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SHORT COMMUNICATION

POTENTIAL PHYTOPHAGOUS INSECTS OF *PTERIDIUM REVOLUTUM* (BLUME) NAKAI, AN INVASIVE FERN

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Potential phytophagous insects of *Pteridium revolutum* (Blume) Nakai, an invasive fern

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Abstract: The article reports an observation on the phytophagous behaviour by the insect larvae of two insect species on a fern, Pteridium revolutum, which is fast emerging as an invasive plant species threatening local biodiversity and wildlife in Kerala State, India.

Keywords: Biological control, phytophagous nature, Pteridium, Western Ghats.

Bracken ferns (genus Pteridium) represent an ancient species complex with a natural worldwide distribution (Der et al. 2009). Notorious as weeds because of its exceptional ability to grow rhizomatously in dense patches, these ferns are widely reported to overgrow in open fields and pastures (Tryon 1941; Holm et al. 1997). Invasiveness of these clonally growing ferns is attributed to their vigorous vegetative propagation ability and genetic variability (Zhou et al. 2014). Pteridium revolutum (Blume) Nakai has reported distribution in diverse ecosystems in India, Sri Lanka, China, Taiwan, southern Japan, Myanmar, the Philippines, Thailand, throughout southeastern Asia, New Guinea, and Australia (Ranil et al. 2010; Deepa et al. 2013). In tropical and subtropical areas of Asia, above 1,000m, P. revolutum is perennial with fronds that grow from the robust underground rhizomes, reaching over 1m in height (Zheng et al. 2008).

In Chinese medicine, rhizomes of this fern have uses and the fronds are regarded to be attractive to the landscape (Zhang & Zhang 1986).

PLATINUM

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Toxic effects on herbivores

Many workers like Smith (1990) and Taylor (1990) have reported that in China, the Bracken Fern Pteridium sp. is a very common plant and is often browsed by domestic herbivores, developing several syndromes. Enzootic haematuria, the clinical name of the urinary bladder neoplasia of ruminants (bovine enzootic haematuria), tends to occur persistently in localized bracken infested regions throughout the world. In China, enzootic haematuria of cattle was observed in almost all the provinces where P. revolutum occurred, but the disease has not been reported outside of these regions (Leren 1989; Xu 1992). Furthermore, in areas where enzootic haematuria was found, the disease usually occured in highland or mountainous areas at 950-2,000 m where conditions are suitable for the growth of P. revolutum (Xu 1986). Consumption of this fern has also been reported to cause urinary bladder cancer in ruminants. It is also associated with carcinoma of the upper digestive tract of cattle, where it is believed to be caused by the malignant transformation of the bovine papilloma (Jarrett 1987).

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Editor: Anonymity requested.

The major carcinogen of bracken has been identified as Ptaquiloside, a norsesquiterpenoid glycoside (Niwa et al. 1983; Hirono et al. 1984). This readily undergoes glucose elimination to form an unstable conjugated dieneone intermediate capable of alkylating amino acids and DNA (Fletcher et al. 2011). The mutagenicity (Nagao et al. 1989), clastogenicity (Matsuoka et al. 1989), and carcinogenicity (Hirono et al. 1984) of ptaquiloside have been well demonstrated. Bracken has also been associated with livestock poisoning causing bone marrow damage leading to a fatal hemorrhagic disease of cattle ("Bracken" poisoning), and "bracken staggers" of horses (an effect of thiaminase). Fenwick (1989) had drawn attention to the possibility of indirect consumption of the Bracken carcinogen which may cause or increase the risk of cancer in man.

Pteridium revolutum

Rhizomes long-creeping, hairy, subterranean. Stipes and rachises dull yellow brown, bearing abundant non-glandular hairs, stipes 25-60 cm long, 3-6 mm diameter, hard. Laminae broadly ovate or triangular to broader than long, 100 x 30–90 cm, 3-pinnate at base, leathery, dull light green on both surfaces, not mealy on underside. Primary pinnae arising at narrow angles to rachis, the longest 18-60 x 8-45 cm. Secondary pinnae arising at wide angles, the longest 4-25 x 1-4 cm; midribs of primary and secondary pinnae lacking free lobes or wings. Tertiary pinnae all equal in length on each secondary pinna, the longest 0.6–2.5 x 0.3–0.5 cm. Ultimate segments linear, slightly falcate, acute, entire, adnate. Upper lamina surface sparsely hairy along midribs, lower with dense, colourless, spreading, nonglandular hairs throughout. Reflexed lamina margins protecting sori membranous, fimbriate and hairy (Brownsey 1989).

Natural enemies on Pteridium revolutum

Generally, the fern is considered unpalatable to many animal and insect species due to the presence of toxic secondary metabolites like ptaquiloside, however, we observed two "natural insect feeders" relishing on bracken population in the Chembra and Thirunelly areas in Wayanad District, Kerala State, India. Similar observations could also be noted at Thrissur District (Vazhachal high altitude region) and Gavi (Periyar Tiger Reserve area) in Kerala State, India. During a survey on the distribution of *Pteridium* in Kerala, insect larvae seen feeding on this fern were collected and carried to the lab for identification. The feeding nature, extent of damage caused etc were carefully observed and recorded. Arjun & Gopakumar



Image 1. Larvae of Spilosoma obliqua (5th instar stage).



Image 2. Final instar stage of T. catamitus larvae.



Image 3. Adult of T. catamitus.

The collected specimens were later identified as the larvae of two insect species namely, *Spilosoma obliqua* (Lepidoptera: Arctiidae) and *Tetragonus catamitus* (Callidulidae) with the help of insect taxonomists at Kerala Agricultural University (KAU), Kerala State, India.

Spilosoma obliqua

Spilosoma obliqua Walker (Syn. Diacrisia obliqua) (Lepidoptera: Arctiidae), commonly known in Asia as the Bihar hairy caterpillar, is a sporadic but polyphagous plant pest that occurs in Bangladesh, Myanmar, India, Pakistan, and Sri Lanka (Singh & Sehgal 1992). The larvae of this species were found feeding on the frond of the bracken fern in the observed areas.

According to Warad & Kalleshwara (2017), the young larvae are translucent light yellow with dark big head (Plate1). The larval body has number of long hairs arising from dark coloured tubercles. Once fully grown, it is more stout and cylindrical with conspicuous dark anterior and posterior patches. Pupation occurs in the soil. The adults are medium sized brown moths and have pink abdomen with wings pinkish with numerous black spots. The antennae and legs are light brown. The average longevity of the adult male is 4–5 days with an average of 4.40 days. The female is bigger than the male. The abdomen of female is blunt, while the abdomen of male is narrower and pointed.

Tetragonus catamitus

T. catamitus, though easily identifiable, are difficult to observe in the field but have been reported from Kerala (Sondhi et al. 2018). Since the larvae of *T. catamitus* feed on ferns, they are also known as Fern Moth. Holloway (1998) also mentions that it hosts on genus *Drynaria* and further mentioned that *T. catamitus* in Hong Kong hosts on *Pteridium* (unpublished Initial Environmental Examination Report).

Their eggs are very flat, scale-like (Holloway 1998). Eggs are laid on the underside of fronds or the young stalk of the host plant. Larvae start feeding from the tip of the pinnae and it seems that their strong mandibles help them to eat the central veins. The head and first thoracic segment of the larvae are black and they have well-developed, chitinous, shiny, black prothoracic shields, which are separated by a median green line. The same line splits into two at the base of the head carapace and extends towards the forehead forming a 'V' shaped mark. Larvae have grass green, translucent bodies. The head of the observed specimen had two symmetrical pale-whitish triangular patches besides the 'V' shaped marking. The head and prothoracic shield on



Image 4. Damage caused by T. catamitus.



Image 5. Larvae inside the frond.

the first thoracic bore several whitish, translucent bristles of various sizes. The pupa is a medium-sized cocoon of an elongated narrow ovate shape, chocolate brown in colour; with a prominent head, which is thickest in the middle, a parallel-sided abdomen forms a cone at the last four segments.

Potential bio-control agents of Bracken Fern

Even though Bracken Fern's foliage has been reported to possess toxicity, we noticed profuse feeding by these two insect larvae in Wayanad District, Kerala State, India. The frond which was being eaten by these two larvae was neither juvenile nor too mature. While *T. catamitus* larvae were observed as feeding on both the veins and leafy portions, *S. obliqua* were avoiding the veins and feeding only on the leaf portion. *S. obliqua* larvae also left a net-like structure around the frond on which it fed. We noticed that *S. obliqua* larvae. The feeding pattern of



Image 6 . S. obliqua feeding frond of P. revolutum at Chembra, Wayanad, Kerala.

both the larvae was also noticeably different. The larva of *S. obliqua* seems to be concentrating on one frond at a time. As they could not chew the whole frond, some pinnules were left unaffected by the larvae. On the other hand, *T. catamitus* fed at random. Further, the larvae of *T. catamitus* were observed to use the fern frond to make pupa and finally to moth. *S. obliqua* used the fern only for feeding and no sign of any pupa formation in the frond could be seen. The net-like structure caused by the *S. oblique* could make the frond vulnerable in case of forest fire.

CONCLUSION

We have observed the 'invasiveness' of the Bracken or Eagle Fern Pteridium revolutum in the forest ecosystems of Wayanad, Thrissur, and Pathanamthitta districts of Kerala State, India. The threat of this fern is more in the higher altitudes of the Western Ghats landscape, where the unique grassland ecosystem thrives. The phytotoxicity of this 'weed' and its impact on native flora and foraging fauna, including wild herbivores must be researched and conclusions drawn to shape their management strategies. As P. revolutum possess a long, wide creeping rhizome, its mechanical or physical method of management has severe limitations. On the other hand, any disturbance to its root zone will help the weed to establish more aggressively. P. revolutum is also highly resistant to drought and fire, which is another favourable trait of its invasiveness. In the light of these, the potential role of the larvae of Spilosoma oblique (Lepidoptera: Arctiidae) and Tetragonus catamitus (Callidulidae) to manage this invasive fern merits immediate consideration.

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Short Communications

Occurrence of mammalian small carnivores in Kalakad-Mundanthurai Tiger Reserve,

Western Ghats, India – A. Venkatesh, N. Sridharan, S. Agnes Jeya Packiavathi & K. Muthamizh Selvan, Pp. 17984– 17989

Changed avian assemblage of Savitribai Phule Pune University campus in last four decades – Kiran Choudaj & Varsha Wankhade, Pp. 17990–17998

Sandracottus vijayakumari (Coleoptera: Dytiscidae), a new aquatic beetle species from landslide hit area of Nelliyampathy Forest Range, Western Ghats, Kerala, India – P.P. Anand, P.P. Ashiq, M. Smitha, M. Adhithya, T. Tibin & V. Suresh, Pp. 17999–18003

The genus Basiria Siddiqi, 1959 (Nematoda: Tylenchidae) from Dezful region, Iran – Manouchehr Hosseinvand, Ali Eskandari & Reza Ghaderi, Pp. 18004–18010

A new species of braconid wasp *Meteorus* Haliday (Hymenoptera: Braconidae: Meteorinae) from India

- Zaheer Ahmed, Altaf Hussain Mir & Mohammad Shamim, Pp. 18011-18014

Addition of four woodlice species (Crustacea: Isopoda) to the checklist of Iranian Oniscidea – Yaser Bakhshi, Saber Sadeghi, Hamid Darvishnia & Meysam Dashan, Pp. 18015–18019

Catalogue of selected insect groups of Lalwan Community Reserve and Ranjit Sagar Conservation Reserve, Punjab, India

 Amar Paul Singh, Agni Chandra, Virendra Prasad Uniyal & Bhupendra Singh Adhikari, Pp. 18020–18029

Potential phytophagous insects of *Pteridium revolutum* (Blume) Nakai, an invasive fern – M.S. Arjun & S. Gopakumar, Pp. 18030–18034

Notes

Freshwater medusae Limnocnida indica Annandale, 1911 in the Cauvery Wildlife Sanctuary, Dubare Reserve Forest and Shivanasamudram in Karnataka, India, with a commentary note on the exotic Craspedacusta sowerbii Lankester, 1880 – Naren Sreenivasan & Joshua Barton, Pp. 18035–18038

Actinor radians (Moore, 1878) (Hesperiidae: Hesperiinae: Aeromachini): addition to the butterfly fauna of Haryana, India

- Bitupan Boruah, Rajesh Chahal & Abhijit Das, Pp. 18039-18041

Rediscovery of the rare Desert Grizzled Skipper Spialia doris evanida Butler, 1880 (Hesperiidae: Pyrginae) from the Thar Desert, Rajasthan, India – Shyam Sundar Meena, Anil Tripathi, Vijay Kumar Koli & M. Akram Awan, Pp. 18042–18044

Habitat association and hybridization in woodbrowns (*Lethe nicetas, L. sidonis, & L. dakwania*) (Lepidoptera: Nymphalidae: Satyrinae) in Kedarnath Musk Deer Reserve, western Himalaya

– Arun Pratap Singh & Tribhuwan Singh, Pp. 18045–18049

Begonia flaviflora Hara (Begoniaceae): a new record to the flora of Bhutan – Phub Gyeltshen, Sherab Jamtsho, Sangay Wangchuk & Dhan Bahadur Subba, Pp. 18050– 18053

Revisiting the taxonomy of *Strobilanthes lawsonii* and *S. pushpangadanii* (Acanthaceae), two endemic taxa of Western Ghats, India

 Blessy Cherian, K.M. Prabhukumar, R. Jagadeesan, V.V. Naveen Kumar & Indira Balachandran, Pp. 18054–18058





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Article

Decline of White-throated Bushchat *Saxicola insignis* Gray J.E. & J.R. Gray, 1847 (Aves: Passeriformes: Muscicapidae) in Nepal: implications on its global status – Hem Sagar Baral, Tek Raj Bhatt, Bed Kumar Dhakal, Dhiraj Chaudhary, Hemanta Kumar Yadav, Laxman Prasad Poudyal, Hathan Chaudhary, Pradeep Raj Joshi, Carol Inskipp & Rajan Amin, Pp. 17847–17855

Conservation Application

Relocation of a GPS collared conflict Sloth Bear *Melursus ursinus* (Mammalia: Carnivora) in Karnataka, Indiat

 Attur Shanmugam Arun, Shanmugavelu Swaminathan, Yogaraj Pannerselvam, Thomas Robert Sharp, Sydney Rae Stephens, Kartick Satyanarayan & Geeta Seshamani, Pp. 17856– 17864

Communications

Not all gone: the rediscovery of Jaguar (Carnivora: Felidae: Panthera onca) and records of threatened monkeys (Primates: Mammalia) in the Magdalena River Valley of Caldas Department in Colombia, a call for their conservation

– Leonardo Mendieta-Giraldo, Sergio Escobar-Lasso, Esteban Grajales-Suaza & José F. González-Maya, Pp. 17865–17874

First confirmed sightings of Blue Whales Balaenoptera musculus Linnaeus, 1758 (Mammalia: Cetartiodactyla: Balaenopteridae) in the Philippines since the 19th century – Jo Marie Vera Acebes, Joshua Neal Silberg, Timothy John Gardner, Edna Rex Sabater, Angelico Jose Cavada Tiongson, Patricia Dumandan, Diana Maria Margarita Verdote, Christine Louise Emata, Jean Utzurrum & Arnel Andrew Yaptinchay, Pp. 17875–17888

Parasitic infection in captive wild mammals and birds in Bangabandhu Sheikh Mujib Safari Park, Cox's Bazar, Bangladesh

- M. Najmul Hossain, Anita Rani Dey, Nurjahan Begum & Thahsin Farjana, Pp. 17889-17894

A rapid assessment of waterbirds and the mangrove status in the Menabe Antimena Protected Area, Madagascar

- Christoph Zöckler, Solofo Ndrina Razanamaheninina & Matthias Markolf, Pp. 17895-17905

An appraisal of avian species diversity in and around Purulia Town, West Bengal, India – Swastik Mahato, Sudipta Mandal & Dipanwita Das, Pp. 17906–17917

An annotated checklist of amphibians in and around Dampa Tiger Reserve, Mizoram, India – Ht. Decemson, Sushanto Gouda, Lalbiakzuala, Lalmuansanga, Gospel Zothanmawia Hmar, Mathipi Vabeiryureilai & H.T. Lalremsanga, Pp. 17918–17929

Redescription of the bug Aschistocoris brevicornis (Heteroptera: Coreidae) and first report on its life history from northern Maharashtra, India

– Digvijay R. Jadhav, Renuka R. Khairnar, Balasaheb V. Sarode, Swapnil S. Boyane & Hemant V. Ghate, Pp. 17930–17938

A new taxon of *Nacaduba* Moore, 1881 (Lepidoptera: Lycaenidae: Polyommatini) from Agasthyamalais of the Western Ghats, India

– Kalesh Sadasivan, Baiju Kochunarayanan, Rahul Khot & S. Ramasamy Kamaya Naicker, Pp. 17939–17949

Does the size of the butterfly enhance detection? Factors influencing butterfly detection in species inventory surveys

- Anju Velayudhan, Ashokkumar Mohanarangan, George Chandy & S. Biju, Pp. 17950-17962

Dragonflies and damselflies (Insecta: Odonata) of the Kole Wetlands, central Kerala, India – A. Vivek Chandran, Subin K. Jose & Sujith V. Gopalan, Pp. 17963–17971

Distribution and diversity of climbing species in Papum Pare District of Arunachal Pradesh, India

- Soyala Kashung, Padma Raj Gajurel & Binay Singh, Pp. 17972-17983

Member

