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## Odonata from two western Nigeria rainforests, with a record of the rare *Ceriagrion citrinum* Campion, 1914

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### Abstract

A survey of Odonata was carried out in two tropical rainforest habitats, in Omo Forest Reserve (OMO) and Igele Sunmoge village (ISV) in Ogun State, Nigeria with focus on the endangered damselfly *Ceriagrion citrinum* Campion, 1914. A total of 163 individuals of Odonata representing 37 species and 5 families were recorded, including 12 individuals of *C. citrinum* at ISV. A brief note on the conservation status and ecology of the endangered *C. citrinum* in Nigeria is given. OMO is a protected forest managed by the government while ISV is heavily impacted by human activities. Conservation education focusing on the iconic *C. citrinum* was therefore provided to local residents. Dragonfly perception by the residents of Sunmoge village is briefly outlined.

**Keywords:** *Ceriagrion*, Odonata, oviposition, rainforest, anthropogenic disturbance, conservation

### Introduction

Two additional sites were selected for studies in the context of regional studies of the odonate fauna in the southern part of Nigeria (Ekpah et al. 2020, 2020a). Besides a general interest in the regional odonate fauna, the main criterion to study Omo Biosphere Reserve and Igele Sunmoge village is the suspected existence of a very rare African *Ceriagrion citrinum* Campion, 1914.

The enigmatic *C. citrinum* remained largely unrecorded since its description (Dijkstra 2005). The reason for the scarce record of this species in Nigeria could not have been that it was mistaken for other *Ceriagrion* as there is no other green-and-yellow damselfly in the country. This species is obviously rare and therefore was assessed as 'endangered' in the IUCN red-list (Dijkstra & Tchiboza 2018). It was last recorded from Sakpoba forest in Edo state, Nigeria in 1972 (*C. citrinum* records, Dijkstra). Since then, there has been no report of the species from Nigeria. However in the border region of western Nigeria, Tchiboza & Dijkstra (2004) reported *C. citrinum* as a new record to Republic of Benin and noted its occurrence in Nigeria with certainty. Furthermore Tchiboza et al. (2008) recorded it in Lokoli swamp forest in Benin Republic in West Africa.

*C. citrinum* was described in 1914 by Campion (1914) and is restricted to southern Nigeria and Benin Republic. While Campion opined that *C. citrinum* resembles *C. coromandelianum* (Fabricius, 1798) from India in general appearance, it is actually morphologically most similar to *C. tricrenaticeps* Legrand, 1984 (Dijkstra 2021). These endemics are important, often because they need conservation protection in their own right, as they are vulnerable to the impact of human activities. The globally vulnerable *C. citrinum* may occur in the lower Niger delta of Nigeria (Dijkstra et al. 2011) although information about its local distribution and ecological requirements are lacking.

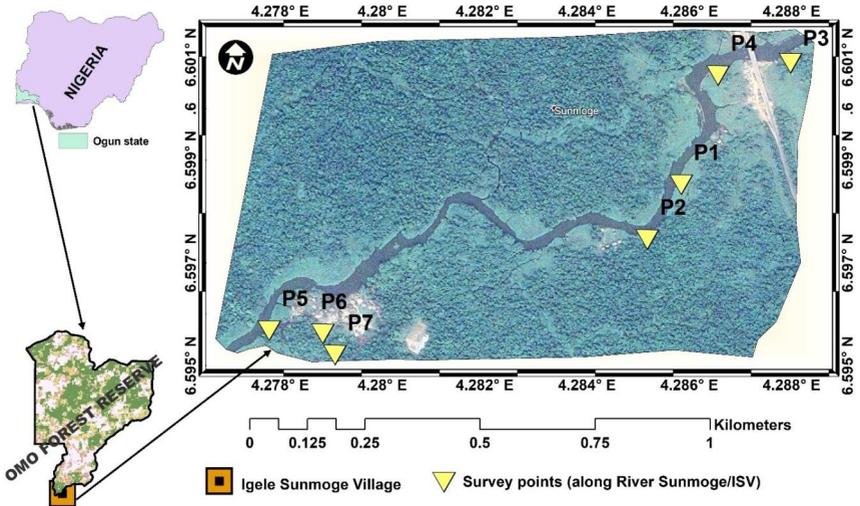
There is no information available about habitat selection and the threat status of *C. citrinum* in Nigeria. The objectives of this study are to record Odonata species in Omo Forest Reserve and the nearby Igele Sunmoge village as well as provide comments on the status and ecology of *C. citrinum* in Nigeria.

## Methodology

### Description of Study Sites

Western Nigeria has a varied habitat for Odonata ranging from swampy forest of the Lekki Conservation Centre (Ekpah et al. 2020) to the well-drained Omo Forest Reserve. The area of focus in the present survey are Omo Forest Reserve and – at its southern margin, but outside of the reserve (Fig. 1) – the neighboring Igele Sunmoge village area. The wet season in the forest reserve occurs from March till November while the dry season is from December to February. Annual rainfall ranges from 1700 to 2200 mm. The ferruginous tropical soils (<https://en.unesco.org/biosphere/africa/omo>) are well-drained, mature, stony and gravelly in the upper parts of the forest. The texture of topsoil in the reserve is mainly sandy loam (Adeduntan 2009). The natural vegetation of the area is tropical rain-forest characterized by emergent plants with multiple canopies and lianas (Ogunjemite & Olaniyi 2012).

The sites were selected based on information in the literature. Isichei (1995) reported that there are swamps in the Southern part of Omo Forest Reserve around the Igele Sunmoge area traversed by River Sunmoge (<https://reliefweb.int/map/nigeria/nigeria-floods-affected-area-zone-4-19-nov-2012>). Dan et al. (2016) reported that the Lokoli Swampy Forest located in southern Benin Republic is the only swampy forest with a known permanent river in West Africa. Igele Sunmoge village has similar vegetation and topography as the Lokoli swamp forest in Benin where Tchiboza et al. (2008) recorded *C. citrinum*.



**Fig. 1.** Map of Omo Forest Reserve and Igele Sunmoge village. A bridge separates P3 and P4 (for more details of ISV see Fig. 5).

### *Omo Forest Reserve*

Omo Biosphere Reserve (OMO), derives its name from the River Omo (also called Sunmoge river) which lies between Latitude 6.5833° – 7.0166° and Longitude 4.3166° – 4.6666° (Fig. 1). The reserve was constituted in 1925 and covers about 130,500 hectares, about 20 km from the Atlantic coast at its southernmost parts. The maximum elevation of 150 m above sea level is towards the west. The lowest parts of the reserve are in the south where River Omo joins the River Oni, the reserve's eastern boundary, before flowing into the Lekki Peninsula on the Atlantic coast. There are swamps in the south especially near the junction of the two rivers. The mean annual rainfall ranges from about 1600 to 2000 mm with two annual peaks in June and September, with November and February being the driest months. The forest reserve is in the mixed moist semi-evergreen rainforest zone. The northern parts of the Reserve are relatively dry forest with typical species such as *Sterculia rhinopetala* while *Nauclea diderrichii* and *Terminalia superba* are common in the wetter central parts. In the wet forests on sandy swampy soils in the south, *Lophira* and trees in the Meliaceae family are common (Isichei 1995). "In the northern part of the reserve, the vegetation consists of a dry evergreen mixed deciduous forest, while in the south, it consists of a moist, mixed, semi-deciduous forest. Parts of the reserve consist of primary forest with mature trees, especially near the watercourses. However, large portions have been disturbed, with the felling of the original trees and the establishment of plantations" ([https://en.wikipedia.org/wiki/Omo\\_Forest\\_Reserve](https://en.wikipedia.org/wiki/Omo_Forest_Reserve)).

### *Igele Sunmoge village*

Igele Sunmoge village (ISV) covers the area of a village with the same name, about 5 km from Sagamu-Ore expressway and opposite the Area J4 of Omo Forest Reserve (Fig. 1). This locality has about 100 inhabitants living along the river in thatched houses made of bamboo and other materials. They make their living from artisanal fishing, which necessitated their settlement on and around the river. Cattle grazing near the riverbank is also common (Fig. 2). This community lies along Latitude 06.598°N and Longitude 04.2858°E. Dragonflies are found on vegetation on and along River Sunmoge.



**Fig. 2. Cattle grazing and trampling along the shore of Sunmoge River.**

### **Sampling of Odonata**

Adult specimens were sampled between 10.00 a.m. and 4.00 p.m., five days in each month for seven months under favourable weather conditions, using a standard insect sweep net. The sampling periods cover the end of the dry season and the onset of the wet season. The collection localities were geo-referenced with a Garmin GPSMAP 64st. Habitat photos were taken with a digital camera (Canon PowerShot SX530, with w/50X Optical Zoom). Samples were collected along the river bank at 4 points in Omo Forest Reserve. Samples were collected on the forest path that led to Erin camp (Fig. 6) and water pump area near the elephant office at Omo Forest Reserve in Ogun State, Nigeria. Sampling also took place at 7 sampling sites in the swamp forest along River Sumonge (Fig. 4 and 5).



**Fig. 3.** The author at the « harbour » in Igele Sunmoge village with a view on the riverside vegetation along River Sunmoge. A point closest to P6 (Fig. 1).



**Fig. 4.** A tributary of River Sunmoge in Igele Sunmoge village (July, 2021). It gets dry during the dry season. *Ceriatgrion citrinum* was found here in April 2021 at point P6 (See distribution map in Fig. 7 and Table 2).



**Fig. 5a-c. a: Regular floating vegetation in River Sunmoge (July 2021). b: River Sunmoge (May, 2021). c: Dominant invasive *Eichhornia crassipes*.**

### **Processing, preservation and identification of specimens**

Adult specimens were stored in properly labeled triangular envelopes and immersed in acetone. Male and female caught in tandem were placed together inside one envelope. Specimens were removed from acetone after 12 hours and air-dried. They were then placed in small transparent plastic bags in which there are label cards before putting them in brown envelopes. The label contained information including the species name, the grid coordinates of collection locality and the date of collection. Identification of specimens were carried-out with the help of Dragonflies and Damselflies of Eastern Africa (Dijkstra & Clausnitzer 2014) and verified from African Dragonflies and Damselflies Online (<http://addo.adu.org.za/>).



Fig. 6. NCF road to Erin camp in Omo forest reserve (December, 2020). This forest path is rich in *Chlorocypha* spp, many individuals of *Sapho ciliata* and many species of butterflies.

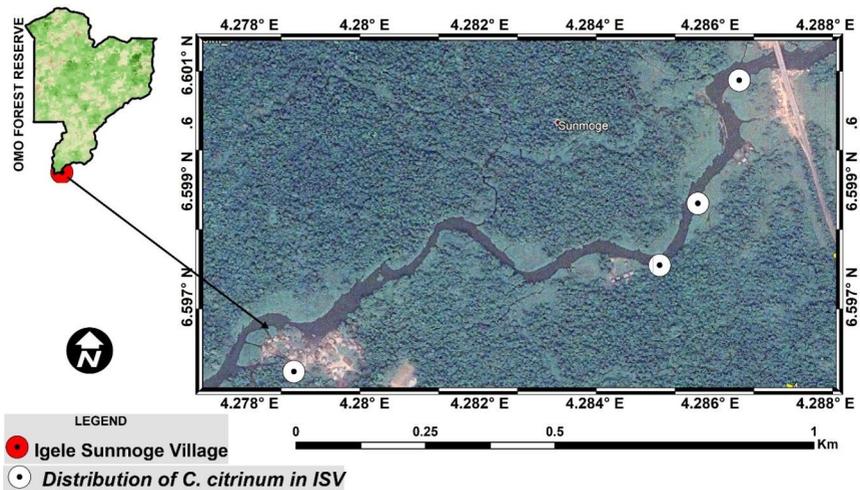


Fig. 7. Distribution map of *C. citrinum* in ISV (Source: google earth map).

### Vegetation analysis

Specimens of plant species collected from the study sites, particularly around the ecological niche of *C. citrinum*, were deposited at the University of Lagos Herbarium for identification. Important habitat parameters (vegetation, shading and stream/river bank structure) were recorded.

## Results

A total of 163 individuals of Odonata representing 37 species and 5 families were sampled (Tab. 1).

**Tab. 1. Number of of Odonata recorded from study sites with their IUCN red list status (OMO-Omo Forest Reserve, ISV-Igele Sunmoge village, LC – Least Concern, EN - Endangered).**

Taxa	OMO	ISV	Total
<b>Calopterygidae</b>			
<i>Phaon iridipennis</i> Burmeister, 1839 (LC)	0	1	1
<i>Sapho ciliata</i> (Fabricius, 1781) (LC)	8	0	8
<b>Chlorocyphidae</b>			
<i>Chlorocypha curta</i> (Hagen in Selys, 1853) (LC)	1	0	1
<i>Chlorocypha cyanifrons</i> (Selys, 1873) (LC)	1	0	1
<i>Chlorocypha selysi</i> (Karsch, 1899)(LC)	1	0	1
<b>Coenagrionidae</b>			
<i>Agriocnemis maclachlani</i> Selys, 1877 (LC)	2	0	2
<i>Ceriagrion citrinum</i> Campion, 1914 (EN)	0	12	12
<i>Ceriagrion glabrum</i> (Burmeister, 1839) (LC)	1	5	6
<i>Ceriagrion rubelloцерinum</i> Fraser, 1947(LC)	2	1	3
<i>Pseudagrion glaucescens</i> Selys, 1876 (LC)	0	2	2
<b>Libellulidae</b>			
<i>Acisoma inflatum</i> Selys, 1882 (LC)	1	2	3
<i>Acisoma trifidum</i> Kirby, 1889 (LC)	1	7	8
<i>Brachythemis impartita</i> (Karsch, 1890) (LC)	1	0	1
<i>Chalcostephia flavifrons</i> Kirby, 1889 (LC)	2	12	14
<i>Crocothemis erythraea</i> (Brullé, 1832) (LC)	1	3	4
<i>Diplacodes luminans</i> (Karsch, 1893) (LC)	0	2	2
<i>Hadrothemis coacta</i> (Karsch, 1891) (LC)	1	0	1
<i>Hemistigma albipunctum</i> (Rambur, 1842) (LC)	2	3	5
<i>Neodythemis klingi</i> (Karsch, 1890) (LC)	1	0	1
<i>Orthetrum austeni</i> (Kirby, 1900) (LC)	0	2	2
<i>Palpopleura lucia</i> (Drury, 1773) (LC)	4	6	10
<i>Palpopleura portia</i> (Drury, 1773) (LC)	2	1	3
<i>Pantala flavescens</i> (Fabricius, 1798) (LC)	0	1	1
<i>Orthetrum chrysostigma</i> (Burmeister, 1839) (LC)	2	0	2
<i>Orthetrum julia</i> Kirby, 1900 (LC)	3	0	3
<i>Orthetrum microstigma</i> Ris, 1911(LC)	1	0	1
<i>Orthetrum saegeri</i> Pinhey, 1966 (LC)	1	0	1
<i>Orthetrum stemmale</i> (Burmeister, 1839) (LC)	8	3	11
<i>Orthetrum trinacia</i> (Selys, 1841) (LC)	0	2	2
<i>Oxythemis phoenicosceles</i> Ris, 1911 (LC)	1	1	2
<i>Rhyothemis notata</i> (Rambur, 1842) (LC)	0	16	16
<i>Tetrathemis camerunensis</i> (Sjostedt, 1900)(LC)	1	0	1
<i>Thermochoria equivocata</i> Kirby, 1889 (LC)	0	18	18
<i>Trithemis aconita</i> Liefink, 1969 (LC)	0	1	1
<i>Trithemis dichroa</i> Karsch, 1893 (LC)	0	3	3
<i>Urothemis edwardsii</i> (Selys, 1849) (LC)	0	9	9
<b>Macromiidae</b>			
<i>Phyllomacromia contumax</i> Selys, 1897 (LC)	0	1	1
<b>Total</b>	<b>49</b>	<b>114</b>	<b>163</b>

### Local Distribution of *C. citrinum*

*C. citrinum* was found at 4 sampling points along River Sunmoge (Tab. 2, Fig. 7).

**Table 2. Number of specimens of *C. citrinum* sighted in seven months.**

Month	GPS Coordinate	Point	Number
October, 2019	N6.59'86.12" E4.28'57.82"	P1	5
July, 2020	N6.59'75.46" E4.28'51.19"	P2	4
January, 2021	N6.60'09.79" E4.28'79.18"	P3	0
February, 2021	N6.60'07.40" E4.28'65.02"	P4	2
March, 2021	N6.59'57.72" E4.27'77.24"	P5	0
April, 2021	N6.59'57.10" E4.27'87.70"	P6	1
May, 2021	N6.59'53.00" E4.27'90.10"	P7	0

### Habitat of *Ceriagrion citrinum*

*Ceriagrion citrinum* prefers sections of River Sunmoge with slow running and twigs of trees and bushes standing on the banks. The River Sunmoge has sandy substratum, is slow-flowing and of turbid water. *Ceriagrion citrinum* perched on the vegetation in an open area (Fig. 8).



**Fig. 8. Tandem of *Ceriagrion citrinum* in ISV (July, 2020).**

*C. citrinum* prefers rich and diverse emergent vegetation at the river banks (Fig. 9 - 11).



**Fig. 9.** *Ceriagrion citrinum* on vegetation with the invasive *Pistia stratiotes* (July, 2020).



**Fig. 10.** Section of the habitat of *Ceriagrion citrinum* with *Sacciolepis africana*, *Pistia stratiotes* and *Lemna* spec. (July, 2020).



Fig. 11a, b. Resting site of *Ceriagrion citrinum*.

Oviposition took place in floating vegetation. Fig. 12 shows leaves of *Salvinia nymphellula* c.f. which are used by a tandem to deposit eggs. As the current here is very slow, it is assumed that the larvae of *C. citrinum* are living there.

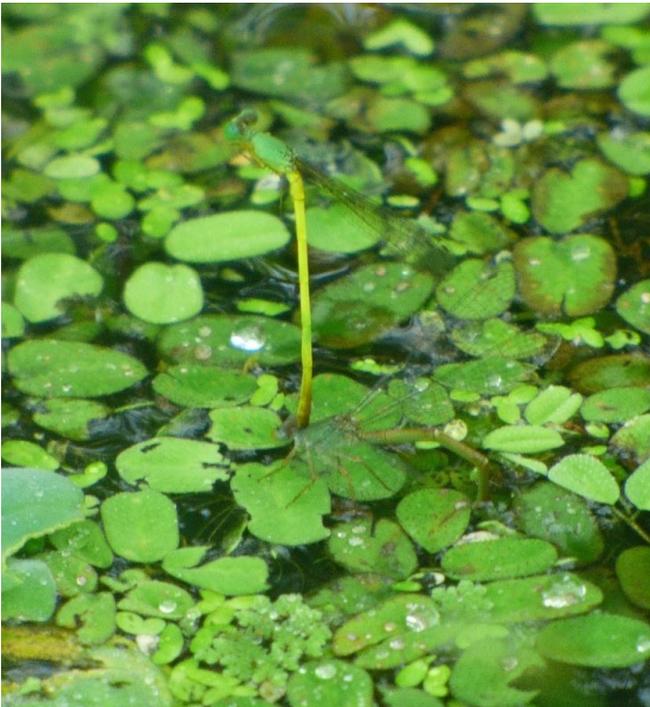


Fig. 12. *Ceriagrion citrinum* ovipositing in leaves *Salvinia nymphellula* c.f. (July 2020).

## Discussion

In this study, *Ceriagrion citrinum* was observed in the months of October, July, and April (wet season), but also in February (dry season). Tchiboza et al. (2008) noted that *Ceriagrion citrinum* was observed in the month of April during the wet season. The flight period of *C. citrinum* is likely to be all through the year. A total of 7 sample points were surveyed in ISV (Figure 1) in this present study. P1, P2, P3 and P4 are sites along River Sunmoge while P5, P6 and P7 are tributaries of River Sunmoge which lies within Sunmoge village. This territory is within Ogun Waterside local government area in Ogun state, Nigeria.

All species of *Ceriagrion citrinum* found in this study were observed on vegetation along the corridor of River Sunmoge. *C. citrinum* is peculiar in being endemic to gallery swamp forest in the savannah of Benin Republic and western Nigeria that separates Africa's western and central rainforest blocks (Dijkstra et al. 2011). *Ceriagrion citrinum* is sparsely distributed in ISV though not within the forest swamp but on aquatic vegetation along the river. Their resting place is on riparian trees and bushes while oviposition takes place on floating leaved vegetation (Fig. 12) utilizing *Salvinia nymphellula*. Dienye & Olopade (2017) found *S. nymphellula* dominating Oyan Lake in Ogun state Nigeria.

In a personal enquiry about the habitat of *C. citrinum* in Lokoli Swamp forest in Benin Republic, Vincent Romera noted that *C. citrinum* is found in secondary arm of a low-current river with a strong presence of floating vegetation such as duckweed, water lily, or water lettuce. It also seems that the areas most frequented by the species are fairly well exposed to sunshine. The Lokoli swamp forest is characterized by stands of *Raffia hookeri* and *Raffia* sp.. Vincent Romera (private communication) suspects the occurrence of the species between the following two geographical coordinates: 7.061951°N 2.258522°E and 7.018757°N 2.278912°E. In River Sunmoge, the geographic coordinates of *C. citrinum* are given in Tab 2. P2 was the point where oviposition of *C. citrinum* was observed in July, 2020. P4 is the site closest to human activities where a market holds in every five days beneath the bridge. It is the site with the heaviest impact on the habitat of *C. citrinum*.

Until now, there is no comprehensive list of Odonata in Omo Forest Reserve to the best knowledge of the authors. Odonate species found within the forest swamp of OMO and ISV included *Acisoma* and *Palpopleura* species which preferred standing and probably often temporary waters in open areas in forest with emergent vegetation and a soft (like muddy) bottom. Apart from *C. citrinum* which is 'Endangered' according to the IUCN red-list (Tab. 1), all other Odonata species collected were of 'Least Concern'. A total of 163 individuals of Odonata was collected in this study of which 49 were collected from OMO and 114 individuals were collected in ISV (Tab. 1).

*Hadrothemis coacta* was one of the species recorded in Erin camp at Omo Forest Reserve (Tab. 1). While *Oxythemis phoenicosceles* was recorded in Igele Sunmoge village. These species seem to be very scarce during the survey while *Rhyothemis notata* and *Thermochoria equivocata* were common. The two species were the most recorded in ISV (Tab. 1). *C. citrinum* is not listed on the ADBI as presented by Vorster et al. (2020). The reason for this omission could be the lack of information about *C. citrinum*. Considering its restricted geographical distribution (Fig. 5), threat status (Endangered) and species vulnerability, the ADBI of *C. citrinum* should be 7 especially that the species is endemic to Nigeria and Benin Republic.

All the sampling sites are protected forests apart from Igele Sunmoge village where *C. citrinum* was found. Human activity there is indeed intense, with constant fishing in the river, canoes plying through and overgrazing by cattle. Moreover, the regular movement on the waters by the villagers put some pressure on the species of Odonata as it amounts to the disturbance of their habitat. Other anthropogenic activities in the area such as defecation in the open water and overgrazing may also affect the distribution and abundance of the Odonata species. This is because of their comparatively dry and fire prone surroundings, human pressure on riparian forests for wood and agriculture is disproportionately high. Few species may be directly threatened by these activities, with the probable exception of *Ceriagrion citrinum* in western Africa, but shaded refuges along rivers are important for many savannah and woodland odonates (Dijkstra et al. 2011). The major anthropogenic activity in ISV against *C. citrinum* is therefore habitat alteration through deforestation and pollution. Deforestation exposes the forest to erosion and enable pastures.

The reception of dragonflies by the local people is given in the Appendix 1, and it may help to explain or assess future threats which may impact *C. citrinum* and the local dragonfly fauna.

## Conclusion

The project area is heterogeneous habitat and Odonata species are distributed according to their ecological requirements. For example, there is no member of the Chlorocyphidae recorded from ISV while three species of the family were recorded in OMO. *C. citrinum* is a species of open macrophyte vegetation along sunny riversides. Only twelve individuals of *C. citrinum* were encountered in seven field trips indicating that this species is genuinely rare. More efforts therefore should be targeted at understanding the area of occupancy of this species and the effect of anthropogenic activities especially on the naiads.

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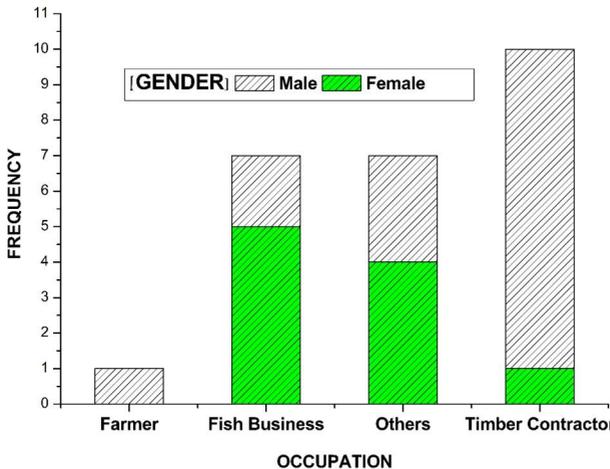
## Appendix 1

### Residents of Sunmoge and their relationship to dragonflies and especially to *Ceriatrion citrinum*

Knowledge of the ecological role of dragonflies remains in literature and are not translated to residents living near forests where the dragonflies are dominant. 87.5% of respondents do not have knowledge of the ecological value of dragonflies in their community (Tab. 3). This could be a reason for the anthropogenic activities that put pressure on *C. citrinum* and other Odonata in the area. More importantly, 40% percent of the 25 respondents were timber contractors (Fig. 13) indicating that the felling of trees is high in the area. Children of Sunmoge were engaged in a series of conservation education and tree planting activities to enrich the forest (Fig. 14-18). This is because nature club experiences may help students form new attitudes toward species which may lead to good conservation behavior (Hassan et al., 2017).

#### Demographic data of Sunmoge residents

The questionnaire covers a total of 25 respondents of which 10 were females and 15 were males. 40% of respondents gave their occupation as timber contractors while 28% of them focus of fish business including harvesting, processing and sales (Fig. 13).



**Fig. 13. Gender and occupation of Sunmoge residents (n=25).**

Information was gathered from residence of Sunmoge to understand their perception of dragonflies in their locality. The period of the year in which they see more dragonflies was the rainy season although 87.5% of them do not see any ecological value in dragonflies. 91.67% of respondents disagreed that dragonflies are used in traditional medicine. 71.43% of them do not know about the endangered *C. citrinum* which is present in their locality (Tab. 3).

**Tab. 3. Percentage of responses to different criteria.**

Criteria		
Seasonal abundance	Wet	72%
	Dry	16%
	Both	4%
	Undecided	8%
Ecological value of dragonflies	No	87.5%
	Yes	8.33%
	Not sure	4.17%
Traditional use	No	91.67%
	Yes	8.33%
Observe dragonflies	No	57.14%
	Yes	14%
	Not Sure	28.86
Have knowledge of <i>C. citrinum</i>	No	71.43%
	Yes	11%
	Not Sure	17.57

**Fig. 14. Dragonfly conservation education in Sunmoge. (Feb. 2021).**



**Fig. 15. Capacity building of Sunmoge children (Feb. 2021).**





Fig. 16. Baale (Chief) of Sunmoge explaining the benefit of the project during an interview (Feb., 2021).



Fig. 17. Cross section of Sunmoge children being educated on dragonfly ecology (February, 2021).



Fig. 18. Ibukun Lawal A. and Augustine Ikunne (Field assistants) as well as O. Ekpah and two residents of ISV transporting seedlings to Sunmoge (March 2021). Photo Credit: Clifford Omonu.



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