ON THE DIVERSITY AND ABUNDANCE OF RIPARIAN ODONATE FAUNA (INSECTA) OF THE MIDSTREAM CHALAKKUDY RIVER, KERALA, INDIA

C. Nitha Bose, C.F. Binoy & Francy K. Kakkassery

26 July 2021 | Vol. 13 | No. 8 | Pages: 19053–19059
DOI: 10.11609/jott.7328.13.8.19053-19059
On the diversity and abundance of riparian odonate fauna (Insecta) of the midstream Chalakkudy River, Kerala, India

C. Nitha Bose 1, C.F. Binoy 2 & Francy K. Kakkassery 3

1 Research and Postgraduate Department of Zoology, St. Thomas’ College (Autonomous), Thrissur, Kerala 680001, India.

2 nithabose123@gmail.com, 2 drcfbinoy@gmail.com, 3 fkakkassery@gmail.com (corresponding author)

Abstract: The riparian Odonate insect diversity of the midstream Chalakkudy River at six locations assessed from February 2018 to January 2019 has revealed the occurrence of 25 species of odonates. Among them, 10 species are dragonflies belonging to seven genera of the family Libellulidae and the remaining 15 species are damselflies belonging to six families and 11 genera. Five endemic damselfly species have been recorded. *Pseudagrion indicum* is endemic to the Western Ghats, while the remaining four species, *Vestalis apicalis, Libellago indica, Dysphaea ethela,* and *Heliocypha bisignata,* are endemic to India. Diversity indices of the odonates in all the six locations were analyzed and it showed less abundance at sites where tourist activities are more and with thin native riparian vegetation. Further, the study has unequivocally revealed that thick native riparian vegetation is essential for their perching and existence. By and large, the uncontrolled tourism activities and habitat alteration interfere with the density and diversity of these endemic species.

Keywords: Damselflies, dragonflies, endemism, odonates, tourism, Western Ghats.
INTRODUCTION

Kerala has a comprehensively documented odonate fauna. The relevant works among them include that of Rao & Lahiri (1982), Mathavan & Miller (1989), Radhakrishnan (1997), Emiliyamma & Radhakrishnan (2002), Emiliyamma (2005), Palot et al. (2005), Adarsh et al. (2014), Varghese et al. (2014), Nair (2017), and Susanth & Anooj (2020). Recent works further added up the rich odonate diversity of Kerala to 174 species (Emiliyamma et al. 2020; Joshi et al. 2020). The seasonal and habitat distribution of Odonata diversity of riparian habitats such as Mula and Mutha river basins in Maharashtra was studied by Kulkarni & Subramanian (2013). Species turn over and abundance of the odonates of riparian zones depends on season and land use types. Endemics and habitat specialists are restricted to undisturbed riverine ecosystems as they possess a narrow range of habitat tolerance. Conservation of riparian zone results in the conservation of endemics of odonates (Subramanian 2007; Subramanian et al. 2008). The present study investigated the odonate diversity and abundance of midstream Chalakkudy river giving special reference to endemics.

METHODS

The survey was conducted once a month from February 2018 to January 2019 by conventional random sampling. Six locations of midstream Chalakkudy River were randomly selected for the observation of odonates. The river is 13.5 km (approximately) long from the first location to last one (Bachan 2003). The details of the study localities are given in Table 1. All the six locations are with rocky river bed and evergreen and semi evergreen forest vegetation. Madhuca neriifolia, Syzigium occidentale, Humboldtia vahliana, Elaeocarpus, and Homonoia riparia are the dominant species of flowering plants in these locations (Bachan 2010). The selected locations have been confronted with anthropogenic disturbances such as habitat alteration due to tourism activities including resorts & commercial establishments, oil palm plantations, and activities of local people. The odonates were documented and identified with the help of photographs, keys, and descriptions given in the literature (Fraser 1933, 1934, 1936; Kiran & Raju 2013). The species richness and abundance were recorded and Simpson & Shannon diversity indices and eveness values were calculated using PAST software. The observed species of odonates were categorized as VC—Very common (180–240 sightings), CO—Common (120–180 sightings), OC—Occasional (60–120 sightings), and RA—Rare (1–60 sightings) depending upon their occurrence during the survey (Palot et al. 2005; Tiple et al. 2012).

RESULTS

During the study period, 2,186 individuals of 25 species were observed. Out of these, 10 species were dragonflies of the suborder Anisoptera, belonging to seven genera and the family Libellulidae. The remaining 15 species were damselflies under the suborder Zygoptera and they come under 11 genera in six families (Tables 1, 2). Libellulidae is the only anisopteran family, which has been observed among the odonates in the present survey. Orthetrum sabina a well-known cannibalistic dragonfly, has been found to be very common. On the other hand, Onychothemis testacea was encountered very rarely during the present survey. Members of the family Coenagrionidae (6 species) were dominating in the order Zygoptera succeeded by Calopterigidae (3 species) and Platycnemididae (3 species). Vestalis apicalis and Prodasineura verticalis were common but Aciagrion occidentale was observed only sporadically in this region. Out of the 25 species recorded, five species are endemics and they belong to the suborder Zygoptera. But Pseudagrion indicum is endemic to Western Ghats, while Vestalis apicalis is endemic to southern and central India, Libellago indica is endemic to peninsular India, whereas Dysphaea ethela and Heliocynthia bisignata are endemic to India (Kalkman et al. 2020). The most dominant endemic species observed in the present survey was Dysphaea ethela and Heliocynthia bisignata, which exhibited a minimum level of occurrence. The percentage distribution of each endemic species is as follows: Pseudagrion indicum 9%, Vestalis apicalis 26%, Libellago indica 28%, Dysphaea ethela 34%, and Heliocynthia bisignata 3%. The first location Ezhattumugham (L1) harboured as many as 536

### Table 1. Odonate collection localities.

| Sample collection sites | Latitude | Longitude | Altitude (m) |
|-------------------------|----------|-----------|--------------|
| L1 Ezhattumugham         | 10.295   | 76.451    | 39           |
| L2 Chiklayi              | 10.294   | 76.470    | 46           |
| L3 Ayyampuzha            | 10.292   | 76.478    | 47           |
| L4 Vettilappara          | 10.289   | 76.512    | 64           |
| L5 Athirappilly          | 10.285   | 76.558    | 86           |
| L6 Athirappilly waterfall| 10.284   | 76.569    | 116          |

Altitude is in meters.
individuals in 21 species. *Vestalis apicalis* was the most abundant, and endemic species. *Onychothemis testacea* and *Zygonyx iris* were recorded only from this location. The highest number of endemics were also recorded from here. In spite of the disturbances from tourists, this location showed a good quantity of native vegetation including emergent vegetation and shade cover and that perhaps resulted in the collection of a maximum number of individuals. The second location, Chiklayi (L2) yielded a maximum observation of 363 individuals of 17 species. *Orthetrum sabina* was the common species but *Libellago indica* was the prevalent endemic of this location. The habitat is rocky in nature with moderate shade cover and prominent emergent vegetation. Tourists’ activities are appreciably low and the native vegetation is limited by oil palm plantation. Maximum value of diversity indices was shown by location. The third location, Ayyampuzha (L3) was polluted by the activities of local people and tourists to some extent. But the oil palm plantation ousted the native vegetation. From this location having traces of shoreline plants, limited shade cover, boulders and rocks, 284 individuals of 15 species were recorded of which, *Trithemis aurora* was dominant with the endemic species *Libellago indica*. Vettilappara (L4) is yet another location having least human interference with appreciable shade cover and riparian vegetation. But the native riparian vegetation is narrowed into a thin belt by the plantation crops. *Libellago indica* (endemic) and *Pseudagrion rubriceps* were the commonly found species during the study period. A total of 501 individuals belonging to 17 species were encountered in Vettilappara. Athirappilly (L5) is slightly polluted by human activities (tourism and nearby construction works) with minimum shade cover and moderate emergent vegetation. Eighteen species were recorded during the survey. *Orthetrum sabina* and *Prodasineura verticalis* were the common species found along with the frequently encountered endemic damselfly, *Libellago indica*. Athirappilly waterfalls (L6) is another beautiful location where the tourists activities are significantly high and endowed with rocky habitat and riparian vegetation. But the presence of macrophytes and overhanging vegetation is scanty due to tourists disturbances. As a result, the numerical abundance of species recorded from this location was very less. However, the endemic dragonflies, *Dysphaea ethela* and *Vestalis apicalis* were the dominating species of this location.

**Effect of flood**

During the month of August of the study period, heavy downpour at Kerala led to a deluge and it badly affected the study areas. Riparian vegetation was totally destroyed. Natural soil texture was lost, soil accumulation could be found in river and river banks. As a consequence, a sudden drop in damselfly diversity
was noticed just after the flood. Only two species of damselflies were recorded in the first two months after the flood, i.e., September and October 2018. But dragonfly diversity was not much affected. In the succeeding months the species richness and abundance were observed to have rebounded.

Simpson & Shannon diversity indices and evenness values of the six locations were calculated (Table 4). Maximum species richness and abundance were found at Location 1. Simpson and Shannon diversity indices (0.9197 and 2.628, respectively) were found to be equally high for location 2, while the least values were shown by Location 6 (0.8694 and 2.191, respectively). Maximum value of evenness (0.8257) was recorded at Location 3 and a minimum at Location 1.

### DISCUSSION

The current study points out the role of native riparian vegetation and the impact of human interference such as habitat alteration by tourism, construction works and plantations on the density and diversity of odonate fauna. Studies revealed that riparian vegetation promotes the occurrence of invertebrates including insects and facilitates suitable habitat for insects by providing food, resting and hiding places for emergent adults and substratum for egg laying. Also the shade cover regulates water temperature and overall quality of the stream (Knight & Bottorff 1981; Ober & Hayes 2008). Moreover, the prey insects are attracted by flowering plants, which in turn form ideal food for odonates. Therefore, these conditions become more pertinent for the carnivorous odonates. The hanging plants and emergent macrophytes furnish perching sites and structures for egg laying and emergence of adults. Literature delineates the role of macrophytes and shoreline structures in oviposition, formation of larval microhabitat, emergence support and adult perching site (Samways & Steytler 1996; Schindler et al. 2003).

In the present study 15 species of damselflies and 10 dragonflies were recorded. As the damselflies are weak fliers, they may depend on their own microhabitat for food and reproduction. But the agile fliers, dragonflies are free to move to more extensive habitats according to their preferences. This is a factor of variation in species richness between the two suborders. The most commonly encountered dragonfly was *Orthetrum*

---

**Table 3. List of damselflies recorded from Chalakudy River.**

| Scientific name (Suborder: Zygoptera) | Abundance | IUCN Red List status |
|--------------------------------------|-----------|----------------------|
| **Family: Calopterygidae**          |           |                      |
| 1 Neurobasis chinensis (Linnaeus, 1758) | R         | LC                   |
| 2 Vestalis apicalis (Selys, 1873)   | VC & EN   | LC                   |
| 3 Vestalis gracilis (Rambur, 1842)  | C         | LC                   |
| **Family: Chlorocyphidae**          |           |                      |
| 4 Libellula indica (Fraser, 1928)   | C & EN    | LC                   |
| 5 Helicopsyche bisignata (Hagen in Selys, 1853) | R & EN  | LC                   |
| **Family: Coenagrionidae**          |           |                      |
| 6 Acisagron occidentale (Laidlaw, 1919) | R         | LC                   |
| 7 Agriocnemis pieris (Laidlaw, 1919) | R         | LC                   |
| 8 Agriocnemis pygmaro (Rambur, 1842) | R         | LC                   |
| 9 Ischnura rubila (Brauer, 1865)    | R         | LC                   |
| 10 Pseudagrion indicum (Fraser, 1924) | O & EN   | DD                   |
| 11 Pseudagrion rubriceps (Selys, 1876) | C         | LC                   |
| **Family: Euphaeidae**              |           |                      |
| 12 Dypsphae eritho (Fraser, 1924)   | VC & EN   | LC                   |
| **Family: Platycnemididae**         |           |                      |
| 13 Copera marginipes (Rambur, 1842) | R         | LC                   |
| 14 Copera vittata (Selys, 1863)     | R         | LC                   |
| 15 Prodasineura verticalis (Selys, 1860) | VC      | LC                   |

**Table 4. Community structure of odonates.**

| Parameters/ Indices | L1 Ezhattumugham | L2 Chiklayi | L3 Ayyampuzha | L4 Vettillappara | L5 Athirappilly | L6 Athirappilly waterfall |
|---------------------|------------------|-------------|---------------|------------------|----------------|---------------------------|
| Species richness    | 21               | 17          | 15            | 17               | 18             | 12                        |
| No. of individuals (per 200m unit sample) | 536       | 363         | 284           | 501              | 377            | 125                       |
| Simpson 1-D         | 0.8983           | 0.9197      | 0.9091        | 0.9121           | 0.9064         | 0.8694                    |
| Shannon H           | 2.518            | 2.628       | 2.517         | 2.561            | 2.545          | 2.191                     |
| Evenness            | 0.5907           | 0.8142      | 0.8257        | 0.7617           | 0.7079         | 0.7456                    |
Image 1. *Dysphaea ethela*

Image 2. *Pseudagrion indicum*

Image 3. *Libellago indica* (male)

Image 4. *Libellago indica* (female)

Image 5. *Vestalis apicalis*

Image 6. *Heliocypha bisignata*
sabina, which predate on other insects and exhibits cannibalistic behavior too (Iswandaru 2018). Further, adequate quantities of reeds support the occurrence of damselflies than dragonflies (Fulan et al. 2008). In the present study, L1, L2, L4 and L5 locations showed the maximum species richness, abundance and diversity. Despite the human disturbances, L1 showed the highest value of species richness and abundance. Presence of comparatively abundant native vegetation including emergent macrophytes supported the diversity in L1. Moreover, in L2, L3 and L4 sites, the native riparian vegetation is narrowed by the plantation crops. Vegetation in location L5 was destroyed as a result of resort construction. Pristine habitat loss results in the loss of odonate diversity (Rodrigues et al. 2016). But the presence of a modest percentage of riparian vegetation could hold up the diversity in these locations to some extent. Although L6 is devoid of plantation crops, the prominent disturbances from tourists have destroyed the emergent macrophytes and overhanging vegetation. This has led to the least diversity indices on species richness and abundance in L6. Another observation noticed in the present study was on the high abundance of endemic species in L1 and minimum distribution at L6. *Dysphaea ethela* and *Heliocypha bisignata* were reported to be respectively the common and rarely occurring endemic species.

As per the literature, undisturbed riparian forests are typically rich with the presence of endemics (Subramanian et al. 2008). Destruction of riparian flora and fauna could be attributed to damming, tourists activities, construction works and expanding the area for agricultural plantations leading to the declined number of species. For instance, it is evident that the fish fauna of Chalakkudy river is highly threatened by damming, deforestation and pesticide pollution (Raghavan et al. 2008). Habitat alteration interferes with the abundance of endemic odonates and supports the occurrence of generalist species like libellulids (Kalkman et al. 2008; Subramanian et al. 2008), and that is evident in the present study. Research work delineates the resilience capacity of organisms to flood (Death 2008; Golab & Sniegula 2012; Raghavan 2019). Inspite of the destructive flood during the current study, odonates showed a tendency to bounce back to pre-flood conditions within a very short time. Further studies are required to authenticate the same.

REFERENCES

Adarsh, C.K., K.S. Aneesh & P.O. Nameer (2014). A preliminary checklist of odonates in Kerala Agricultural University (KAU) campus, Thrissur District, Kerala, southern India. *Journal of Threatened Taxa* 6(8): 6127–6137. https://doi.org/10.11609/jott.63491.6127-37

Bachan, A.K.H (2003). Riparian vegetation along the middle and lower zones of the Chalakkudy river, Kerala, India. Project 26/2000 Sponsored by Kerala Research Programme on Local Level Development, CDS, Thiruvananthapuram

Bachan, A.K.H. (2010). Riparian flora of the Chalakkudy river basin and its ecological significance. Ph D Thesis. Department of Botany, University of Calicut, xi+882pp.

Death, R.G. (2008). The Effect of Floods on Aquatic Invertebrate Communities, pp. 113-121. Proceedings of the Royal Entomological Society’s 24th Symposium. Royal Entomological Society of London. Cromwell Press, Trowbridge, UK.

Emiliyamma, K.G. (2005). On the Odonata (Insect) Fauna of Kottayam District, Kerala, India. *Zoo’s Print Journal* 20(12): 2108–2110. https://doi.org/10.11609/jott.1338.2108-10

Emiliyamma, K.G. & C. Radhakrishnan (2002). Additions to the Odonata (Insecta) of Thiruvananthapuram District, Kerala. *Zoo’s Print Journal* 17(10): 914–917. https://doi.org/10.11609/jott.ZPJ.17.10.914-7

Emiliyamma, K.G., M.J. Palot & C. Chares (2020). A new species of *Platylestes* Selys (Odonata: Zygoptera: Lestidae) from the coastal area of Kannur District, Kerala, India. *Journal of Threatened Taxa* 12(13): 16854–16860. https://doi.org/10.11609/jott.5209.12.13.16854-16860

Fraser, F.C. (1933). The Fauna of British India including Ceylon and Burma. Odonata – Vol. I. Taylor and Francis Ltd, London, 423pp.

Fraser, F.C. (1934). The Fauna of British India including Ceylon and Burma. Odonata – Vol. II. Taylor and Francis Ltd, London, 398pp.

Fraser, F.C. (1936). The Fauna of British India including Ceylon and Burma. Odonata – Vol. III. Taylor and Francis Ltd, London, 461pp.

Fulan, J.A., R. Raimundo & D. Figueiredo (2008). Habitat characteristics and dragonflies (Odonata) diversity and abundance in the Guadiana River, eastern of the Alentejo, Portugal. *Boletin de la Asociación española de Entomología* 32(3-4): 327–340.

Gobal, M.J. & S. Sniegula (2012). Changes in reproductive behavior in adult damselfly *Calypteryx splendens* (Odonata: Calopterygidae) in response to flood. *Entomological Science* 15(3): 280–287. https://doi.org/10.1111/j.1174-8999.2012.00516.x

Iswandaru, D. (2018). Diversity of dragonflies (Odonata) in swamp ecosystem University of Lampung. *Agricultura* 105(1–2): 101–109.

Joshi, S., K.A. Subramanian, R. Babu, D. Sawant & K. Kunte (2020). Three new species of *Protosticta* Selys, 1885 (Odonata: Platystictidae) from the Western Ghats, India, with taxonomic notes on *P. mortoni* Fraser, 1922 and rediscovery of *P. rufostigma* Kimmins, 1958. *Zootaxa* 4858(2): 151–185. https://doi.org/10.11646/zootaxa.4858.2.1

Kalkman, V.J., V. Claussnitzer, K.D.B. Dijkstra, A.G. Orr, D.R. Paulson & J.V. Tol (2008). Global diversity of dragonflies (Odonata) in freshwater. *Hydrobiologia* 595: 351–363. https://doi.org/10.1007/s10750-007-9029-x

Kiran, C.G. & D. Raju (2013). Dragonflies and Damselflies of Kerala. Tropical Institute of Ecological Sciences, Greenleaf Publications, Kottayam, Kerala, India.

Knight, A.W. & R. Bottorff (1981). The importance of riparian vegetation to stream ecosystems. In: Warner & K.M. Hendrix (eds.). *California Riparian Systems Conference: Ecology, Conservation, and Productive Management*. University of California Press.

Kulkarni, A.S. & K.A. Subramanian (2013). Habitat and seasonal
distribution of Odonata (Insecta) of Mula and Mutha river basins, Maharashtra, India. *Journal of Threatened Taxa* 5(7): 4084–4095. https://doi.org/10.11609/JoTT.o3253.4084-95

Mathavan, S. & P.L. Miller (1989). A Collection of Dragonflies (Odonata) made in the Periyar National Park, Kerala, South India, in January 1988. *International Odonatological Society, Bilthoven, Rapid communications (supplements) 10*: 1–10

Nair, V.P. (2017). Dragonflies: Additions to the Odonata (Insecta) fauna of Varadod, Kannur, Kerala, South India. *Bugs R All #164*. In: *Zoo’s Print 32*(11): 24–30.

Ober, H.K. & J.P. Hayes (2008). Influence of forest riparian vegetation on abundance and biomass of nocturnal flying insects. *Forest Ecology and Management* 256(5): 1124–1132. https://doi.org/10.1016/j.foreco.2008.06.010

Palot, M.J., C. Radhakrishnan & V.P. Soniya (2005). Odonata (Insecta) diversity of rice field habitat in Palakkad district, Kerala. *Record of Zoological Survey of India* 104(Part 1-2): 71–77.

Radhakrishnan, C. (1997). Ecology and conservation status of entomofauna of Malabar. *Zoot’s Print 11*: 2–5.

Raghavan, R. (2019). Impact of 2018 Kerala floods on aquatic biodiversity with special reference to single location endemic species. Report submitted to the Kerala State Biodiversity Board.

Raghavan, R., G. Prasad, P.H.A. Ali & B. Pereira (2008). Fish fauna of Chalakudy River, part of Western Ghats biodiversity hotspot, Kerala, India: patterns of distribution, threats and conservation needs. *Biodiversity and Conservation* 17: 3119–3131. https://doi.org/10.1007/s10531-007-9293-0

Rao, R. & A.R. Lahiri (1982). First records of odonates (Arthropoda: Insecta) from the Silent Valley and New Amarambalam Reserved Forests. *Journal of the Bombay Natural History Society* 79(3): 557–562.

Rodríguez, M.E., F.O. Roque, J.M.O. Quintero, J.C.C. Pena, D.C. Sousa & P.D.M. Junior (2016). Nonlinear responses in damselfly community along a gradient of habitat loss in a savanna landscape. * Biological Conservation* 194: 113–120. https://doi.org/10.1016/j.biocon.2015.12.001

Samways, M.J. & N.S. Steytler (1996). Dragonfly (Odonata) distribution patterns in urban and forest landscapes, and recommendations for riparian management. *Biological Conservation* 78(3): 279–288. https://doi.org/10.1016/S0006-3207(96)00032-8

Schindler, M., C. Fesl & A. Chovanec (2003). Dragonfly associations (Insecta: Odonata) in relation to habitat variables: A multivariate approach. *Hydrobiologia* 497(1):169–180. https://doi.org/10.1023/A:1025476220081

Subramanian, K.A. (2007). Endemic Odonates of the Western Ghats: Habitat distribution and conservation. *Odonata: Biology of Dragonflies*. Scientific Publishers.

Subramanian, K.A., S. Ali & T.V. Ramachandra (2008). Odonata as indicators of riparian ecosystem health a case study from south western Karnataka, India. *Fraseria (N.S.)* 7:83–95.

Susanth, C. & S.S. Anooj (2020). Checklist of Odonata of Wayanad district, Kerala. *Indian Journal of Entomology* 82(2): 315–323. https://doi.org/10.5958/0974-8172.2020.00072.3

Tiple A.D., S. Paunikar & S.S. Talmale (2012). Dragonflies and Damselflies (Odonata: Insecta) of Tropical Forest Research Institute, Jabalpur, Madhya Pradesh, Central India. *Journal of Threatened Taxa* 4(4): 2529–2533. https://doi.org/10.11609/JoTT.o2657.2529-33

Varghese, A.P., P.R. Nikesh & J. Mathew (2014). Odonata (Insecta) diversity of Salim Ali Bird Sanctuary and its adjacent areas in Thattekkad, Kerala, India. *Journal of Threatened Taxa* 6(6): 5887–5893. https://doi.org/10.11609/JoTT.o3395.5887-93
Diversity of ants in Aarey Milk Colony, Mumbai, India

Distribution and habitat preferences of the Chinese Pangolin

Communications

– Le Xuan Son, Nguyen Thi Tu Anh, – Suresh M. Kumbar, Shrikant S. Jadhav, Swapnali B. Lad, Abhijit B. Ghadage, Satyawan S. Patil &

On the rediscovery of a rare root parasite

Notes

First photographic record of Mishmi Takin Budorcas taxicolor taxicolor and Red Goral

On the rediscovery of a rare root parasite

First record of the hoverfly genus Spilomyia Meigen (Diptera: Syrphidae) for Pakistan

Rediscovery of Watson's Demon

A new distribution record of

A preliminary checklist of dragonflies and damselflies (Insecta: Odonata) of Vakkom Grama

Identification of a unique barb from the dorsal body contour feathers of the Indian Pitta

A new distribution record of

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

On the rediscovery of a rare root parasite

First photographic record of Mishmi Takin Budorcas taxicolor taxicolor and Red Goral

First record of the hoverfly genus Spilomyia Meigen (Diptera: Syrphidae) for Pakistan

A new distribution record of

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes

Notes