerstaecker
T. pluvialis Förster
T. stictica (Burmeister)
T. werneri Ris
Zygonyx natalensis (Martin)
Z. torridus (Kirby)
Olpogastra fuelleborni Grünberg
O. lugubris Karsch
Rhyothemis semihyalina Desjardins
Zyxomma atlanticum Selys
Parazyxomma flavicans (Martin)
Tholymis tillarga (Fabricius)
Pantala flavescens (Fabricius)
Tramea basilaris burmeisteri Kirby
T. continentalis Selys
Urothemis assignata (Selys)
U. edwardsi (Selys)
U. luciana Balinsky
Aethriamanta rezia Kirby
Macrodiplax cora (Brauer)

ASSEMBLAGE PROFILE

The Anisoptera, with 90 species (= 59% of the total), is more species-rich than the Zygoptera, with 63 species (= 41% of the total). There are 11 odonate families in South Africa (Fig. 3). The Libellulidae is by far the dominant family in numbers of species, making up over a third of the fauna. This family together with the other highly dominant one, the Coenagrionidae, account for almost two-thirds of all South African Odonata. In turn, over half of the Coenagrionidae is made up of *Pseudagrion* species (PINHEY, 1964). One or more species of this genus can be found at almost any type of water body throughout the country. Other highly polyspecific genera are *Chlorolestes* (Chlorolestidae), *Lestes* (which makes up the whole of the Lestidae), *Enallagma* and *Agriocnemis* (Coenagrionidae), and *Orthetrum* and *Trithemis* (Libellulidae).

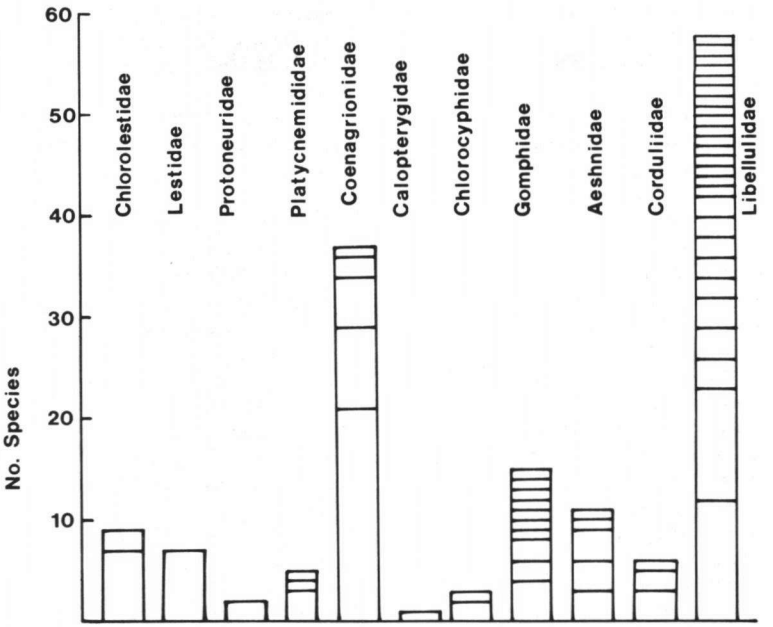

Fig. 3. The 153 South African species fall into 11 families. The horizontal bars in each block illustrate the number of genera in each family.

SPECIES STATUS

MIGRANTS AND PARTIAL RESIDENT BREEDERS

Two species are definite migrants with large swarms having been recorded. *Pantala flavescens* populations vary enormously from year to year, sometimes reaching huge numbers (SAMWAYS & CALDWELL, 1989). *Hemianax ephippiger* occurred in a loose but large migrant swarm flying south-westerly in the Winterton, Natal area on 4th December 1988 (unpublished observations). The two *Tramea* species, but particularly *T. burmeisteri*, often accompany *P. flavescens* feeding swarms, and appear to be partially migratory. Similarly, *Sympetrum fonscolombei* is highly variable in numbers and has regularly been sighted at 2000-2500 m a.s.l. in the Natal Drakensberg mountains, where it apparently does not breed. *Hemicordulia asiatica* has been recorded in South Africa (PINHEY, 1985), and was probably a vagrant. None of these species are of conservation management status in South Africa.

SPECIES OCCURRING ELSEWHERE IN AFRICA THAT ARE WIDESPREAD OR LOCALLY COMMON IN SOUTH AFRICA

Several species are widespread or locally common in South Africa and throughout various parts of Africa: *Lestes pallidus, L. plagiatus, L. virgatus, Elattoneura glauca, Allocnemis leucosticta, Ceriagrion glabrum, Pseudagrion acaciae, P. hageni, P. kersteni, P. massaicum, P. salisburyense, P. spernatum natalense, P. sublacteum, E. glaucum, E. nigridorsum, Ischnura senegalensis, Phaon iridipennis, Platycypha caligata, Ictinogomphus ferox, Notogomphus praetorius, Ceratogomphus pictus, Paragomphus cognatus, Paragomphus genei, Aeshna subpupillata, Anax imperator mauricianus, A. speratus, Macromia bifasciata, Macromia picta, Orthetrum abbotti, O. brachiale, O. caffrum, O. chrysostigma, O. guineense, O. hintzi, O. icteromelan cinctifrons, O. julia falsum, O. trinacria, Nesciothemis farinosa, Palpopleura jucunda, P. lucia, Hemistigma albipuncta, Acisoma panorpoides, Diplacodes lefebvrei, Crocothemis erythraea, C. sanguinolenta, Brachythemis leucosticta, Philonomon luminans, Trithemis arteriosa, T. annulata, T. dorsalis, T. furva. T. kirbyi, T. stictica, Zygonyx natalensis, Z. torridus, Rhyothemis semihyalina, Urothemis assignata,* and *U. edwardsi.*

None of these species is in need of special protection in South Africa.

SPECIES OCCURRING ELSEWHERE IN AFRICA THAT ARE LOCAL OR RARE IN SOUTH AFRICA

This category overlaps with the last, depending very much on which sites and which part of the country are visited. Several species included here are at the tip of their southern range, and as such their populations are in some cases rather fragmented. Locally occurring, more widespread, African species include: *Lestes dissimulans, L. ictericus, L. tridens, L. uncifer, Mesocnemis singularis, Ceriagrion suave, Pseudagrion assegaii, P. commoniae, P. gamblesi, P. hamoni, P. inconspicuum, P. makabusiense, Enallagma elongatum, E. sinuatum, E. subfurcatum, Agriocnemis exilis, A. gratiosa, A. pinheyi, Chlorocypha consueta, Gomphidia quarrei, Lestinogomphus angustus, Neurogomphus ? vicinus, Phyllogomphus brunneus, Crenigomphus cornutus, C. hartmanni, Paragomphus elpidius, Onychogopmhus supinus, Aeshna ellioti, Anaciaeschna triangulifera, Anax tristis* (possibly migratory ?), *Gynacantha manderica, G. villosa, Macromia monoceros, Tetrathemis polleni, Notiothemis jonesi, Orthetrum machadoi, O. robustum, Palpopleura deceptor, Chalcostephia flavifrons, Diplacodes deminuta, Crocothemis divisa, Bradinopyga cornuta, Brachythemis lacustris, Trithemis aconita, T. donaldsoni, T. hecate, T. pluvialis, T. werneri, Olpogastra fuelleborni, O. lugubris, Zyxomma atlanticum, Parazyxomma flavicans, Tholymis tillarga, Aethriamanta rezia, Macrodiplax cora* (possibly migratory ?).

None of these species is of individual conservation concern within South

Africa, but should be given the opportunity to breed in already-established nature reserves. They may, in the future however be of considerable conservation concern as indicators of climatic change.

UNCOMMON SOUTH AFRICAN SPECIES WITH RANGES EXTENDING TO THE NORTH AND WEST

Some species are southern African in a wider sense, having their centers of origin clearly in South Africa, but with ranges extending into Namibia to the north and west, Zimbabwe to the north, and Mozambique to the north and east. These include: *Chlorolestes elegans, Agriocnemis ruberrima, Platycypha fitzsimonsi, Aeshna minuscula, Gynacantha zuluensis* (perhaps Natal, South Africa, is the southernmost part of its range?).

Exept for *G. zuluensis,* which is not a common insect anywhere, the other three species can be common at specific sites. Three of the five species are known to occur in well-established nature reserves: *A. ruberrima* and *G. zuluensis* at St. Lucia, and *A. minuscula* at Cathedral Peak. *P. fitzsimonsi* is in a more vulnerable position as it inhabits fast-running rivers in the Natal Midlands, and is susceptible to increasing silt loads from soil erosion due to overgrazing. *C. elegans* occurs along forested streams in a relatively restricted area in the northern Transvaal.

Elattoneura frenulata is a south and southwestern lowland Cape species which is also known from southwestern Angola, but not from Namibia in between (PINHEY, 1984).

SPECIES INDIGENOUS TO SOUTH AFRICA

Table I lists the 28 endemic species, distributions, biotopes and rarity status. These endemics form 18.3% of the total number of species recorded from the country.

Of the 28 endemic species, only 6 are anisopterans, and one of these (*Paragomphus dicksoni*) is of doubtful species status. This makes, at most, 4% of the South African anisopteran Odonata endemic compared with just over 14% for the zygopterans.

Some of these endemics (e.g. *Chlorolestes tessellatus, Pseudagrion citricola, P. vaalense*) have wide ranges but may or may not be restricted to certain Physiographic Regions or Climatic Zones. *C. tessellatus* is principally associated with Climatic Zone 5 (Plateau slopes), *P. citricola* with several Physiographic Regions and Climatic Zones and *P. vaalense* with Physiographic Region 2 and Climatic Zone 6. Other species occur along the Great Escarpment, particularly in Natal, where it is most pronounced. *Chlorolestes draconicus* is a good example that is highly localized in high altitude streams. *C. fasciatus* is similar but distinctly

Table I

Odonata species indigenous to South Africa, with their distribution, biotopes and rarity status

Species	Distribution	Biotope	Status
Chlorolestes apricans	E. Cape	Open sedge and reed beds	Locally common, but with a restricted range
C. conspicuus	SW. Cape	Montane streams and pools	Locally common, but restricted range. Occurs in a protected area (Table Mountain)
C. draconicus	Natal Drakensberg	Partly wooded montane streams and pools	IUCN Category 'R', occurring in a few remote mountain streams in protected areas (Royal Natal National Park, Mzimkulu Wilderness Area)
C. fasciatus	Natal Drakensberg	Open mountain streams and pools with overhanging vegetation	Locally abundant, but restricted range. occurs in protected areas (e.g. Mlambonja and Mzimkulu Wilderness Areas)
C. tessellatus	Coastal Cape (S & SE), Natal	Shaded, semi-montane streams and pools	Locally common in appropriate biotope. Occurs in many small parks and reserves (e.g. Queen Elizabeth Park, Pietermaritzburg)
C. umbratus	SW Cape	Montane pools and streams	Locally common
Ecchlorolestes nylephtha	SW Cape	Little known, probably forest	Extremely rare species, IUCN Category 'E'. Possibly occurs in the protected area of Tzitzikama forest
E. peringueyi	SW Cape	Open streams with rocks and edged with bushes	IUCN Category 'E'. A rare and little known species
Metacnemis valida	SW Cape	Fairly fast flowing streams and rivers	Locally abundant
M. angusta	SW Cape	Not known	IUCN Category 'I', but this requires revision on further field work
Pseudagrion caffrum	Cape, Natal	Small, shallow, sunlit, montane streams	Locally abundant. Occurs in many preserved rain catchment areas (e.g. Mlambonja Wilderness Area)

Table I (continued)

Species	Distribution	Biotope	Status
P. citricola	Cape, Natal, Transvaal	Sluggish streams and pools in upland regions	Widely scattered localities. Locally common. Has been recorded at Giant's Castle Reserve
P. draconis	SW Cape	Streams and pools at fairly low altitudes (200-500 m a.s.l.)	Locally abundant
P. furcigerum	SW Cape	Pools and streams at various altitudes (50-800 m a.s.l.)	Locally abundant and widespread
P. inopinatum	E Transvaal	Biotope unrecorded, although known to be montane	Very few specimens in existence, none of which are from a reserve
P. newtoni	E Cape, Transkei, Natal	Biotope unrecorded, although apparently wide altitudinal tolerance (20-1200 m a.s.l.)	Highly localized over a wide area. No specimens have yet been recorded from a nature reserve
P. umzingaziense	Only recorded from 2 widely separated localities: Umsingazi Lake area in Natal en Ellisras in the Transvaal	Marshy areas	The Umsingazi Lake is protected but there is considerable urban development surrounding the lake. The Ellisras locality requires confirmation.
P. vaalense	Various central parts of S. Africa, incl. Cape, Orange Free State, Transvaal, Lesotho	Over strong, fast currents, ♀ settling on supports far from the banks	Locally common and at present under no threat
Enallagma polychromaticum	SW Cape	Among reeds at pools	IUCN Category 'I'. A highly localized species that has not been recorded since 1962
E. rotundipennis	Natal, Transvaal, Lesotho	Unrecorded	Widely scattered, isolated localities
E. sapphirinum	Natal, Orange Free State, Transvaal	Small streams and among sedges at the edge of large dams	Locally common in widely scattered localities
Agriocnemis falcifera	Natal, Transvaal	Among bush and long grass in Natal, and forest in the Transvaal	Locally common at isolated sites
Paragomphus dicksoni (uncertain whether this is a good species)	SW Cape	Unknown	Only one specimen known

Table I (continued)

Species	Distribution	Biotope	Status
Ceratogomphus triceraticus	SW Cape	Edge of pools and slow streams	Highly local, few localities known
Syncordulia venator	SW Cape	Montane streams	Locally common, restricted range
S. gracilis	Cape, Natal	Montane streams	Very rare and localized
Orthetrum rubens	SW Cape	Uncertain, but seen flying on mountain slopes.	IUCN Category 'V'. A very rare and localized endemic
Urothemis luciana	Natal	Adults fly around bushes and trees adjacent to Lake Umsingazi	IUCN Category 'V'. Extremely localized, occurring at one locality

more widespread and locally abundant. *Pseudagrion caffrum* occurs along the Great Escarpment, down through Natal to the Cape. Both *P. citricola* and *P. inopinatum* also have north-south strip distributions influenced by the Great Escarpment, with their ranges principally falling within Physiographic Regions 15, 16, 17 and Climatic Zone 5. Among the anisopterans, *Syncordulia gracilis* appears to have a similar geographic response.

Two of the *Enallagma* species, *E. rotundipennis* and *E. sapphirinum* are upland species that have ranges extending either side of the Great Escarpment, rather wider than originally proposed by BALINSKY (1967). A similar situation occurs with *Agriocnemis falcifera*, but interestingly there are two different subspecies either side of the Great Escarpment.

Pseudagrion umsingaziense also occurs either side of the Escarpment but only one specimen has been recorded on the Interior Plateau of the Transvaal, yet it is highly local but common at Lake Umsingazi at sea level near the coast in Physiographic Region 22 NN (Coastal Belt, Northern Natal). At this same site is the highly localized and threatened *Urothemis luciana*.

The remaining species are Cape endemics. Only *Chlorolestes apricans* and *Metacnemis valida* are southeastern Cape endemics. *Chlorolestes conspicuus, C. umbratus, Ecchlorolestes nylephtha, E. peringueyi, Metacnemis angusta, Pseudagrion draconis, P. furcigerum, Enallagma polychromaticum, Paragomphus dicksoni, Ceratogomphus triceraticus, Syncordulia venator,* and *Orthetrum rubens* are all southwestern Cape endemics. Southeastern and southwestern Cape endemics together form just over 9% of the total South African odonatan fauna.

THREATENED SPECIES

The IUCN (The World Conservation Union) recognizes several categories of threat. Of relevance to the threatened South African dragonflies are the categories:

Endangered ('E'). – Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included are taxa whose numbers have been reduced to a critical level, or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction. Also included are taxa that are possibly already extinct, but nevertheless have been seen in the wild within the past 50 years.

Vulnerable ('V'). – Taxa believed likely to move into the Endangered category in the near future if the causal factors continue operating. Included are taxa of which most or all of the populations are decreasing because of over-exploitation, extensive destruction of their habitat or other environmental disturbances. It also includes taxa with populations that have been seriously depleted and whose ulitmate security has not been assured, and taxa with populations which are still abundant but are under threat from severe adverse conditions throughout their range.

Rare ('R'). – Taxa with small world populations that are not at present Endangered or Vulnerable, but nevertheless are at risk. These are usually localized taxa with restricted geographical areas or habitats, or are thinly scattered over a more extensive range.

Intermediate ('I'). – Taxa that are known to be Endangered, Vulnerable or Rare, but where there is not enough information to say which of these three categories is appropriate.

The 1988 IUCN Red List (IUCN, 1988) lists five highly localized Cape endemics. *Orthetrum rubens* (Category 'I') is erroneously listed as occurring in 'Tropical Africa'. The other four species are *Ecchlorolestes nylephtha* ('E') (sic *E. nylepytha*), *E. peringueyi* ('E'), and *Enallagma polychromaticum* ('I'). The 1990 IUCN Red List (IUCN, 1990) adds *Chlorolestes draconicus* ('R') (BALINSKY, 1956) and *Urothemis luciana* ('V'). *C. draconicus* is known only from three localities to date. All these localities are high up (± 1700 - 2300 m a.s.l.) in the Great Escarpment (the Natal Drakensberg), and one locality is in the Royal Natal National Park and the others are in a protected water catchment area, the Mzimkulu Wilderness Area. This species, although extremely localized, appears to be well-protected.

The other recent addition to the 1990 Red List, *U. luciana*, has not been seen since 1959 (BALINSKY, 1961). It is a lowland species, the few adults of which have been recorded flying close to Lake Umsingazi, northern Natal. The lake is freshwater and is protected as a reservoir for domestic water supply for the nearby rapidly growing port of Richards Bay. The species is vulnerable because of extensive and rapid housing development in the area.

CATEGORIES OF THREATS

Of the 153 species of South African Odonata, seven are listed as threatened (4.6%). Few other insect groups in this geographical area have been assessed in this way, owing to the great insect diversity of the area. There are about 80,000 described species of insects in southern Africa (PRINSLOO, 1989), representing probably only about 25% of the actual total. One group that has already been assessed is the butterflies (Papilionoidea and Hesperioidae) of which 16% are under some form of threat (HENNING & HENNING, 1989).

At this stage in our knowledge, it is difficult to determine the exact threats to the rare and endemic species. Fortuitously, most occur in montane, rain-catchment

areas that are protected wilderness areas. Several are also known to occur in nature reserves. Possibly the most directly vulnerable species is *Urothemis luciana*, which occurs in the rapidly urbanizing Richards Bay area.

For most of the species, a much more detailed appraisal of their rarity status is required. This is a difficult task for a country the size of South Africa, with so few practising odonatologists. Further searches are more likely to give an optimistic view of Odonata conservation. With due consideration to some of the taxonomic problems associated with a few isolated specimens, which may or may not be good species, the local threats are likely to be less than appears at present. One of the reasons also is that as South Africa is a generally arid country, water bodies are generally well protected, and creation of artificial water bodies is known to be highly beneficial in increasing the overall geographical density of many species (SAMWAYS, 1989a).

The greatest threats in the long-term are global influences. By the year 2050 the earth's temperature overall may be 3°C higher with little change at the equator, but the poles may be 7°C warmer (PEARMAN, 1988). South Africa may be generally warmer and drier, and as soil conditions may be 11-18% drier (HUNTLEY et al., 1989; TYSON, 1990) there may well be increasing silt loads in the streams and rivers. The endemic Cape species may be particularly affected. Additive upon these general effects will be an increase in inclement conditions such as droughts, hailstorms and hurricanes. Some South African species, however, appear to be remarkably well-adapted to flood conditions, with populations recovering remarkably quickly (SAMWAYS, 1989b). Others, not particularly of conservations status, e.g. *Pantala flavescens*, *Tramea* spp. and *Ischnura senegalensis* are particularly quick to utilize temporary water bodies (pans) (BRINCK, 1955).

Adding further stress will be the growing hole in the ozone layer of the stratosphere over the South Pole, with depletion in parts of up to 45-50% (BRUNKE, 1988; SCOURFIELD et al., 1990). South Africa, with its southerly geographical position, is likely to be particularly affected by the increased levels of ultraviolet radiation. These global changes will be compound and the effects unpredictable at this stage, but physiological stress on plants at the edge of their ranges is likely to be great (PARSONS, 1990). This might well have a cascade effect throughout ecosystems, affecting all biotic components, particularly predators such as Odonata.

Many of the South African species are of fairly wide African distribution and extend down the eastern seaboard e.g., *Anax tristis*, *Tetrathemis polleni*, *Trithemis hecate* etc. (BRINCK, 1955; SAMWAYS, 1989c). With global warming and the adjacent Drakensberg, it is likely that they may in the future be seen at higher altitudes. Of particular concern however, are the montane endemics. Temperature falls by 0.6°C for every 100 m rise in altitude, which suggests that to maintain the same local thermal environment, species must move up the mountainside by

at least 500 m by the middle of the next century. For species such as *Chlorolestes draconicus* this may leave them with no suitable habitat on the sheer and massive wall of the Drakensberg Escarpment.

CONSERVATION MEASURES

Apart from the threats of general global impacts, most dragonflies are automatically protected by wilderness areas, nature reserves and farm dams. However, overall general abundance has inevitably declined as wetlands, for example, in Natal have been reduced to a few scattered remnants (leaving less than 10%) since commencement of mechanized agriculture (BEGG, 1986).

Wetlands within nature reserves and rivers running through reserves, particularly the major reserve area of the Kruger National Park, are being monitored closely from a physico-chemical perspective. The dragonfly fauna of the southern Kruger National Park and of the nature reserves throughout Natal is being undertaken. Conservation measures are therefore an intrinsic part of wetland management at this stage, and far more information is required on the distribution status of the rare species.

The only project underway that is specifically designed to encourage the overall dragonfly assemblage, is the development of an aesthetically-pleasing and habitat-varied dragonfly reserve as part of the creation of a wetland habitat within the National Botanic Gardens, Pietermaritzburg (SAMWAYS, 1989d). This follows the lead of Japan in particular (MOORE, 1987; SUGIMURA, 1989). Besides building up of distributional resources, much more information is required on habitat preferences of both adults and larvae. In the case of the larvae, keys for recognition are required. A key is available to the generic level (B. Wilmot, in preparation), but the larvae of many species are yet to be comprehensively described.

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