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"First Record of Bipalium indicum (Whitehouse, 1914) and Bipalium bengalensis (Bhakat, 2020) in Nepalgunj Sub-Metropolitan City, Nepal"

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Abstract

Numerous planarian species showing a significant phenotypic diversity have been documented to exist in different countries, but there are no documented reports about *Bipalium* in Nepal. In this paper, I presented the first report on the occurrence of *Bipalium* species in Nepal. The collected flatworm species were identified based on external morphological characteristics. Body length, body colour, the shape of the head, and the presence of longitudinal stripes on the dorsal side of the body were considered key for species identification. The description of the hammer-headed land flatworm *Bipalium* serves as the foundation for the current paper. Two species of *Bipalium* i.e., *Bipalium indicum* and *Bipalium bengalensis* were identified from the Nepalgunj sub-metropolitan city of Banke district, Nepal at 28°2′53.39″N and 81°37′17.48″E. The species identified are new to Nepal and have not ever been documented.

Keywords: *Bipalium*, hammer-headed flatworm, Nepalgunj, Nepal

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1. Introduction

The country Nepal is rich in biodiversity but yet many species of animals and plants have to be explore. Hammer-headed flatworms (*Bipalium*) are broad-headed terrestrial planarians with distinct hammer-like heads. They are very special in that they have a "creeping sole" and a highly ciliated area on the epidermis of the ventral side that allows them to creep on the substrate. Flatworms are included in the phylum Platyhelminthes, their species number is over 20,000. The majority of flatworms are parasitic; however, some are free-living and all have flat bodies that are bilaterally symmetrical. They have a ribbon-like dorso-ventrally flattened structure. Flatworms fall into four main categories: Cestodes, Planarians, Trematodes, and the parasite Monogenea. Mostly Planarian flatworms are free living and can be found in wet terrestrial, marine, or freshwater environments. Land flatworms were among the first categories of organisms that developed terrestrial adaptations and spread extensively (Sluys, 2019). The genus *Bipalium* is a predatory hammer-headed Planarian flatworm with a spade-shaped expanded head. Since several species in this genus resemble a pickaxe, the name *Bipalium* is derived from the Latin bi-, "two," and pala, "shovel," or "spade" (Stimpson, 1857). *Bipalium kewense* Moseley, a terrestrial planarian, was originally identified in 1878 from a greenhouse at Kew Botanical Gardens outside of London, England. Land flatworms are easy to identify by their large size, distinctive colours, and the typical shape of their head, making them easy to identify (Winsor, 1983). There are just 822 known nominal species of terrestrial planarians in the world, making them a very species-poor category (Carbayo et al., 2002; Jones, 1998; Sluys, 1999; Winsor, 1997). This Asiatic triclad group contains more than 160 species of the genus *Bipalium* (Stimson, 1857). High temperatures and humidity are perfect conditions for land planarians to thrive; hence they are widely distributed in tropical and subtropical countries. Records for this group have been found in China, India, Japan, Korea, Madagascar, the Russian Far East, and Taiwan, and it exhibits the greatest diversity in Asia and Africa (Kawakatsu et al., 2005). Records of the existence of Plannarian species have also been reported in Eastern Europe (Mori et al., 2023). Additionally, records for the island of Ischia (Campania, Italy) have also been reported recently (Mori[1] et al., 2024). Despite having Asian roots and being native to India, Indochina, Indonesia, and Japan, the majority of organisms have spread around the world (Graff, 1899).

Under the name *Dunlopea*, Wright (1860) identified a few hammerhead worms from China and India but later, the genus *Bipalium* was created to include all terrestrial planarian species. Graff (1899) initially identified three land planarian genera based on the morphology of their heads: *Bipalium*, *Perocephalus*, and *Placocephalus*. Elliot (1848) designated a few terrestrial planarians as members of the genus *Planaria*. Kawakatsu & Jayashankar (2013) published a list of 27 bipaliid species of India along with their distribution in India under the four genera viz., *Bipalium*, *Humbertium*, *Novibipalium*, and *Diversibipalium*. *Bipalium* is believed to be native to the Indo-China region, and has been commonly found in American greenhouses

since 1901. *Bipalium* Stimpson 1857, *Novibipalium* Kawakatsu, Ogren & Froehlich 1998, and *Humbertium* Ogren & Sluys 2001, are three genera into which all of the known bipaliid species have been reassigned and the remaining questionable species were put in a distinct group called *Diversipalium* (Kawakatsu et al., 2002). Despite significant studies on hammer-headed flatworms, there are still many knowledge gaps about their biology, ecology, and management approaches. More research is needed to understand the precise effects they have on ecosystems, the variables that contribute to their invasiveness, and effective control strategies. Hammer-headed land flatworms pose a threat to the biodiversity and ecology of soil because they prey on soil invertebrates including earthworms, slugs, and snails (Fourcade et al., 2022; Zhongming et al., 2022). However, using the MaxEnt software, Negrete et al., (2020) examined the possible global distribution of *Obama nungara* and made predictions about the expansion of species to Europe, Oceania, and other Asian countries, including Nepal. However, hammer-headed land flatworms are a major threat to soil biodiversity and ecology no research has been done regarding species diversity and the status of hammer-headed flatworms, *Bipalium* in Nepal. The main goal of this article is to identify and document those land planarians that have not been documented from Nepal. The present research paper fills up the gap by describing the record of *Bipalium* species in Nepal, highlighting key characteristics.

2. Materials and Methods

2.1. Study area

The study area for the research was Nepalgunj sub-metropolitan city which is located in Banke district of Lumbini province, Nepal. It has a total of 23 wards, which are scattered across 86 km^2 of geographical area. The Janaki rural municipality borders from north and west sides of the Nepalgunj sub-metropolitan city. The east side boundary is the Dundwa rural municipality whereas the south border is the Indian Territory.

2.2. Methods

The survey was conducted in all 23 wards of Nepalgunj sub-metropolitan city (28°2′53.39″N and 81°37′17.48″E) of Banke district Nepal from June 10 to October 5, 2022. The flatworms were picked up from the damp soil surface with the help of forceps. The live individuals were kept under 30% NaCl solution and preserved in 80% alcohol till the study on it. Photographs of animals were taken by the mobile Redmi 7 pro model.

The species of the collected animals were determined based on external morphological traits. Key characteristics for identifying a species include body length, body color, head form, and the presence of longitudinal stripes on the dorsal side of the body. Each individual was measured using a digital dial caliper at an accuracy of 0.1mm. The body length (BL) was measured from the anterior end to the tail end. Measurement of mouth and gonopore positions is expressed as a percentage of body length (BL).

3. Result and Discussion

Report and description of *Bipalium* spp. new to Nepal

1. *Bipalium indicum* Whitehouse, 1914 (Figure – 2)

Classification

Phylum: Platyhelminthes

Class: Turbellaria

Order: Tricladida

Family: Bipaliidae

Genus: *Bipalium*

Species: *indicum* Whitehouse, 1914

Explanation: A long, dorso-ventrally flat, and bilaterally symmetrical body having a crescent-shaped expanded head. The frontal region of the body connecting the head and neck is tapered at first and progressively becomes wider until it is at its widest point at the area of the mouth. It could grow to be 4 mm wide and 7 cm long (Fig.-2, a, and b). There is a noticeable narrow "neck" behind the head that widens toward the pharynx and copulatory area. The tail end of the body is blunt. The body length (BL) varied from 35.10 to 45.05 mm, and breadth ranged from 9.75 to 12.00% BL. From the anterior end, the position of the mouth ranged from 48 to 51.00% BL, and the position of the gonopore from 70.00 to 74.50% BL, respectively. Ogren & Masaharu (1987) have indexed the *Bipalium indicum* Whitehouse, 1914 as an Indian species describing body length of 30 to 40mm, breath from10 to 12.50% BL, the position of mouth from the anterior end 50% BL, and the position of the gonopore 75% BL.

The dorsal surface has a continuous pale brown ground color without any stripes or grooves. Except for the mid-ventral crawling sole, the body color is somewhat brighter on the ventral side.

A total of 6 specimens were collected from close to the handpump and moist area of the agricultural field in the study area.

Figure 2. Photographic record of *Bipalium indicum*

2. *Bipalium bengalensis* (Figure – 3)

Classification

Phylum: Platyhelminthes

Class: Turbellaria

Order: Tricladida

Family: Bipaliidae

Genus: *Bipalium*

Species: *bengalensis* Bhakat, 2020

Explanation: The animal's body is long, dorso-ventrally flat, and bilaterally symmetrical with a crescent head. In a live animal, the huge head of a sexually mature specimen is expanded and crescentic shaped. It might grow to be 5 mm wide and 5 cm long (Fig.-3, a, and b). There is a noticeable narrow "neck" behind the head, which gets wider toward the pharynx and copulatory area. The body's rear end is bluntly pointed. The body length (BL) varied from 17.19 to 50.05 mm, while its breadth ranged from 9.25 to 12.14% BL. The mouth's position ranged from 49.37 to 59.03% BL, and the gonopore's position from 68.00 to 74.25% BL, respectively from the anterior end of the body. Bhakat (2020) has described the *Bipalium bengalensis* from Suri, West Bengal, India. He has described the species with body length (BL) 19 to 45mm, body breadth 10.71± 1.13% BL, position of mouth from anterior end 55.22 ± 2.68% BL, and position of gonopore 70.55 ± 2.84% BL.

The background of dorsal surface is jet black in colour without any strips or colour patterns. Except for the mid-ventral crawling sole, the body's ventral side is somewhat lighter in color.

A total of 8 specimens were picked up from the boundary walls near outdoor bathroom and moist habitat of the study area.

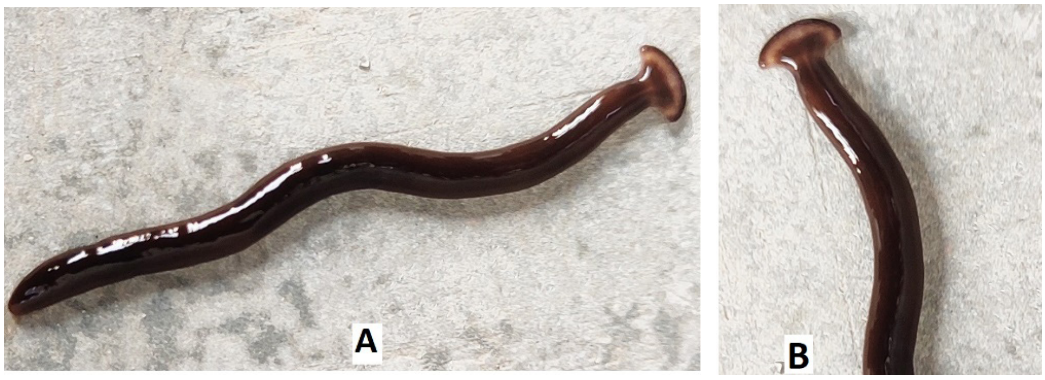

Figure 3. Photographic record of *Bipalium bengalensis*

Bipalium indicum and *Bipalium bengalensis* have comparable morphological traits. They have elongated, flat bodies with a unique hammerhead-shaped front end, which lends them their common name. They have slippery mucus covering on their ventral surface that helps them glide over the ground.

Both species are native to Asia, specifically India, Bangladesh, Sri Lanka, and Myanmar. They prefer damp environments such as forests, gardens, and agricultural areas. They have, however, been imported to other places and have become invasive species in several areas. *Bipalium indicum* and *Bipalium bengalensis*, as invasive species, have the potential to profoundly damage ecosystems. They are known to be voracious predators, preying on earthworms, snails, and other invertebrates. This predatory behavior can have a severe impact on native invertebrate populations and upset ecological balance. One of the biggest worries about their ecological implications is the possible alteration of soil ecosystems. Earthworms, in particular, are vital for soil structure, nitrogen cycling, and organic matter decomposition. Land planarians have been observed feeding on earthworms, perhaps lowering their populations. This can impact soil health, nutrient dynamics, and overall ecosystem functioning.

Bipalium indicum and *Bipalium bengalensis* have a high reproductive capacity, which contributes to their ability to expand and settle in new locations. They reproduce asexually through fragmentation. Carnivorous Platyhelminthes known as land planarians (Geoplanidae) are found outside of their native habitat, and the precipitation has a major effect on deciding the expansion of these species (Fourcade et al., 2022). Human activities such as the transportation of soil, plants, and other things aid in their spread. Infestations are common in greenhouses, nurseries, and gardens where plants and soil are transferred. Due to their adaptability and durability, these flatworms can be difficult to eradicate once established in a new location. *Bipalium indicum* and *Bipalium bengalensis*, as land planarians, represent important ecological concerns due to their predatory nature and their impact on soil ecosystems. More study and appropriate management measures are required to limit their spread and minimize the ecological impacts in invaded areas.

4. Conclusion

The present research work identified and described 2 species of *Bipalium* (*B. indicum* and *B. bengalensis*) from the Nepalgunj Sub-metropolitan city of Nepal. The species were identified and explained based on similarity in the morphological structure of the related species and comparative study of body length, the width of the body, position of the mouth, and position of gonopore which have been identified in the neighbour country, India. According to Graff (1899), *Bipalium* spp. is native to the Indo-China region and widely distributed in different countries but no previous research reports of *Bipalium* from Nepal were seen. This is the first report of the *Bipalium* in Nepal. So, these two species described by the author in this paper are new to Nepal. More research is required to fully determine the taxonomic status of species using

morphological and genetic information. Further, this research would improve our knowledge of the distribution of *Bipalium* species in Nepal.

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