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# A survey of odonate assemblages associated with selected wetland localities in southern Sri Lanka

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## ABSTRACT

**The dragonflies and damselflies are a major insect group (Class Insecta; Order Odonata) associated with water courses. Odonate assemblages with reference to their habitat characters have not been widely studied in Sri Lanka. We have investigated odonate assemblages for a period of three months in selected localities in southern Sri Lanka with reference to the habitat characters. Bundala and Embillakala lagoons in Bundala National Park (A Ramsar wetland in Sri Lanka), "Kirala Kele" Eco-tourism Zone-Matara, Bandaththara marshland system-Matara, "Kirala Kele" Biological Garden-Ambalanthota and Kosgahadola stream which belongs to Mulatiyana Rain forest reserve were selected as study sites since these sites are important in conservation of biodiversity. A total of 28 species were identified during the study period. Our data reveals odonate assemblages specific to the studied habitats such as bushlands, marshlands, lagoons, flowing water bodies, stagnant water bodies and vegetation type (wet zone and dry zone). These data will be useful in future studies and conservation of biodiversity in the studied habitats.**

**Key words:** Odonates, Assemblage patterns, Habitat characters, Vegetation

## INTRODUCTION

Insect surveys facilitate characterization of the land/ water interface, structural habitat heterogeneity and hydrological features of aquatic systems. Among the essential tools in ecological assessments in the land water interface" characterization of the odonate communities (Dragonflies and Damselflies) has been a widely accepted tool (Sahlen and Ekestubbe, 2001; Chovanec & Waringer, 2001; Schindler *et al.,* 2003). Odonates were the first insect group that has been globally assessed (Clausnitzer *et al.,* 2009).

Odonates survive in a wide range of aquatic habitats and are susceptible to habitat alterations induced by human activities. Dragonflies have been proposed as indicators to assess the ecosystem health of freshwater wetlands (Suhling *et. al*., 2006). Odonates serve as an umbrella species in biodiversity conservation (Noss, 1990; Lambeck, 1997) and represent specific biotic wetland assemblages.

Odonates require a wide range of functional and structural features of a particular habitat for their survival and reproduction (Tockner and Ward, 1998). Habitat heterogeneity especially the quality and quantity of aquatic and semi-aquatic plant communities, shoreline structures, hydrological features and sunlight are the most important variables determining the appearance of odonate species or associations (Lenz, 1991; Moore, 1991; Corbet, 1999). On the other hand habitat alterations and climate change have threatened odonate survival.

Sri Lanka boasts a complex and diverse wetland systems including riverine habitats, lagoons and marshlands. These wetlands and associated environments support many insect species including odonates. As per previous records there were approximately 120 species of odonates have been reported in Sri Lanka (Bambaradeniya, 2006). Odonate species assemblages with reference to their habitat features have less studied in Sri Lanka. Monitoring methods for the rapid assessment of ecological integrity of these ecosystems have been little developed. In this context, the odonate species diversity with reference to the habitat features will be a useful tool in developing assessment methods.

There are many nationally and internationally important ecosystems in southern Sri Lanka. Bundala and Embillakala lagoons in Bundala National Park (A Ramsar wetland in Sri Lanka), "Kirala Kele" eco-tourism Zone-Matara, Bandaththara marshland system-Matara, "Kirala Kele"Biological Garden-Ambalanthota and Kosgahadola stream which belong to Mulatiyana Rain forest reserve are important ecosystems in southern Sri Lanka since they are nature reserves. These specific ecosystems are important for the conservation of biodiversity. In this context continuous assessment of biodiversity in these ecosystem with reference to the habitat features might be useful.

In this study our objective was to conduct a preliminary survey on odonate species assemblages in selected wetland habitats in order to understand the nature of odonate species assemblages with reference to the habitat characters.

## MATERIALS AND METHODS

### *Site selection*

Embillakala and Bundala lagoons of Bundala National Park (BNP), "Kirala Kele" Research Center & Biological Garden in Ambalanthota and "Kirala Kele" eco-tourism zone, Bandaththara marshland system associated with Nilwala River & Kosgahadola stream which belongs to Mulatiyana Rain Forest reserve were selected as study sites. The first three sites were located in Hambanthota District (dry zone) and latter three sites were located in Matara District (wet zone). Study belts of 500 m in length and 5 m in width were established at each study site (indicated as white dotted lines in each picture of study sites).

In 1993, Bundala National Park (BNP) was

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designated as the first Ramsar wetland in Sri Lanka. BNP falls within the southeastern semi arid zone of Sri Lanka (Figure 1), with a general climate that can be classified as hot and dry (6º08' – 6º14'N, 81º08'- 81º18'E).

"Kirala Kele", Eco-tourism Zone (5°58′38″N, 80°31′27″ E) is a large marshland system covering an area of 1,800 ha, accessible from Matara- Hakmana and Matara-Akuressa roads and 3 km away from Matara town, Sri Lanka. In 2003, this land had been declared as a conserved wetland by a special gazette notification. It comprises marshlands, irrigation canals and mangrove habitats dominated by *Sonneratia caseolaris*. "Kirala Kele" today stands as an ideal habitat for wetland biodiversity, and is considered as one of the most valuable conserved areas in the Matara District of Sri Lanka. Being close to Matara town, it is a potential site for nature-based tourism (Figure 2).

Bandaththara marshland system (5°58′31″N, 80°33′55″ E) associated with "Kirala Kele" is also a less disturbed wetland system (Figure 3). This marshland continues with Kirala-Kele Eco-tourism Zone and consists with marshlands including *Sonneratia caseolaris* dominated mangrove ecosystems.

"Kirala Kele" Research Center & Biological Garden in Ambalanthota (6°07′09″N, 81°00′08″E) is a *Sonneratia caseolaris* dominated mangrove ecosystem where freshwater canals running along the margin. Adjacent paddy fields surround the area (Figure 4).

The study site at Kosgahadola stream (6°12′00″N, 80° 35′02″E) is different from all other study sites. It is a part of Mulatiyana Rain Forest reserve. The environmental conditions are much different from the other study sites (Figure 5).

***Ododnate sampling***

Belt transect method was employed for sampling (Villanueva and Mohagan" 2010). Sampling was carried out along belts of 500 m length at each study site on warm and sunny days between 9:00 h and 16:00 h when dragonflies are most active at the water bodies (Loiola and De Marco" 2011). Dragonfly specimens were identified by sight or by photographs. Where necessary, individuals were caught with a hand net and released after identification. Odonates were identified using standard guides and keys (de Fonseka, 2000; Bedjanic *et al*, 2006). Study was conducted in non-rainy season (May, June and July). In these months average temperature, rainfall and humidity were 25-32$^0$C, 15-45mm and 71% respectively in Hambanthota District while they were 24-30$^0$C, 30-80 mm and 73% respectively in Matara District. Each site was visited weekly for sampling.

Water quality parameters (conductivity, pH, salinity and water temperature) of each study site were measured according to the standard methods described elsewhere (Wilson, 1973; Mackereth, 1989). Vegetation structure and other important habitat features were also studied at the sampling sites. Data were statistically treated using SPSS version 16.

## RESULTS

This survey yielded a total 28 species of odonates. List of species recorded at each study site is given in Table 1. Water quality parameters recorded at study sites are

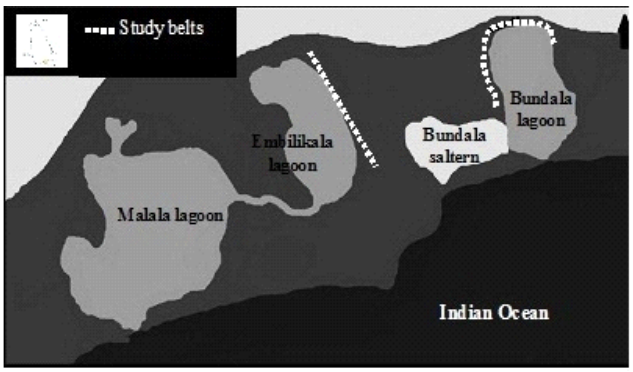


**Figure 1.** Study sites of Bundala National Park (transect is shown by a white dotted line).

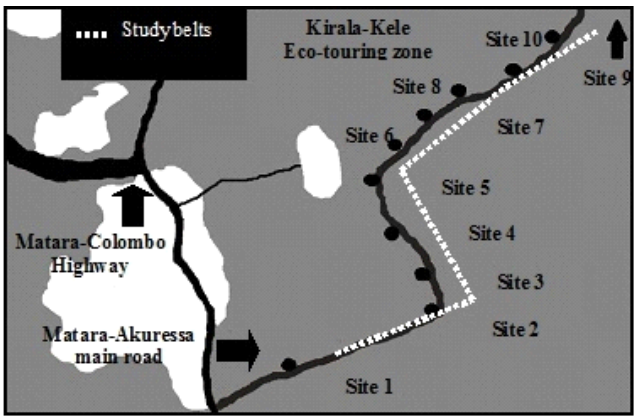


**Figure 2**. Study sites at "Kirala Kele" Eco-tourism zone-Matara (human settlement areas are shown in white colour; transect is shown by a white dotted line).

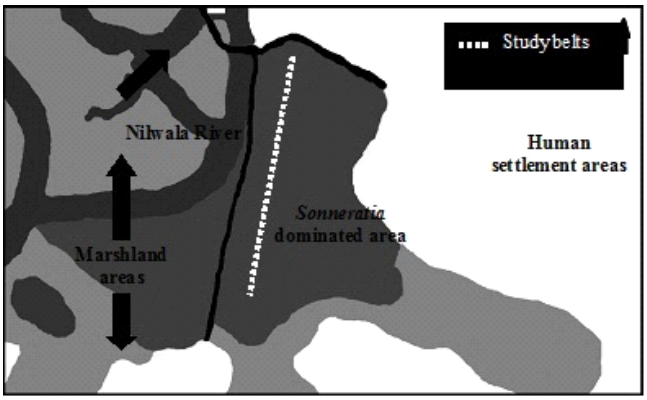


**Figure 3.** Study site at Bandaththara marshland associated with Nilwala river (transect is shown by a white dotted line).

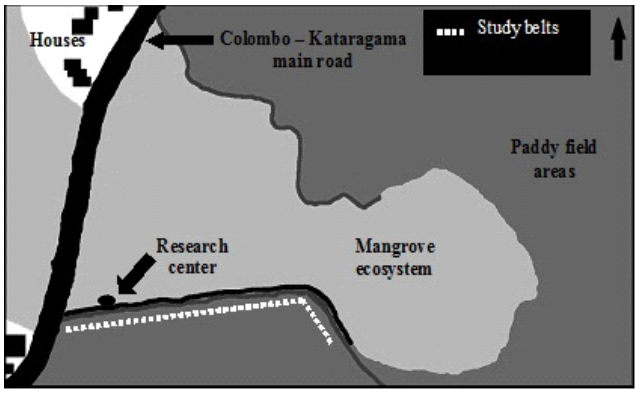


**Figure 4.** Study sites at "Kirala Kele" biological garden-Ambalanthota (transect is shown by a white dotted line).

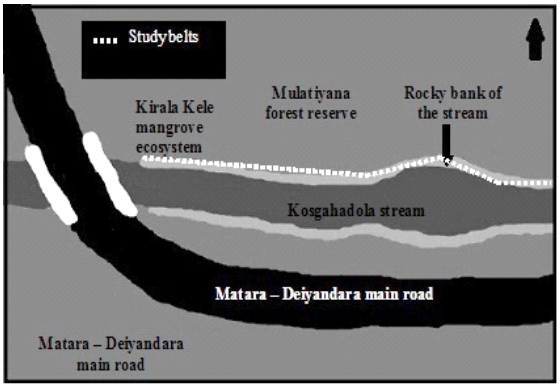


**Figure 5.** Study site at Kosgahadola running water ecosystem-Mawarala (transect is shown by a white dotted line).

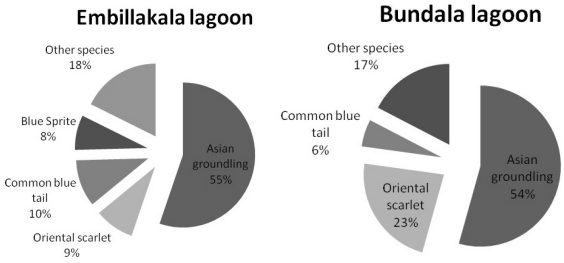


**Figure 6.** Percentage species composition recorded at the study sites of Embillakala lagoon and Bundala lagoon.

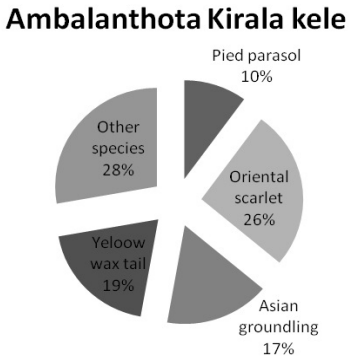


**Figure 7.** Percentage species composition recorded at the study site of "Kirala Kele" biological garden-Ambalanthota.

given in Table 2. Key vegetation types recorded at the study sites are given in Table 3. At the study sites associated with Embillakala and Bundala lagoons, Asian Groundlings (*Brachythemis contaminate*) were the dominant species as they contributed 55 ± 3 % of total species composition (Figure 6). Oriental Scarlet (*Crocothemis servilia*), Common Blue Tail and Blue Sprite were the other species recorded significantly. Common Blue Tail (*Ischnura senegalensis*), however, has not been detected at the study site of Bundala lagoon (Figure 6). Bundala lagoon was more saline than Embillakala lagoon. Nevertheless dragonfly species assemblages were almost similar at these two locations (Figure 6).

Highest species diversity was recorded at "Kirala Kele" Biological Garden-Ambalanthota where Oriental Scarlet slightly dominated the area as they contributed 26 ± 4 % of total species composition at the study site. Yellow Wax Tail (*Ceriagrion coromandelianum*), Pied Parasol (*Neurothemis tullia*) and Asian Groundling were more abundant in the site than other species recorded (Figure 7). "Kirala Kele"

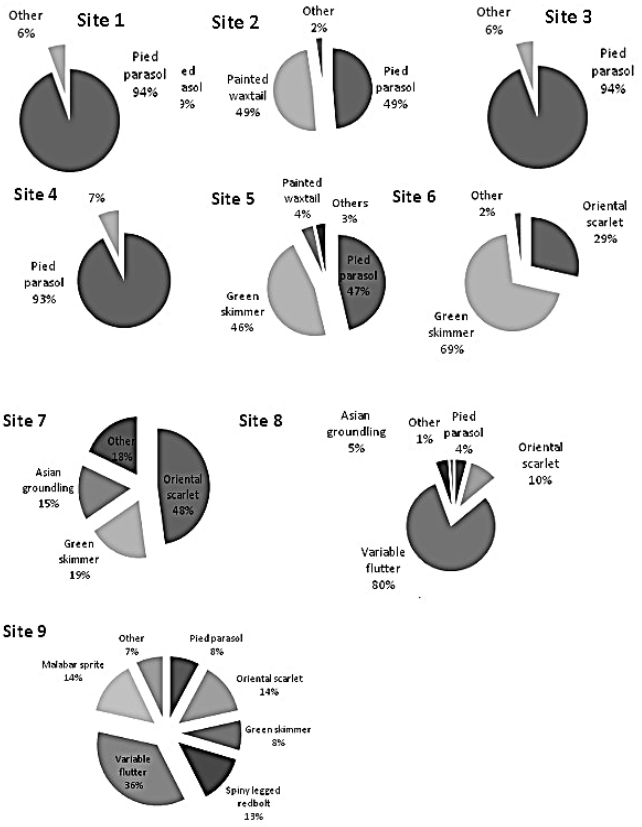


**Figure 8.** Percentage species composition recorded at the study site of "Kirala Kele" sanctuary Matara.

Eco-tourism zone, Matara supported almost similar species diversity as recorded at "Kirala Kele" Biological Garden-Ambalanthota (Figure 8). Pied Parasol dominated at sites 1, 2, 3 and 4 where they contributed 49 ± 4 %, 49 ±2 %, 59 ± 4 % and 93 ± 3 % to the total species compositions at the study sites respectively. Green Skimmer (*Orthetrum sabina*) and pied Parasol, however, contributed almost equally for the total species composition at site 5 (46 ± 2 %. and 47 ± 3 % respectively). Green Skimmer dominated at site 6 contributing 69 ± 4 % for the total species composition while Oriental Scarlet contributed 29 ± 4 %. Oriental Scarlet were the most abundant species (48 ± 4 %) at study site 7 while Green Skimmer contributed 19 ± 3 % and Asian Groundling contributed 15 ± 3 % for the total species composition. Variable Flutter dominated the site 8 contributing 80 ± 4 %. Variable flutter (*Rhyothemis variegate*), Oriental Scarlet and Spiny Legged Red-bolt (*Rhodothemis rufa*) contributed 36 ± 4 %, 14 ± 3 % and 13 ± 4 % respectively to the total species composition at study site 9. According to the cluster analysis two major species assemblages based on their occurrences in habitats can be distinguished in "Kirala Kele" Eco-tourism Zone-Matara (Figure 9).

Variable flutter was the most abundant species (32 ± 5 %) recorded at Nilwala river associated Bandaththara freshwater marshland. Percentage abundance of Spiny Legged Red-bolt, Pied Parasol and Oriental Scarlet were 28 ± 3 %, 19 ± 3 % and 15 ± 5 % respectively at this site (Figure10).

Shining Gossamamerwing (*Euphaea splendens*) was the most abundant damselfly species recorded at the study sites associated with Kosgahadola running water system while Restless Demon was the only dragonfly species recorded.

**Table 1.** Odonate species recorded at five different study sites.

| Species | Embillakala lagoon | Bundala lagoon | Bandaththara marshland | "Kirala Kele"biological garden, Ambalanthota | "Kirala Kele" Eco-touring zone, Matara | Kosgahadola Lentic water system |
|---|---|---|---|---|---|---|
| Pied parasol**CR** *Neurothemis tullia* | + | + | + | + | + | _ |
| Oriental scarlet **CR** *Crocothemis servilia* | + | + | + | + | + | _ |
| Green skimmer **CR** *Orthetrum Sabina* | _ | _ | + | + | + | _ |
| Asian pintail **CR** *Acisoma panorpoides* | _ | _ | + | + | + | _ |
| Spiny legged redbolt **CR** *Rhodothemis rufa* | + | + | + | + | + | _ |
| Variable flutter **CR** *Rhyothemis variegata* | + | + | + | + | + | _ |
| Asian groundling **CR** *Brachythemis contaminata* | + | + | + | + | + | _ |
| Blue percher **CR** *Diplacodes trivilais* | + | + | _ | + | + | _ |
| Scarlet Basker **CR** *Urothemis signata* | + | + | _ | _ | _ | _ |
| Rapacious flangetail **CR** *Ictinogomphus rapax* | + | + | _ | + | + | _ |
| Fiery Emperor **CR** *Anax immaculifrons* | _ | _ | _ | + | _ | _ |
| Indian Rockdweller **CR** Bradinopygra germinata | + | _ | _ | _ | _ | _ |
| Dancing dropwing**UR** *Trithemis pallidinervis* | _ | + | _ | _ | _ | _ |
| Foggy winged twister **CR** *Tholymis tillarga* | _ | _ | _ | _ | + | _ |
| Black tipped percher **CR** *Diplacodes nebulosa* | + | + | + | + | + | _ |
| Aggressive River hawk**SR** *Onychothemis tonkinensis* | _ | _ | _ | + | _ | _ |
| Restless Demon**SR** *Indothermis limbata* | _ | _ | _ | _ | _ | + |
| Wandering glider **CM** *Pantala flavescens* | _ | _ | _ | + | _ | _ |
| Pink skimmer **CR** *Orthetrum pruinosum* | _ | _ | _ | + | _ | _ |
| Yellow wax tail **CR** *Ceriagrion coromandelianum* | _ | _ | _ | + | + | _ |
| Shining Gossamerwing **CE** *Euphaea splendens* | _ | _ | _ | _ | _ | + |
| Painted waxtail **CR** *Ceriagrion cerinorubellum* | _ | _ | + | + | + | _ |
| Common Blue tail **CR** *Ischnura senegalensis* | + | + | _ | + | + | _ |
| Sri Lanka orange faced sprite *Pseudagrion rubiceps* **CE** | _ | _ | _ | + | _ | _ |
| Malabar sprite **SR** *Pseudagrion malabaricum* | _ | _ | _ | + | _ | _ |
| Blue sprite **CR** *Pseudagrion microcephalum* | + | _ | _ | _ | _ | _ |
| Mash dancer **UR** *Onychargia actrocyana* | _ | _ | + | _ | _ | _ |
| Dark-glittered Thread Tail **R** *Elattoneura bigemmata* | _ | _ | _ | _ | _ | + |

**Table 2.** Water quality parameters recorded at the study sites during study period (Mean and Standard Deviation is given, n=6; Minimum and maximum values recorded are also given).

| Study Site / Parameter | Bundala lagoon | Embillakala lagoon | Ambalanthota "Kirala Kele" biological garden | "Kirala Kele" sanctuary Matara | Kosgahadola lentic water system (Mawarala) | Bandaththara Marshland |
|---|---|---|---|---|---|---|
| pH | 6.9 ± 0.3 (6.6-7.2) | 6.4 ± 0.4 (6.1-6.9) | 6.8 ± 0.6 (6.0-7.5) | 6.2 ± 0.4 (5.8-6.7) | 6.9 ± 0.6 (6.2-7.5) | 6.4 ± 0.5 (5.8-7.0) |
| Conductivity (ms) | 17.58 ± 1.23 (16.4-18.7) | 0.22 ± 0.01 (0.16-0.3) | 0.35 ± 0.02 (0.23-0.45) | 0.40 ± 0.03 (0.34-0.46) | 0.12 ± 0.02 (0.09-0.17) | 0.41 ± 0.03 (0.32-0.5) |
| Temperature ($^0$C) | 33 ± 0.6 (32.3-33.7) | 30 ± 0.8 (29.2-31.0) | 26.9 ± 1 (26.1-27.3) | 28.4 ± 0.8 (27.4-29.0) | 27.8 ± 0.9 (27.0-28.9) | 28.6 ± 0.6 (28.1-29.4) |
| Salinity (PPT) | 8.72 ± 1.2 (8.1-10.1) | 0.13 ± 0.01 (0.09-0.16) | 0.17 ± 0.01 (0.12-0.19) | 0.23 ± 0.01 (0.18-0.28) | 0.05 ± 0.01 (0.02-0.08) | 0.2 ± 0.01 (0.18-0.26) |

**Table 3.** Key components of the aquatic and surrounding vegetation at study sites.

| Bundala lagoon | Embillakala lagoon | Ambalanthota "Kirala Kele" biological garden | "Kirala Kele" sanctuary Matara | Kosgahadola lentic water system (Mawarala) | Bandaththara Marshland |
|---|---|---|---|---|---|
| Adjacent *Julis melifera* and *Opuntia sp* (Invasive Plants) | Adjacent *Julis melifera* and *Opuntia sp* (Invasive Plants) | Adjacent *Sonneratia caseolaris* forest and paddy lands | Abandoned paddy lands *Sonneratia caseolaris* | Adjacent Tropical Rainforest | Adjacent *Sonneratia caseolaris* forest *Pandanus ceylanicus* |
| No floating or emergent aquatic macrophytes<br>Peripheral algal beds | *Typha* beds *Salvinia sp* *Potamogeton sp* | *Nelumbo sp* | *Typha sp* *Nelumbo sp* *Pistia sp* | No floating or emergent macrophytes present | *Nelumbo* patches |

## DISCUSSION

In Sri Lanka, approximately 120 species of odonates have been recorded so far. Among them, 57 species are endemic to the country, 20 species are threatened and all the 20 threatened species are endemic (Bambaradeniya, 2006).

Water quality parameters were different between two study sites in Bundala National Park. Among other study sites water quality parameters did not indicate any significant difference. Nevertheless surrounding vegetation structure of the study sites differed vastly (Table 3). The observed difference of the odonate species composition might be a result of the surrounding vegetation type.

Although major water quality parameters differed between Bundala lagoon and Embillakala lagoon, surrounding vegetation of these two lagoons was almost similar. These two lagoons are primarily surrounded by *Prosipis julifora* (E: Mesquite) and *Opuntia* (E:Cactus). Climate is hot and dry. Similarity of odonate species assemblage at the study sites of these two lagoons can be possibly attributed to similar vegetation structure cover rather than water quality. Low species diversity of odonates recorded at study sites of Bundala National Park might be a result of less habitat heterogeneity.

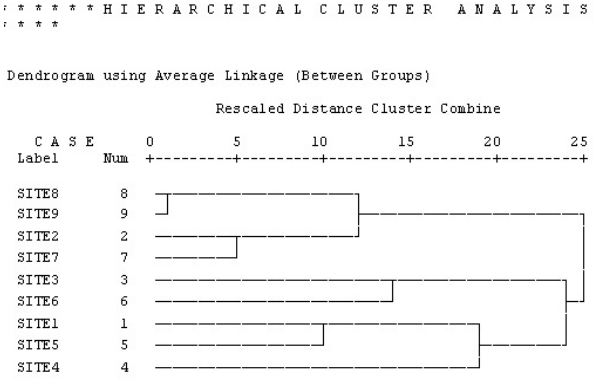


**Figure 9.** Grouping of study sites at "Kirala Kele" sanctuary, Matara based on the dragon fly species occurrence.

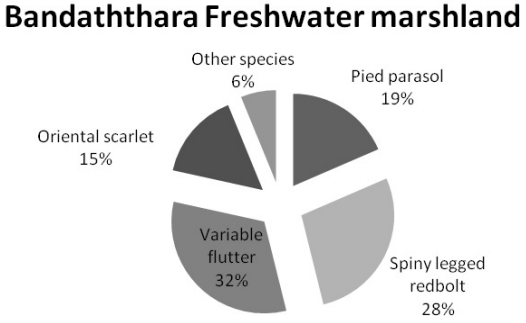


**Figure 10.** Percentage species composition recorded at the study site of Bandaththara freshwater marshland associated with Nilwala river.

Dragonfly diversity of Ambalanthota --"Kirala Kele" Biological Garden was comparatively high. Lentic and lotic fresh water systems of the area, openness of the area, adjacent paddy fields and associated *Sonneratia caseolaris* (Mangrove Apple Fruit) forest might support a diverse community of odonates. Stagnant water and slow moving water might provide good breeding sites for many odonate species (Bond *et al.,* 2006). Paddy fields and mangrove ecosystem provide habitat for millions of insects which in turn supply food for odonates. Warm climate of the region is another positive factor for odonates. Odonates prefer warm conditions (Corbet and May, 2008).

In "Kirala Kele" Eco-tourism Zone, a diverse species assemblage was recorded. Different areas of the study transect support different assemblages of odonates. Low species richness was recorded at first seven sites (1 to 7) in the study transect where shady bushlands were abundant. These bushlands were surrounded by marshlands. Comparatively high species richness was recorded at the last four sites (7 to 10) in the study transect where *Nelumbo sp* was abundantly available in the water bodies. These areas are open marshland areas consisting open water bodies and *Sonneratia caseolaris* vegetation. These open water bodies might provide good breeding sites for odonates. This might indicate the importance of habitat heterogeneity and openness of the area for odonate distribution. There are clear differences of the odonate species assemblages between the sites 1 to 6 and sites 7 to 9 indicating the difference of water bodies and associated vegetation types.

Bandaththara marshland system supports less species richness comparative to other study sites. A considerable area of this site has been covered by water. Nilwala river flows adjacent to western margin of the study transect. *Sonneratia caseolaris* dominated mangrove vegetation is situated adjacent to eastern margin of the transect . Nevertheless odonate nymphs might not be able to tolerate the flow rate of the river. The shaded water in mangrove ecosystem might also suppress odonate species survival and reproduction.

Similarly, Kosgahadola lentic water system supports low number of odonate species. Kosgahadola belongs to headwater region of the Nilwala riparian system. High flow rate and shady environment might negatively affect odonate diversity of the area.

Endemism of odonate species remains low among these study sites. Sri Lanka orange faced sprite (*Pseudagrion rubiceps*) recorded from "Kirala-Kele" biological garden-Ambalanthota and Shining Gossamerwing recorded from Kosgahadola stream-Mawarala were the endemic species recorded during the study period. Aggressive River hawk (*Onychothemis tonkinensis*) and Malabar sprite (*Pseudagrion malabaricum*) (damselfly species) from Kirala-Kele biological garden-Ambalanthota, Restless Demon (*Indothermis limbata)* from Kosgahadola stream-Mawarala were the three rare species recorded during the study period. Wandering glider from "Kirala-Kele" biological garden, Ambalanthota was the only migrant species recorded during the study period. There were no previous records of odonate species assemblages specific to the studied habitats. Our data indicates the key odonate species inhabiting studied habitats during the study period. These data will be useful in designing rapid ecological assessment tools. Further studies are required for a much comprehensive analysis. Nature and the type of aquatic vegetation and nearby vegetation might be key determinant of odonate species distribution.

## ACKNOWLEDGEMENTS

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