

Odonata collected in the Ankarafantsika National Park, Madagascar

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Abstract

Records of 33 species of Odonata from Ankarafantsika National Park are presented. Four additional species have been reported in the literature. Nineteen species are recorded from the site for the first time. The site is the largest remaining block of dry forest in Madagascar's Western Region. While 80% of Madagascar Odonata species are endemic, only 40% of the species recorded in Ankarafantsika is endemic. Moreover, the endemics recorded are mostly common throughout the island. The dry forests are thus of relatively little importance for Madagascar's diversity of Odonata.

Introduction

Odonata of Madagascar

Madagascar is home to a large diversity of Odonata. Summing up all reported species from numerous sources, 173 species of Odonata were described so far. Three quarters of the genera and a fifth of the species are shared with continental Africa, the remainder being endemic. Four species are also found in nearby archipelagos. Of the 80 species of Anisoptera, 60% is endemic. No less than 94% of the 93 species of Zygoptera is endemic. The difference between the suborders is explained by the superior dispersal capacity of the Anisoptera. The number of occurring species should be around 200 (García & Dijkstra, unpubl. estimate), including both undiscovered colonists from the continent and endemic forms. The fauna shows clear affinities to that of tropical Africa. Despite this, taxa well-represented in continental Africa, such as Calopterygidae, Chlorocyphidae, Protoneuridae and Macromiinae, are not or very poorly represented. On the other hand, the families Megapodagrionidae, Platycnemididae and Corduliidae are more diverse here than on the continent.

The species endemic to Madagascar can roughly be separated into two groups. One group (about a fifth of the species), is composed of species with close relatives on the African mainland. They are probably derived from recent arrivals of savannah species, which have good dispersal capacity. Examples of such "new endemics" are *Gynacantha hova*, *Hemistigma affine* and *Zygonyx elisabethae*, close relatives of continental African *G. manderica*, *H. albipunctum* and *Z. natalensis* respectively. These species probably occur all over the island in open, often anthropogenic, habitat. The other group (the remaining four-fifths) is composed of species with few or no close relatives on the African mainland. Many of these species belong to (near-)? endemic genera and are restricted to rainforest habitat. These old endemics include the radiations of genera like *Pseudagrion* and *Platycnemis*, the species being dissimilar to congenics on the continent. They have "relatives" in the same genera on the African continent, but appear not to be closely related and are probably old, monophyletic radiations endemic to the island.

Odonatology of Madagascar

The study of the Odonata of Madagascar began with Rambur (1842), who described twelve species now known from the island, nine of which are endemic. These included some of the earliest described tropical dragonflies.

All the great odonatologists of the late 19th and early 20th century, Förster, Karsch, Kirby, McLachlan, Martin, Ris, Selys and Sjöstedt, made small contributions between 1872 and 1917. The next episode of Malagasy odonatology was to begin with the publication of Schmidt's revision of the Zygoptera in 1944, but the entire edition was destroyed by fire during the bombardment of Neubrandenburg in 1945 by the Soviet Army (Schmidt 1966). Not until 1951 was his work to appear in an English translation of the proofs produced by Fraser. Dissatisfied with the result, Schmidt republished the work in German in 1966. Fraser himself published numerous papers between 1948 and 1962, including a monograph of the Anisoptera in 1956. Aguesse (1967; 1968), Lieftinck (1963; 1965) and Pinhey (1964) published some taxonomic papers, mainly on damselflies. The Odonata of Madagascar have been practically neglected since the 1960s, besides five new species descriptions (Cammaerts 1987; Gauthier 1988; Legrand 1992; 2001; Lohmann 1980) and a few faunistic notes (e.g. Carfi & Terzani 1991).

In summary, there has been no comprehensive treatment of the fauna since the monographs of Fraser (1956) and Schmidt (1951; 1966). Since those times extensive stretches of forest have been cleared. On the other hand, progress has been made in the conservation of forest and protected areas have been created. It is important to know how the island's unique fauna has fared since and whether it has profited from these measures. The study presented here provides data from the largest remaining area of dry Western forest.

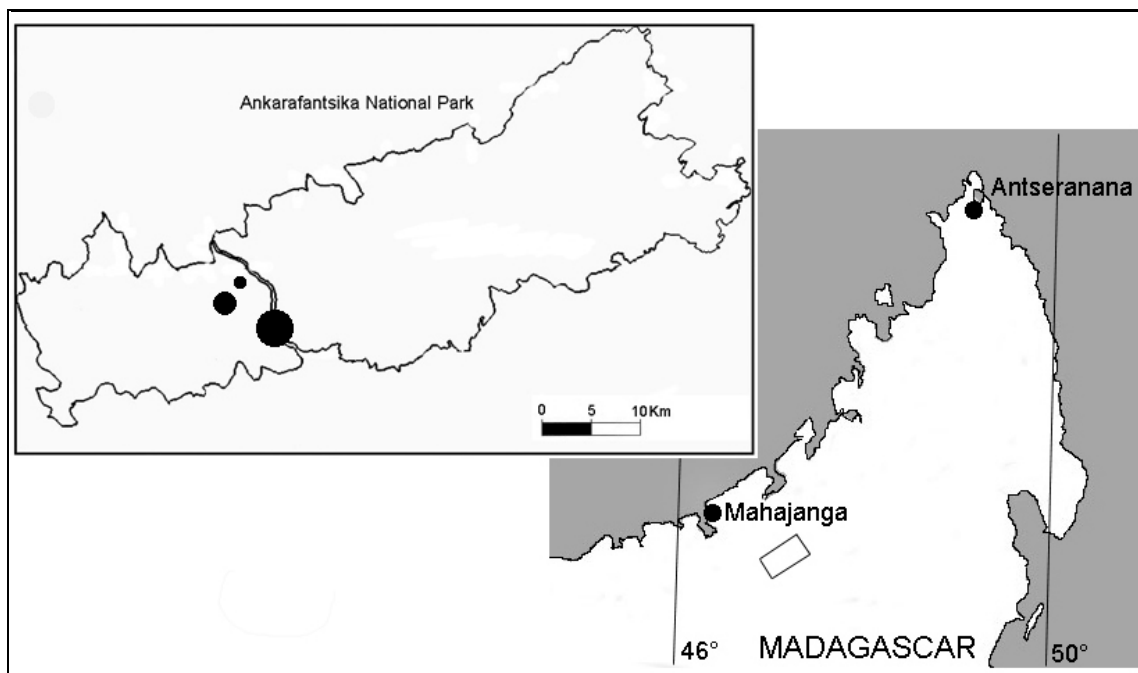


Figure 1: Map of the Ankarafantsika National Park. The black dots indicate the collection sites.

Ankarafantsika National Park

The Ankarafantsika National Park, originally known as the Complex of Protected Areas in Ankarafantsika (CAPA), is situated in NW Madagascar (Fig.1), in the Marovoay and Ambato-Boeni regions of Mahajanga province ($16^{\circ}00' - 16^{\circ}20'S$, $49^{\circ}15' - 49^{\circ}91'E$). The total area of the Park is 135,800 ha. This consists of a 65,000 ha of Integral Natural Reserve (RNI), a 70,000 ha Forest Reserve (RF), and a 800 ha Forest Station (SF) at Ampijoroa within the RF (Conservation International 1999). The National Road N^o.4 (RN4) cuts through the CAPA from north to south, connecting Andranofasika and Marosakoa villages. In May 2001, the areas incorporated in CAPA were designated as the Ankarafantsika National Park.

The Park is bounded by the Mahajamba watershed (NE), the Betsiboka tributary (SW), the Marovoay plain (NW), and the steep cliffs of the Ankarafantsika massif (SE). To the north, the Park is bordered by the Bongolava Classified Forest (FC) (50,300 ha), and to the south by buffer zones (9,000 ha). The FC, established on 2 February 1961, permits some extractive practices, but agriculture and human settlement are forbidden.

The area provides the main water supply for the Marovoay Plain, Madagascar's second largest rice growing region after Lake Alaotra. In addition to the 40,000 people directly dependent of the rice production in the plain, the Ankarafantsika massif provides the water resources to about 25,000 people living around the area. The regional hydrology is characterised by heavy rains and severe floods, provoking the deterioration of riverbeds. The area includes more than 35 rivers and lakes. The mean annual rainfall is 1482.5 mm. The mean annual temperature is 28° C, with a mean maximum of 30° C and a mean minimum of 19° C (Figure 2). Relative humidity is higher from November to March and then decreases until October.

Previous records from Ankarafantsika National Park

The earliest records from the Ankarafantsika area were published by Sjöstedt (1917), who reported on the collections of Dr. W. Kaudern. He travelled around the island in 1911-1912, going from Mahajanga to Sainte Marie de Marovoay, a rubber farm on the Ankarafantsika Plateau. Fraser (1949; 1956) included specimens taken by Jacques Millot in the Ankarafantsika Forest on 4 August 1947. Lieftinck (1963; 1965) examined material obtained by Dr. Fred Keiser, who visited Ankarafantsika on 18 June 1958. The collected Anisoptera of that expedition, with the exception of the genera *Crocothemis* and *Zygonyx*, have never been published.

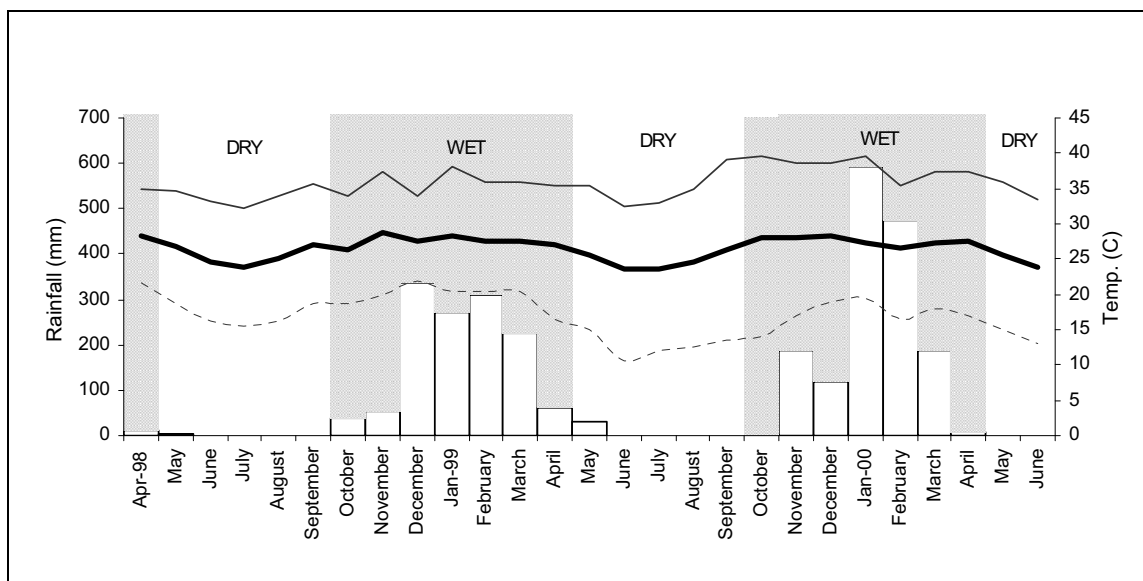


Figure 2: Rainfall and temperatures in Ankarafantsika NP during the study period. Bars: rainfall; thick line: average temperature; continuous line: maximum temperature and discontinuous line: minimum temperature.

Methods

Collection sites

All collection sites are within the Ankarafantsika National Park (Mahajanga Province).

Ambarindahy, 16 km N of Amboromalandy:

A1: Ankorovoka River at Lake Antsilomba (16°16'18.0"S 46°43'35.1"E and 16°16'25.2"S 46°43'04.3"E). 9 - 10 March 2001. The river is a tributary of the Antsilomba River (locally called Vavaron Belafrika) that comes from the forest of Belafrika and crosses Andranovaka village. In 1984 a cyclone destroyed this entire area. The sandy forest and riverbank sediments were deposited in the river. Before this catastrophe the river was bordered along its length by *Raphia farinifera* palms, but these were washed away. The newly created habitat consists of shallow water with a substrate of mud and sand. The vegetation mainly consists of *Phragmites mauritanicus*, *Typhonodorum lindleyanum*, *Cyperus papyrus*, *Ficus* sp., ferns, and some *Raphia farinifera* that survived at some distance of the river bank.

A2: Lake Antsilomba (16°16'25.2"S 46°43'04.3"E). 10 March 2001. The lake lies in the NW of the National Park and has a area of 7 ha. It is surrounded by some forest and by savannah, which is burnt regularly for grazing.

A3: Savannah (16°15'10.6"S 46°43'23.7"E). 8 March 2001. Continuous bush fires, exploitation of forest products (like wood) and grazing by cattle have left only bushes, grass and patches of secondary forest.

Ambodimanga, 2 km N of Andranofasika:

B1: Rice fields (16°18'45.2"S 46°48'54.2"E). 3 March 2001.

B2: Between Ampijoroa and Ambodimanga, Route National 4 (16°18'45.2"S 46°48'54.2"E). 25 & 27 February 2001.

Ampijoroa, 4 km N of Andranofasika:

C1: Captive Breeding Project *Erymnochelys* (16°18'45.2"S 46°48'54.2"E). 5 March 2001. Concrete ponds built for breeding of freshwater turtles. Water and aquatic vegetation is present permanently.

C2: Forest Station (16°18'45.2"S 46°48'54.2"E). 25 February 2001. Secondary forest with small seasonal ponds, close to the Lake Ravelobe and Ambavan Ampijoroa River.

C3: Jardin Botanique A (16°18'45.2"S 46°48'54.2"E). 20 - 25 February 2001. Botanical garden of 31 ha near the forestry station of Ampijoroa. Surrounded by forest.

- C4: Lake Ravelobe (16°18'41.1"S 46°49'21.4"E). 24 February 2001. The lake lies between the villages of Ambodimanga and Ampijoroa and in front of the Forest Station. It is 2 km long and 500 m wide. The Ambavan Ampijoroa River flows into the lake. A dam (rebuilt in 1995/96) regulates the flow of water to rice fields in the Marovoay Plain, resulting in lake level fluctuations of up to 2 m.
- C5: Route National 4 (16°18'45.2"S 46°48'54.2"E). 25 February 2001. The road cuts through the Park from South to North, running parallel to the Ambavan Ampijoroa River. Temporary ponds and swamps are found along the road as a result of modifications of the riverbed for rice cultivation.
- C6: Pond (16°18'45.2"S 046°48'54.2"E). 3 – 5 March 2001. Seasonal pond, approximately 2 m deep and 25 m in diameter during the wet season. Lake Ravelobe flows over into the pond during high water levels.

Between Ampijoroa and Ampombolava, 8.5 km N of Andranofasika:

- D: Ambavan Ampijoroa (16°18'45.2"S 46°48'54.2"E). 4 – 7 March 2001. The river has its source in the forests North of Andranofasika village and flows into Lake Ravelobe. Where it leaves the lake it is followed by the RN4. The river passes several villages that lie along this road (Ampombolava, Ambikakely and Betofoana). Its level depends on the demand for water in the rice fields in Marovoay Plain, but these changes in level are less marked than in Lake Ravelobe.

All specimens were captured during the day with a butterfly net. The samples were immediately stored in envelopes. Photographs were taken of almost all specimens in order to facilitate future identification. A day after capture, and giving enough time for the dragonflies to defecate, they were preserved using acetone. Material was mainly identified using Fraser (1956), Schmidt (1951) as well as other titles listed under references.

Results

The 164 specimens collected belonged to 33 species. Each species is discussed below. An indication is given whether there are previous records from Ankarafantsika Forest (AF), or the Western Region (WR) in which it lies. Where relevant, records from the adjacent, drier South-western Region (SWR) are mentioned.

Phaon iridipennis (Burmeister, 1839)

No new records.

Known throughout tropical Africa and Madagascar. Recorded from AF by Fraser (1949), who described these specimens as *Phaon rasoberinae*. That taxon was synonymised with *iridipennis* by Lieftinck (1965). That species had previously been recorded by Sjöstedt (1917) from Majunga.

Lestes cf. ochraceus Selys, 1862

D: 1 female.

Widespread throughout tropical Africa and Madagascar. Formerly regarded as the endemic species *L. unicolor* McLachlan, 1895, which was made a subspecies of *ochraceus* by Pinhey (1980). Recorded from AF by Sjöstedt (1917), six additional WR sites listed by Lieftinck (1965) and Schmidt (1951).

Lestes simulator McLachlan, 1895

C6: 7 males.

Widespread endemic. New for WR, although reported from Andranohinaly in SWR by Schmidt (1951).

Agriocnemis exilis Selys, 1872

B1: 1 male.

Known throughout tropical Africa, Madagascar and the Mascarenes. New for AF, although Lieftinck (1965) listed two WR localities.

Azuragrion kauderni (Sjöstedt, 1917)

A1: 2 females, C1: 1 male, 2 females, C6: 3 males, 1 female.

Widespread endemic, also occurring on the Comoros. Formerly regarded a subspecies of *A. nigradorsum* (Selys, 1876) (May 1997). Recorded from AF by Lieftinck (1965), as well as from six other (S)WR localities (Lieftinck 1965; Schmidt 1951).

Ceriagrion auritum Fraser 1951

D: 1 tandem.

Endemic. This species has not been reported since the description of a single male from Behara (WR) (Fraser 1951), but probable specimens have been collected throughout Madagascar (pers. comm. S. Dunkle and M.J. Parr). The species is close to *C. suave* Ris, 1921 from the mainland, but has a relatively long inferior appendages and a distinctive penis.

Ceriagrion glabrum (Burmeister, 1839)

B2: 1 tandem, C6: 3 males, 1 female.

Known throughout tropical Africa, Madagascar, the Mascarenes and Seychelles. Recorded from AF by Fraser 1949 (the locality name ForÍt de l'Ankarafantsy being spelled incorrectly), with additional WR sites given by Grünberg (1917), Lieftinck (1965) and Schmidt (1951).

Ischnura senegalensis (Rambur, 1842)

C1: 1 female.

Widespread in Old World tropics. New for AF, although known from two WR and one SWR site (Grünberg 1917; Lieftinck 1965).

Pseudagrion malgassicum Schmidt, 1951

A1: 1 female, C3: 1 female, D: 4 males, 5 females.

Widespread endemic. Recorded from AF (Fraser 1949) and two more WR sites (Pinhey 1964). Pinhey (1964) also studied more females than males (11:23). Normally random sampling of *Pseudagrion* leads to a surplus of males. Perhaps this is an indication that females do not wander from the breeding habitat in the degree of other species of the genus (as is known in some *Agriocnemis* and *Ischnura* species)

Pseudagrion punctum (Rambur, 1842)

D: 1 tandem.

Widespread endemic, also occurring in the Mascarenes. Appears to be rather local in Madagascar, while it is abundant on Mauritius (Pinhey 1962). New for WR.

Platycnemis malgassica Schmidt, 1951

C6: 1 male, 2 females, D: 5 males, 6 females.

Widespread endemic. Recorded from AF by Fraser (1949) and from another WR site by Lieftinck (1965).

Anax tristis Hagen, 1867

C6: 1 female and exuviae.

Known throughout tropical Africa, Madagascar and the Comoros. New for AF, the only previous site in WR where the species was known from is Majunga (Sjöstedt 1917).

Anax tumorifer McLachlan, 1885

A2: 1 male.

Widespread endemic. New for AF, only WR site thus far being Namoroka (Fraser 1956).

Onychogomphus aequistylus Selys, 1892

No new records.

Localised endemic. Reported from AF by Fraser (1956).

Acisoma panorpoides Rambur, 1842

C3: 1 female, D: 1 male.

Widespread in Old World tropics. New for AF, but listed from WR by Grünberg (1917).

Aethriamanta rezia

B2: 1 male.

Known throughout tropical Africa and Madagascar. New for WR.

Brachythemis leucosticta (Burmeister, 1839)

B2: 1 male.

Known throughout tropical Africa, and Madagascar, reaching southern Europe. New for WR.

Crocothemis erythraea (Brull , 1832)

A1: 4 males, 2 females, B2: 3 males, 4 females.

Known throughout tropical Africa, Madagascar and the Comoros, reaching into Europe and West Asia. Recorded from AF by Fraser (1949; 1956) and Sj stedt (1917), as well as from other WR sites by these authors and Gr nberg (1917).

Diplacodes lefebvrii (Rambur, 1842)

A1: 4 males, 4 females, B2: 2 females, C2: 1 female, C3: 1 male, C4: 2 males, C5: 1 male, C6: 3 males.

Known throughout tropical Africa, Madagascar, the Mascarenes and Seychelles, reaching into Europe and West Asia. New for AF, although listed from numerous WR localities by Fraser (1956), Gr nberg (1917) and Sj stedt (1917).

Hemistigma affine (Rambur, 1842)

A1: 1 male, 1 female, B2: 1 male, C3: 1 male, 2 females, C6: 5 males, 3 females.

Widespread endemic. Recorded from AF and other WR localities by Fraser (1949; 1956). *Hemistigma* is a neuter (pers. comm. R. J dicke), hence the specific epitheton should be *affine*, not *affinis*.

Neodythemis hildebrandti Karsch, 1889

A1: 2 females.

Widespread endemic. New for AF, but recorded from two WR sites by Fraser (1956). One female has darkened wingtips, a variation also mentioned by Sj stedt (1917).

Orthetrum abbotti Calvert, 1892

A1: 3 males, D: 1 male.

Widespread throughout tropical Africa, extending into the Middle East. The endemic subspecies *malgassicum* Pinhey, 1970 is very distinctive from the mainland form, being larger and having stronger, differently configured facial markings (already apparent in teneralis). This taxon may deserve species status. Mentioned from AF by Sjöstedt (1917) and the WR by him and Grünberg (1917).

Orthetrum azureum (Rambur, 1842)

C: 1 male.

The nominate subspecies is a widespread endemic, the subspecies *lugubre* Ris, 1915 occurs on the Comoros. New for AF, the only previous WR record is given by Grünberg (1917).

Orthetrum lemur Ris, 1909

A1: 4 males, A3: 1 female, B2: 1 male.

Widespread endemic. Listed by Fraser (1949, 1956) for AF and by him and Grünberg (1917) for other (S)WR localities. On maturity, males differ from most African *Orthetrum* species by the entirely black labium, labrum and frons (only the clypeus remaining as a pale facial band). Female is diagnostic by what Pinhey (1970) calls “interlacing black bands” (not distinct lines) on thorax.

Orthetrum stemmale (Burmeister, 1839)

A1: 1 males.

The nominate subspecies is known throughout tropical Africa, Madagascar, the Comoros and the Mascarenes, while the subspecies *wrighti* occurs in the Seychelles. New for AF and possibly new for WR, as previously confused with *O. brachiale* (Beauvois, 1805) (Pinhey 1970; Pinhey 1979) which was recorded from WR by Fraser (1956) and Grünberg (1917). Insular records of *O. brachiale* still await confirmation.

Palpopleura lucia (Drury, 1773)

C5: 1 female.

Widespread in tropical Africa, Madagascar and the Comoros. New for AF, but recorded from WR by Grünberg (1917).

Palpopleura vestita Rambur, 1842

No new records.

Reported from AF by Fraser (1956) and from three more (S)WR sites by him and Grünberg (1917).

Pantala flavescens (Fabricius, 1798)

A1: 1 female, C5: 1 male.

A nearly cosmopolitan species, absent only in polar areas and Europe. New for AF, but known from three WR sites (Fraser 1956; Grünberg 1917).

Rhyothemis semihyalina (Desjardins, 1832)

B2: 1 male, C1: 2 males, C5: 3 males, 2 females, C6: 3 males, 1 female, D: 1 male.

Known throughout tropical Africa, Madagascar, the Mascarenes and Seychelles. Mentioned for AF by Sjöstedt (1917) and other WR sites by Fraser (1956) and Grünberg (1917).

Tetrathemis pollenii (Selys, 1869)

C6: 1 male, D: 1 male.

Known throughout tropical Africa and Madagascar. New for AF, but recorded from WR by Fraser (1956).

Thobymis tillarga (Fabricius, 1798)

A1: 1 female, C4: 2 females, D: 1 male.

Widespread in Old World tropics. Recorded from AF by Fraser (1949; 1956).

Tramea limbata (Desjardins, 1832)

C6: 2 males.

Known throughout tropical Africa, Madagascar, the Mascarenes and Seychelles. Various geographical forms have been described, which have given specific value by some authors, but no taxonomic value at all by others. This is a wide-ranging wandering species and we agree with Ris (1913) and Schneider & Dumont (1997) that insular and continental forms are unlikely to be specifically distinct, hence the name *limbata* takes priority. Recorded from AF by Sjöstedt (1917).

Trithemis annulata (Beauvois, 1805)

B2: 2 males.

Known throughout Africa, Madagascar, the Mascarenes and reaching southern Europe and the Middle East. New for AF, but recorded from six WR sites by Fraser (1949, 1956), Grünberg (1917) and Sjöstedt (1917).

Trithemis selika (Selys, 1869)

A1: 4 males, 3 females, A2: 1 female, B1: 1 male, B2: 1 female, C1: 1 male, C3: 1 male, 1 female, D: 2 males, 1 female.

The nominate subspecies is a widespread endemic, while the subspecies *maia* occurs on the Comoros. ”This species is apparently the dominant one of the genus in Madagascar” according to Fraser (1949). Recorded from AF by Fraser (1949; 1956) and other (WR and SWR localities by him and Grünberg (1917). This species has a bright pink-red, almost magenta, colour. This, and the lack of plum-like pruinescence, distinguishes it from *T. annulata* on the wing.

Urothemis assignata (Selys, 1872)

C6: 1 male.

Known throughout tropical Africa and Madagascar. New for AF, but recorded from the WR by Fraser (1956) and Sjöstedt (1917).

Zygonyx elisabethae Lieftinck, 1963

D: 2 males.

Widespread endemic. New for the WR. Lieftinck (1963) compared this species with *Z. hova* (Rambur, 1842), but it seems especially close to the widespread mainland species *Z. natalensis* (Martin, 1900). *Hova* has much more in common with another widespread mainland species, *Z. torridus* (Kirby, 1889). Our *elisabethae* males differ from *natalensis* from Kenya by the postclypeus being marked with black in middle, not all yellow. The superior appendages are slightly longer and thicker terminally. Accessory genitalia appear essentially the same. *Natalensis* males from Ghana are relatively even paler, but have appendages similar to those of *elisabethae*.

Zygonyx ranavalonae Fraser, 1949

No new records. Localised endemic. Listed from AF and two other WR sites by Fraser (1949, 1956).

Discussion

Diversity

37 species have been found in AF, 33 of which were found in this study. Nineteen were recorded from AF for the first time. About 80% of the Odonata known from Madagascar is endemic. Our inventory shows a much lower score: fifteen recorded species (40.5%) are endemic to Madagascar. This includes the four species also known from the Comoros and/or Mascarenes. Moreover, most of the endemics belong to the group of “new endemics”, that are closely related to taxa on the mainland. All the endemics found in our investigation are widespread on the island. *O. aequistylus* and *Z. ranavalonae*, two more localised endemics previously found in AF may owe their scarceness (and their absence in our material) being difficult to collect. Table 1 list species reported from WR but not from AF. A total of 58 species, a third of Madagascar’s total, is thus known from WR. 47% of these are endemic. Of the three large zygopteran radiations that occurred on Madagascar, the WR list includes only two of the

33 megapodagrionids, two of the eight *Platycnemis* species and four of the 31 *Pseudagrion* species. A similar picture can be drawn for other groups, such as Tetrathemistinae and Corduliidae. Although further fieldwork is still recommended, it appears that the dry forests of Madagascar's West, contribute very little to the odonate diversity of the island. This richness is concentrated in the island's Eastern rainforests, which consequently should be the focus of future odonatological work in Madagascar.

Table 1: Summary of records of species from Western Region not recorded from Ankarafantsika Forest. Whether the species is endemic to Madagascar is indicated.

Family / Species	Endemic	Locality	Source
Megapodagrionidae <i>Protolestes leonorae</i>	+	Marovoay	Schmidt 1951
Coenagrionidae <i>Agriocnemis gratiosa</i> <i>Pseudagrion pterauratus</i> <i>Pseudagrion renaudi</i>	+ + +	Ambongamaranitra Région d'Analalava, Beraty Namoroka, bord de l'Andriambe	Lieftinck 1965 Aguesse 1968 Fraser 1953
Platycnemididae <i>Metacnemis secundaris</i> <i>Platycnemis protostictoides</i>	+ +	Région d'Analalava, Beraty Namoroka, bord de l'Andriambe	Aguesse 1968 Fraser 1953
Aeshnidae <i>Gynacantha bova</i>	+	Ambilobe	Fraser 1956
Gomphidae <i>Paragomphus obliteratus</i>	+	km 530 route de Majunga	Fraser 1956
Corduliidae <i>Phyllomacromia trifasciata</i>	+	Menabe	Grünberg 1917
Libellulidae <i>Chalcostephia flavifrons</i> <i>Crocothemis divisa</i> <i>Diplacodes exilis</i> <i>Orthetrum trinacria</i> <i>Philonomon luminans</i> <i>Rhyothemis cognata</i> <i>Tramea basilaris</i> <i>Trithemis arteriosa</i> <i>Trithemis furva</i> <i>Trithemis kirbyi</i> <i>Trithemis persephone</i> <i>Viridithemis viridula</i>	+ + + +	Antsingy de Bekopaka, Antsingy de Maintirano Maevatanana Ambilobe Antsingy de Bekopaka, Namoroka Tulear Ambilobe Majunga; Morondava, Forêt Befasy Ambilobe Miandrivazo Morondava, Forêt Befasy Kinkunigebiet Namoroka	Fraser 1956 Fraser 1956 Fraser 1956 Fraser 1956 Grünberg 1917 Fraser 1956 Sjöstedt 1917, Fraser 1956 Fraser 1956 Fraser 1956 Fraser 1956 Fraser 1956 Fraser 1956 Fraser 1956 Fraser 1956 Grünberg 1917 Fraser 1960

Habitats

Table 2 compares the records from the three best investigated sites, A1, C6 and D, a strongly disturbed river (creating a stagnant water situation), a temporary pond and a more natural river respectively. The ecology of the Madagascar Odonata is very poorly known and therefore only a limited discussion of the habitat requirements of the recorded species can be given. *Zygonyx* species are all strongly rheophilous and therefore the record of the endemic *Z. elisabethae* only from a river site does not come as a surprise. Similarly, that *Ceriagrion auritum* and *Pseudagrion punctum* were only found here suggests they may be river species too. Endemic species found at stagnant water sites are *Lestes simulator*, *Azuragrion kauderni*, *Hemistigma affine*, *Neodythemis hildebrandti* and *Orthetrum lemur*. These all belong to genera known principally from stagnant habitats in mainland Africa as well. The exception is *Neodythemis*, this genus appears to be much more common on Madagascar than on the continent. *Pseudagrion malgassicum*, *Platycnemis malgassica* and *Trithemis selika* were found at both running and standing waters. This conforms with them being among the most widespread, and probably ecologically versatile endemic Madagascar Odonata.

Table 2: Comparison of three sites with more than 10 recorded species.

Species	A1	C6	D	Species	A1	C6	D
<i>Lestes cf. ochraceus</i>			+	<i>Neodythemis hildebrandti</i>	+		
<i>Lestes simulator</i>		+		<i>Orthetrum abbotti</i>	+		+
<i>Azuragrion kauderni</i>	+	+		<i>Orthetrum lemur</i>	+		
<i>Ceriagrion auritum</i>			+	<i>Orthetrum stemmale</i>	+		
<i>Ceriagrion glabrum</i>		+		<i>Pantala flavescens</i>	+		
<i>Pseudagrion malgassicum</i>	+		+	<i>Rhyothemis semihyalina</i>		+	+
<i>Pseudagrion punctum</i>			+	<i>Tetrathemis polleni</i>		+	+
<i>Platycnemis malgassica</i>		+	+	<i>Tholymis tillarga</i>	+		+
<i>Anax tristis</i>		+		<i>Tramea limbata</i>		+	
<i>Acisoma panorpoides</i>			+	<i>Trithemis selika</i>	+		+
<i>Crocothemis erythraea</i>	+			<i>Urothemis assignata</i>		+	
<i>Diplacodes lefebvrei</i>	+	+		<i>Zygonyx elisabethae</i>			+
<i>Hemistigma affine</i>	+	+					

Concluding remark

More intensive studies on the odonate fauna of Ankarafantsika National Park are needed to better understand the impact of the modification and destruction of the wetlands inside the protected areas.

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REFERENCES

- Aguesse, P. 1967:** Nouveaux Protolestes Förster, 1899 de Madagascar (Odonata; Zygoptera). - Deutsche Entomologische Zeitschrift, N.F. 14: 277-284.
- Aguesse, P. 1968:** Zygoptères inédits de Madagascar [Odon.]. - Annales de Société entomologique française (N.S.) 4: 649-670.
- Cammaerts, R. 1987:** Taxonomic studies on African Gomphidae (Anisoptera) 1. Malgassogomphus robinsoni gen. nov., spec. nov. from Madagascar. - Odonatologica 16: 335-346.
- Carfi, S. & Terzani, F. 1991:** Some Odonata from Madagascar. - Notulae Odonatologicae 3: 113-114.
- Conservation International 1999:** Monographie de la zone d'intervention du Projet, PCIDI-Ankarafantsika: 68.
- Fraser, F.C. 1949:** Odonata of Madagascar Appendix I. - Mémoires de l'Institut scientifique de Madagascar (A) 3: 21-40.
- Fraser, F.C. 1951:** Appendix to the Zygoptera of Madagascar. - Mémoires de l'Institut scientifique de Madagascar (A) 6: 407-417.
- Fraser, F.C. 1953:** Odonates nouveaux de Madagascar. - Le Naturaliste Malgache 5: 159-166.
- Fraser, F.C. 1956: Faune de Madagascar I Insectes Odonates Anisoptères. - Publications de L'Institut de Recherche scientifique Tananarive-Tsimbazaza, Tananarive.
- Fraser, F.C. 1960:** A new genus and species of Odonata from Madagascar. - Le Naturaliste Malgache 12: 71-72.
- Gauthier, A. 1988:** Les Anax de Madagascar, avec la description d'une nouvelle espèce: *A. mandrakae* n. sp. (Odonata: Aeshnidae). - Bulletin de Société d'Histoire Naturelle de Toulouse 124: 191-195.
- Grünberg, K. (Editor), 1917:** Odonaten von Madagaskar, den Comoren und Ostafrika. Reise in Ostafrika in den Jahren 1903-1905, III, 5. - Wissenschaftliche Ergebnisse, Stuttgart.
- Legrand, J. 1992:** Un nouveau Zygoptère de Madagascar *Tatocnemis virginiae* n.sp. [Odonata, Megapodagrionidae]. - Revue française d'Entomologie (N.S.) 14: 25-28.
- Legrand, J. 2001:** *Malgassophlebia mayanga* (Ris, 1909) et un nouvelle espèce du genre à Madagascar (Odonata, Anisoptera, Libellulidae). - Revue française d'Entomologie (N.S.) 23: 225-236.
- Lieftinck, M.A. 1963:** The type of *Libellula hova* Rambur, 1842, with notes on the other species of *Zygonyx* Selys from Madagascar. - Verhandlungen der Naturforschenden Gesellschaft in Basel 74: 53-61.
- Lieftinck, M.A. 1965:** Notes on Odonata of Madagascar, with special reference to the Zygoptera and with comparative notes on other faunal regions. - Verhandlungen der naturforschenden Gesesllschaft von Basel 76: 229-256.
- Lohmann, H. 1980:** Zur Taxonomie einiger Crocothemis-Arten, nebst Beschreibung einer neuen Art von Madagaskar (Anisoptera: Libellulidae). - Odonatologica 10: 109-116.
- May, M. 1997:** The status of some species of *Enallagma* (Odonata: Zygoptera: Coenagrionidae). - Entomological News 108: 77-91.
- Pinhey, E. 1964:** Dragonflies of the genus *Pseudagrion* Selys collected by F. Keiser in Madagascar. - Verhandlungen der naturforschenden Gesesllschaft von Basel 75: 140-149.
- Pinhey, E. 1970:** A new approach to African *Orthetrum* (Odonata). - Occasional Papers of the National Museum of Southern Rhodesia (B) 4: 261-321.
- Pinhey, E. 1979:** The status of a few well-known African anisopterous dragonflies (Odonata). - *Arnoldia Zimbabwe Rhodesia* 8(36): 1-7.
- Pinhey, E. 1980:** A revision of African *Lestidae* (Odonata). - Occasional Papers of the National Museum of Rhodesia (B) 6: 1-479.
- Rambur, J.P. 1842:** Histoire naturelle des Insectes. Névroptères. - Roret, Paris.
- Ris, F. 1913:** Libellulinen monographisch bearbeitet. Volume 8. - Collections Zoologiques du Baron Edm. de Selys Longchamps. Catalogue Systématique et Descriptif 15: 965-1042.

- Schmidt, E. 1951:** The Odonata of Madagascar, Zygoptera. - *Memoires de l'Institute Scientifique de Madagascar (A)* 6: 116-283.
- Schmidt, E. 1966:** Die Libellen der Insel Madagascar (Odonata), Teil I. Zygoptera. - *Deutsche Entomologische Zeitschrift* 1-4: 1-171.
- Schneider, W. & Dumont, H.J. 1997:** The dragonflies and damselflies (Insecta: Odonata) of Oman. An updated and annotated checklist. - *Fauna of Saudi Arabia* 16: 89-110.
- Sjöstedt, Y. 1917:** Odonaten aus Madagaskar eingesammelt von Dr. W. Kaudern, 1911-12. - *Arkiv för Zoologi* 11: 1-12.