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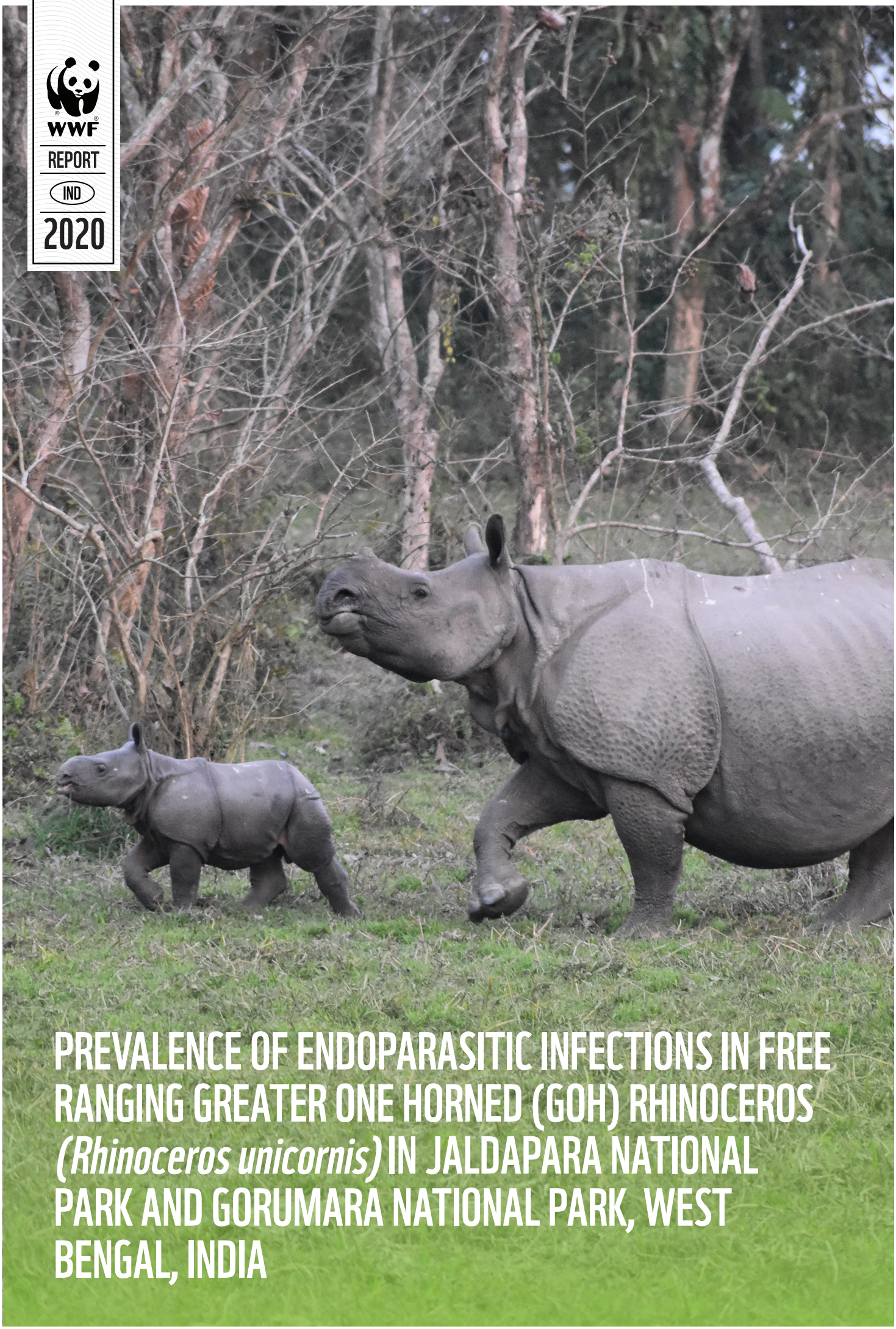

PREVALENCE OF ENDOPARASITIC INFECTIONS IN FREE RANGING GREATER ONE HORNED (GOH) RHINOCEROS *(Rhinoceros unicornis)* IN JALDAPARA NATIONAL PARK AND GORUMARA NATIONAL PARK, WEST BENGAL, INDIA

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Prevalence of endoparasitic infections in free ranging Greater One Horned (GoH) rhinoceros *(Rhinoceros unicornis)* in Jaldapara National Park and Gorumara National Park, West Bengal, India

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EXECUTIVE SUMMARY

The greater one-horned rhinoceros (GoH) (*Rhinoceros unicornis*), also known as the Indian rhino, is a vulnerable wildlife species found in the Indian subcontinent. Of the Indian population (approximately 2979 individuals), the Dooars region of West Bengal is home to the second largest population of the Indian rhino after Assam. The Dooars are the alluvial floodplains in North-Eastern India that lie South of the outer foothills of the Himalayas and North of the Brahmaputra River basin. As per the 2019 rhino estimation in West Bengal, Jaldapara National Park (JNP) accounts for 237 rhinos and Gorumara National Park (GNP) accounts for 52 individuals.

The need to initiate studies on diseases and pathogens affecting the Indian rhino is urgent as a considerable number of cases on rhino deaths go unaddressed; and due to increasing livestock pressures on some PAs, there is a possible threat of pathogenic transference from domestic animals to wild animals. Additionally, a lack of data in India makes it crucial to initiate such studies to bridge the knowledge gap on rhino diseases, and to draw up measures to address a disease outbreak in the country. The National Conservation Strategy for the Indian rhino advocates for concerted efforts by the Central and State Governments, scientific institutions and NGOs to address this gap and conduct research on rhino ecology, disease, habitat and population dynamics. This study assesses the prevalence of parasites in rhino dung using a non-invasive qualitative methodology.

The current study was conducted in West Bengal's two rhino-bearing Protected Areas (i.e. JNP and GNP) respectively. Dung samples (weighing about 100g) were collected and kept in plastic zip bags without any preservative and immediately dispatched for analysis. Insulated boxes with ice packs were used if samples were to be kept for a longer duration, to prevent the parasitic ova from hatching.

A total of 208 rhino dung samples were collected from JNP and GNP which were screened for parasitic load using qualitative methods. Overall parasite prevalence rate in both the parks combined is 88.46 % (N=184). From the 109 dung samples from GNP, 90 samples (82.56 %) were found to have moderate to heavy *Strongyle* spp. infection and out of the 99 dung samples analysed from JNP, 94 samples (94.94 %) were found with positive infection of *Strongyle* spp. Based on the National Conservation Strategy for the Indian One Horned Rhinoceros, and to

secure the existing rhino population in India from health-related threats, the following recommendations were drawn up based on the current study:

1. Detailed post-mortem of rhino carcasses is imperative.
2. Dung screening of other wild herbivores and domesticated elephants in the PAs is required.
3. Increase disease surveillance of domestic animals in the adjoining village areas of PAs.
4. Conduct seasonal examinations of rhino dung samples in the rhino-bearing PAs.

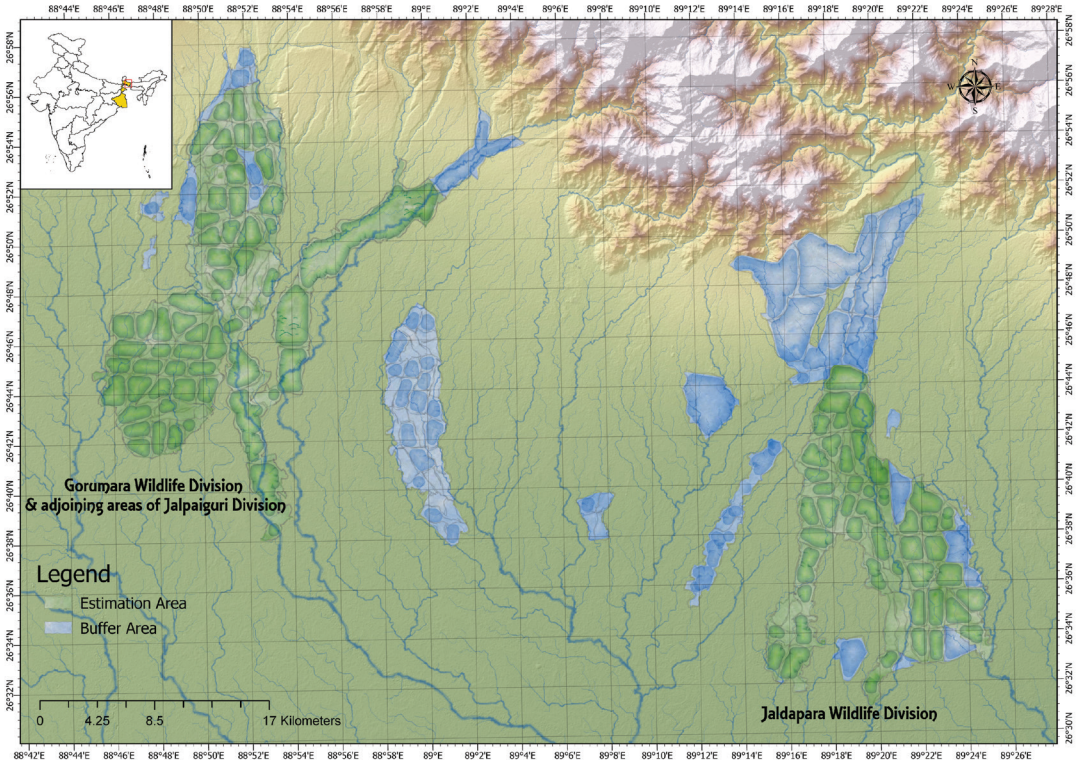
INTRODUCTION

The Greater One-horned (GoH) Rhinoceros (*Rhinoceros unicornis*) also known as the Indian rhino is a vulnerable wildlife species found in the Indian subcontinent. Historically, rhinoceros were once distributed in the floodplains and forest tracts in the Brahmaputra, the Ganges and the Indus river valleys (Fig 1), but its population gradually declined over the last 400 years as a result of habitat destruction and poaching. By the 19TH century, rhino populations survived only in the Terai grasslands of Northern Uttar Pradesh, Southern Nepal, Northern Bihar, Northern West Bengal and the Brahmaputra valley of Assam. The highest population of GoH rhinoceros (89.35%) is found in Assam with a total of about 2652 individuals, out of which around 91% of these are found in Kaziranga National Park alone with a population of 2413 individuals (The Hindu, 2018), 102 in Pobitora Wildlife Sanctuary (Times of India, 2018), 101 in Rajiv Gandhi Orang National Park (Dutta and Kakati, 2019) as per the 2018 rhino estimation in Assam and 36 in Manas National Park (Unpublished report, MNP, 2018). The remaining GoH rhino population in India is found at Dudhwa National Park in Uttar Pradesh with 38 rhinos (WII RhoDIS report 2019, Unpublished). The remaining 645 individuals are distributed in Nepal's four PAs, namely, Chitwan National Park (CNP) with 605 individuals, Bardia National Park (BNP) with 29, Shuklaphanta Wildlife Reserve (SWR) with 8 and Parsa Wildlife Reserve (PWR) with 3 rhinos respectively as per the National Rhino Census, 2015 carried out in Nepal (GoH Rhinoceros Conservation Action Plan for Nepal 2017- 21).

In India, West Bengal is the home to the second largest population of the GoH-Rhinoceros. As per the 2019 rhino estimation in West Bengal, JNP accounts for 237 rhinos and GNP accounts for 52 individuals (Directorate of Forest, Govt. of West Bengal, Estimation of Indian Rhinoceros (*Rhinoceros unicornis*), 2019, West Bengal).

Talking about non-poaching threats to the GoH rhinoceros population, the first thing that comes to everyone's mind are diseases. Among many etiologies, parasites are one those factors which can result in causing multiple parasitic diseases in the rhino population. Endoparasites are those parasites which inhabits the internal organs and tissues of its host. They may be any of the following types- round worms or nematodes, flat worms or trematodes, tape worms or cestodes and even certain protozoan parasites fall under the broad classification of endoparasites. These parasites compete with their host for their nutrition, completion of their lifecycle and other obligatory or facultative biological processes during which there might be pathogenic effects on their hosts.

Till date, systematic studies on the prevalence of endoparasites and parasitic



Source - Forest Department, Govt. of West Bengal

diseases were rarely attempted in the free-ranging GoH Rhino population in India. In order to address this knowledge gap, the present study is a part of a series that involves screening of pathogens through a non-invasive method of dung sample analysis. The study is not confined to parasites alone and will extend to bacterial fauna (i.e. bacterial pathogens and commensals), viral agents and also hormonal studies.

The first part of the study is an attempt to document the prevalence of endoparasites in rhinos in both JNP and GNP. This study will provide an idea on the presence of different genera of parasites harboured by the species and such data will enable us to establish a baseline of parasitic prevalence in these rhinos for future reference. By the end of 2021, we will be able to create a repository of the rhino parasites and other pathogens/commensals, which will help forest department officials and conservationists alike in ensuring better security and welfare in terms of rhino health and wellbeing.

RATIONALE

Poaching and habitat destruction are the most pressing threats to the survival of the GoH rhino. Disease and the presence of large populations in isolated habitats also pose significant threats.

According to Pant et al, 2019, there are limited studies addressing the likely effects of climate change on the species, and limited information is available on GoH rhinoceros genetics, diseases, habitat dynamics and the impacts of tourism and other infrastructural development in and around rhino habitat. These issues will need addressing to maintain the conservation successes of the GoH in the future.

Habitat loss and fragmentation can restrict species dispersal, which in turn increases contact rates and parasite transmission which will ultimately increase parasite abundance (Scott, 1988). Furthermore, habitat fragmentation and isolation also often create more frequent and unwanted interactions between wildlife and livestock. Domestic livestock can act as high-density reservoir-hosts for parasites of wildlife, leading to higher parasite abundance within wildlife (Lafferty and Gerber, 2002). It has been shown that wildlife living in close proximity to domestic animals are more likely to be affected by parasitism (Pedersen et al., 2007). In West Bengal, similar to the rest of India, there is a knowledge gap in comparing parasitic infections in domestic and wild animals and possible risks of transmission of the parasites between the two populations.

The final outcome of the present study is expected to give us an insight on the health and disease-causing pathogens in the GoH rhino, and determine the root cause of diseases. If there is disease transmission from domestic livestock to wild animals and vice versa, appropriate management practices can be put in place by the Forest Department. This will not only ensure welfare of the rhino population but also improve the wellbeing of the local community; encouraging them to live in harmony with the forest as a majority of the villages in the vicinity of both JNP and GNP parks are dependent on livestock farming and agriculture for their livelihood.

Threatened species like the GoH are also more likely to suffer from other issues like inbreeding. A key effect of inbreeding is increased vulnerability to parasitism, which can ultimately increase mortality rates (Coltman et al., 1999).

Animal translocations in particular, are situations in which the host-parasite population dynamic may be changed, especially in the relocated (reintroduced) population. This may be exacerbated by the stress caused by the translocation making individuals more susceptible to parasitism. As per the IUCN reintroduction guidelines under biological feasibility (5.1) and disease and parasite consideration (5.1.6), surveillance of source populations can establish the potential pathogen community present and individuals can then be selected for purposes of reintroduction or translocation, based on a risk assessment. Pathogenicity may

be promoted by the stress of unfamiliar or unnatural conditions of confinement, especially during the translocation process and that is why the management of disease and known pathogen transfer is important, both for maximizing the health of translocated organisms and for minimizing the risk of introducing a new pathogen to the destination area (IUCN Guidelines for Reintroductions and Other Conservation Translocations).

The Indian Rhino Vision (IRV) 2020 program in the state of Assam has been instrumental in the translocation of 20 rhinos (till date), but the deaths of two translocated rhinos in Burachapori Wildlife Sanctuary failed to reveal much regarding the cause of death which might have been health-related. Stress from the translocation, along with the presence of a concurrent disease or pathogen might have flared up leading to death. In order to confirm these hypotheses and prevent such episodes in the future, screening of to-be-translocated animals, or those in the source areas is necessary.

The male: female ratio in the rhino population in North Bengal is 25:17 i.e. 1:0.68 (Estimation of Indian Rhinoceros (*Rhinoceros unicornis*), 2019, West Bengal). To maintain a balance in the sex ratio, management interventions such as translocation may also be a remedial measure in maintaining a steady balance in the sex ratio of rhinos in GNP. As a translocation program is being planned by the West Bengal Forest Department, this study will help in documenting prevalence of any harmful parasites and prevent any diseases in translocated rhinos. Surveillance and monitoring of threats and probable pathogens which might affect the rhinos in the PAs of West Bengal is critical for future management interventions.

EXISTING STUDIES ON PARASITIC DISEASES IN THE FREE RANGING GOH RHINOCEROS IN INDIA

Till date, systematic studies on the prevalence of parasites and parasitic diseases were rarely attempted in the free-ranging GoH rhino population in India.

In the state of Assam

A total of 309 GoH Rhino dung samples were collected from the four PAs in Assam for a study on the prevalence of endoparasitic infections in the GoH rhino population during the period 2018-19 (Kakati et al., 2019). The overall prevalence of endoparasites were found to be 58.57 % (N=181) comprising of four genera of endoparasites mainly *Amphistome* spp. with a prevalence rate of 17.15 % (n=53), *Strongyle* spp. with a prevalence rate of 43.68 % (N=135) and two sporadic occurrence of *Bivitellobilharzia nairii* (N=1) and *Spirurid* spp. (N=2) only in Pobitora Wildlife Sanctuary. Mixed infection rate was found to be 6.47 % (N=20) amongst all the four areas. The study served as a basis for future research on the species involving parasites and host interaction and their pathology.

Luke et al (2018) during a study in Kaziranga National Park, reported 100% prevalence of endoparasites in the wild rhino samples, 96% in orphaned juvenile samples and 27% in orphaned calf samples. In wild rhino, observed parasite ova were primarily of trematodes *Paramphistomum* sp. (100%), followed by those of *Strongyle* nematodes (94%) and the cestode *Anoplocephala* sp. (56%). Orphaned juvenile and calf samples were positive only for *Strongyles*.

Phukan (2013) in his study in Manas National Park, Assam found 33.33 % prevalence with *Amphistome* spp. in 11 dung samples.

Chakraborty and Islam (1993) reported 46.42 % infection with *Amphistome* spp. in GOH Rhinoceros based on examination of 84 dung samples collected from 11 different areas viz. Mihimukh, Kathpura, Tatibeel, Diphalu, Bagori, Amkathani, Rowmari, Bimoli, Borbeel and Baruntika in Kaziranga National Park, Assam. They also recorded the prevalence *Strongyle* spp. (20.23%), *Anoplocephala* spp. (2.38%) and *Coccidia* spp. (3.57 %) infection from the same samples.

The parasites collected from post mortem examination of GoH rhinoceros from the Assam State Zoo also revealed infections with *Kiluluma* spp., *Amphistome* spp., *Chabertia* spp., *Bunostomum* spp., *Anoplocephala* spp. and *Balantidium coli* infection (Chakraborty and Gogoi, 1995).

In the State of West Bengal

No previous published reports on parasite-prevalence in GoH rhinos in West Bengal exists in the public domain. However, scant data on other diseases are as follows:

1. A report of Anthrax outbreak in Wild Elephants (Pandit and Sinha, 2006) and its control in GoH Rhinos by vaccination in the year 1994 in Jaldapara NP is the only source of literature we came across which was directly related to a disease.
2. Another report (Datta, 2018) states male aggression and interspecies fighting to be the main cause of death of the GoH in the Dooars region of West Bengal.
3. In a report (Sinha et al., 2011) on the deaths of 16 rhinos in JNP and GNP, disease and natural deaths in case of 7 carcasses were mentioned, while others causes of death were attributed to infighting and poaching.

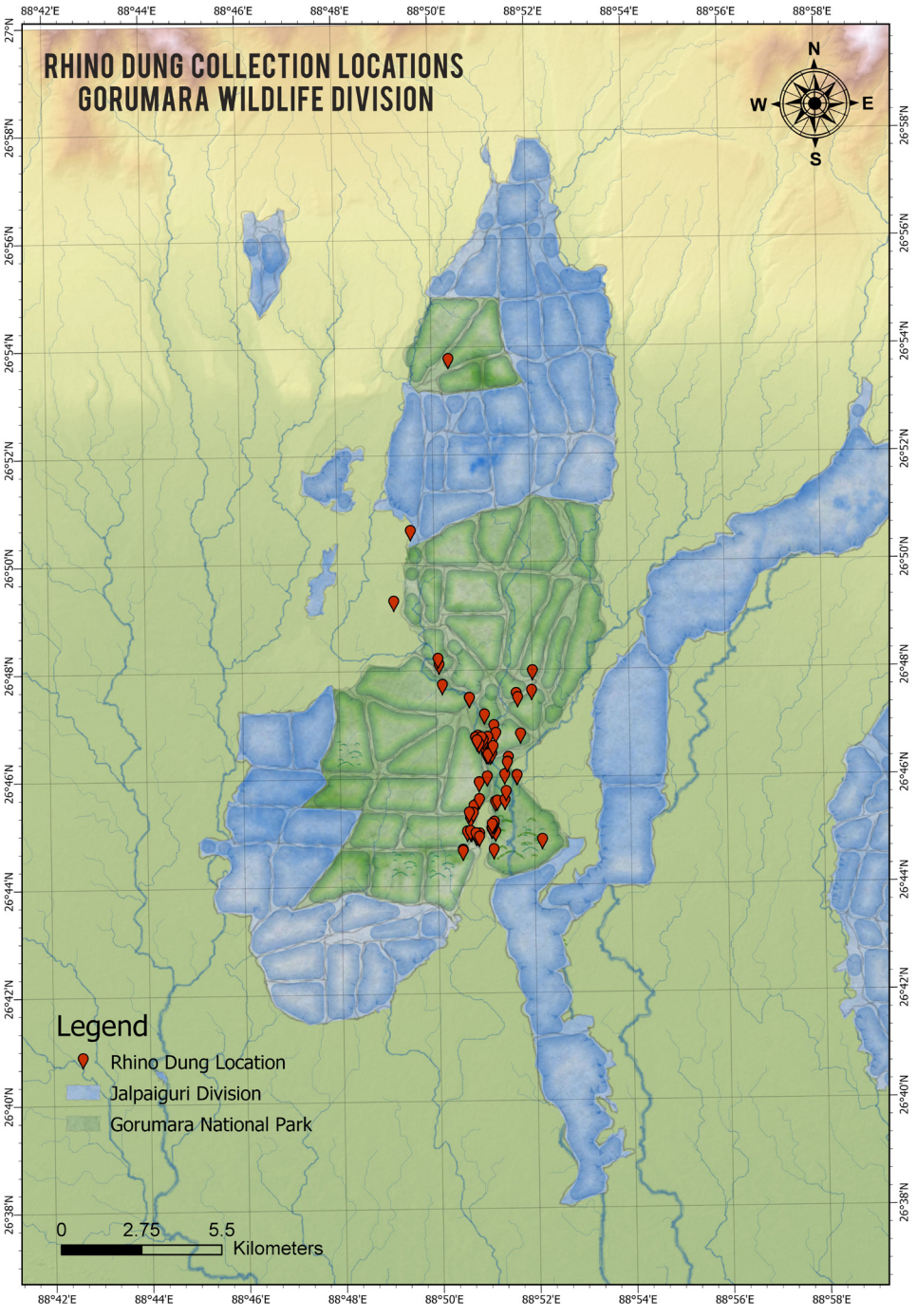
OBJECTIVE

By 2021, the West Bengal Forest Department will have enhanced information on the diseases and disease-causing factors in the GoH rhino population in the state; to put in place a pre-emptive support system for securing the health and welfare of the free-ranging rhino population in JNP and GNP.

In order to achieve our objective, the present study aims to document the endoparasitic infection in the GoH rhinoceros population in Jaldapara and Gorumara national parks using non-invasive qualitative* dung examination method to identify the parasites based on their eggs and establish a baseline for future intervention.

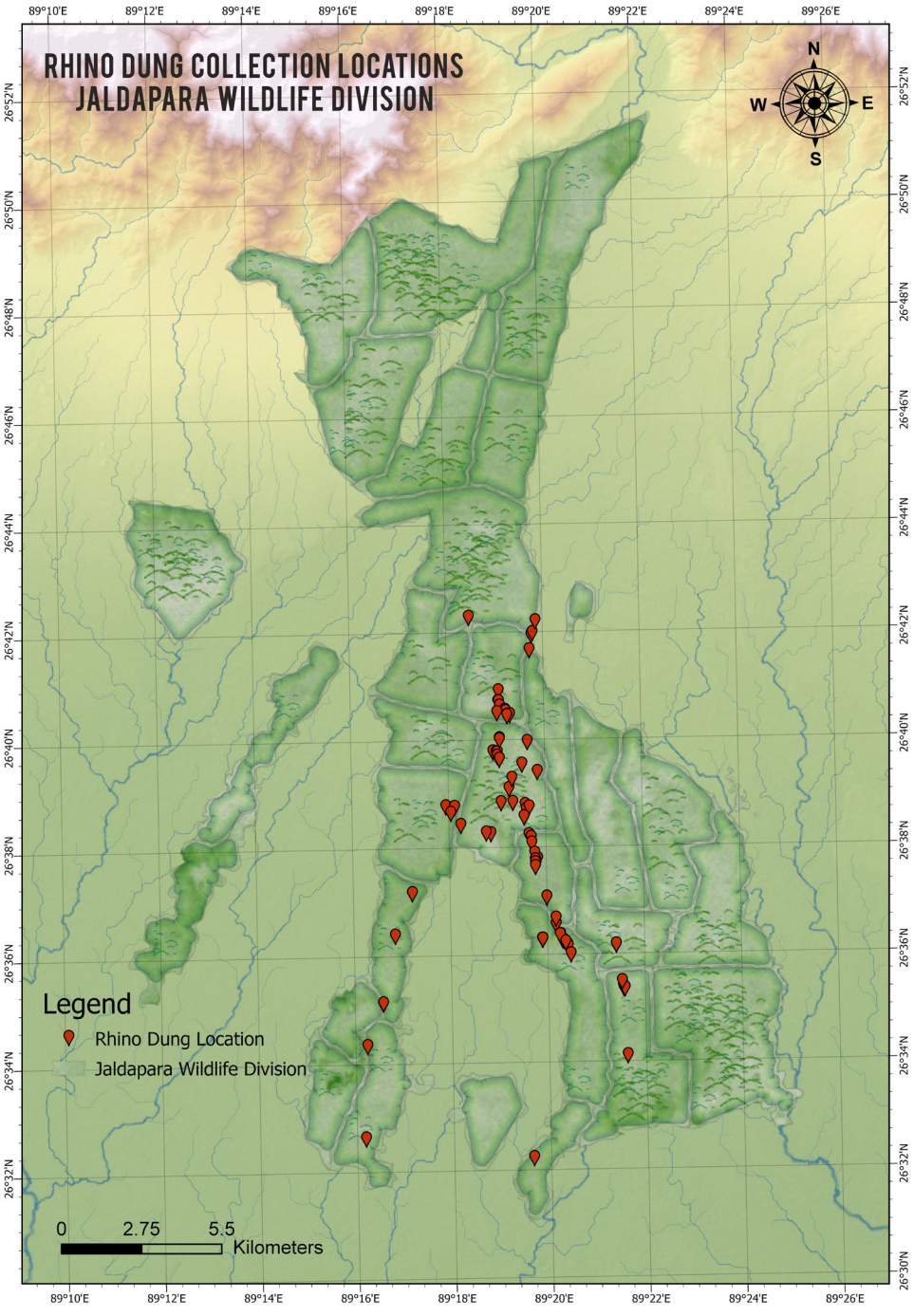
FOOTNOTE

*: Simple sedimentation qualitative method: Which will give the indication of the presence or absence of the parasite species without quantifying the load.



MAP SOURCE: WEST BENGAL FOREST DEPARTMENT

Fig. 2: Dung collection locations in Gorumara Wildlife Division



MAP SOURCE: WEST BENGAL FOREST DEPARTMENT

Fig. 3: Dung collection locations in Jaldapara Wildlife Division

THE SAMPLING METHODOLOGY UNDERTAKEN

1. Forest staff conducted a reconnaissance before the day of sampling to determine the dung heap locations used by the rhinos.

2. All possible rhino-ranging areas in the parks were covered using vehicles, departmental elephants and on foot. Sample collection commenced at 5am and was completed by noon.

3. Dung samples (minimum 100g) were collected and kept in plastic zip bags without any preservative. Only freshly voided dung samples were collected. The selection was purely based on physical and visual parameters of the dung (i.e. moisture content, presence of maggots, dung beetles and external/surface fungal growth like mushrooms and toad stools). The dried samples with external fungal growth over the surface, scratched dung heaps and those dispersed by wild fowls, birds and wild boars were not picked for the study. Local knowledge of the forest staff was utilized to ascertain the rhino home-range and avoid replication of samples as far as possible.

4. The samples collected were marked with unique IDs and dispatched to the Department of Parasitology in the College of Veterinary Science at Assam Agricultural University for analysis.

5. Both salt floatation and sedimentation techniques were done as per standard protocols (Soulsby, 1982) to detect the presence of parasitic ova and larvae in the dung samples.

RESULTS

A total of 208 rhino dung samples were collected from the two parks which were screened for parasitic load using qualitative methods. A total of 109 samples were collected from GNP and 99 samples were collected from JNP. Most of the rhino-ranging areas identified in Gorumara National Park and its adjoining areas were covered during sample collection. In JNP however, due to various constraints, this could not be done.

The overall parasite prevalence rate in both the parks of North Bengal in West Bengal is 88.46 % (N=184). From the 109 dung samples analyzed from GNP, 90 samples (82.56 %) are parasitized with moderate to heavy *Strongyle* spp. infection. (Annexure-I). Out of the 99 dung samples from JNP, 94 samples (94.94 %) were found with positive infections from *Strongyle* spp. (Annexure: II).

No other parasitic infections could be detected in any of the samples during the study. The presence of only one species of parasite in the rhino population of both parks may be due to the absence or limited presence of different species of fresh water snails which are the intermediate hosts for *Amphistome* spp., low presence or absence of interaction with the domestic livestock or some natural effects.

The same study was also carried out in the states of Assam (Kakati et al, 2019) and Uttar Pradesh (Kakati et al. 2018). When comparing this study with that conducted in Assam, we find that the rhino population in West Bengal has a higher prevalence rate of infection, but the occurrence of different parasites were higher in Assam. A comparative table (Table 2 BELOW) clearly shows the difference between the PAs.

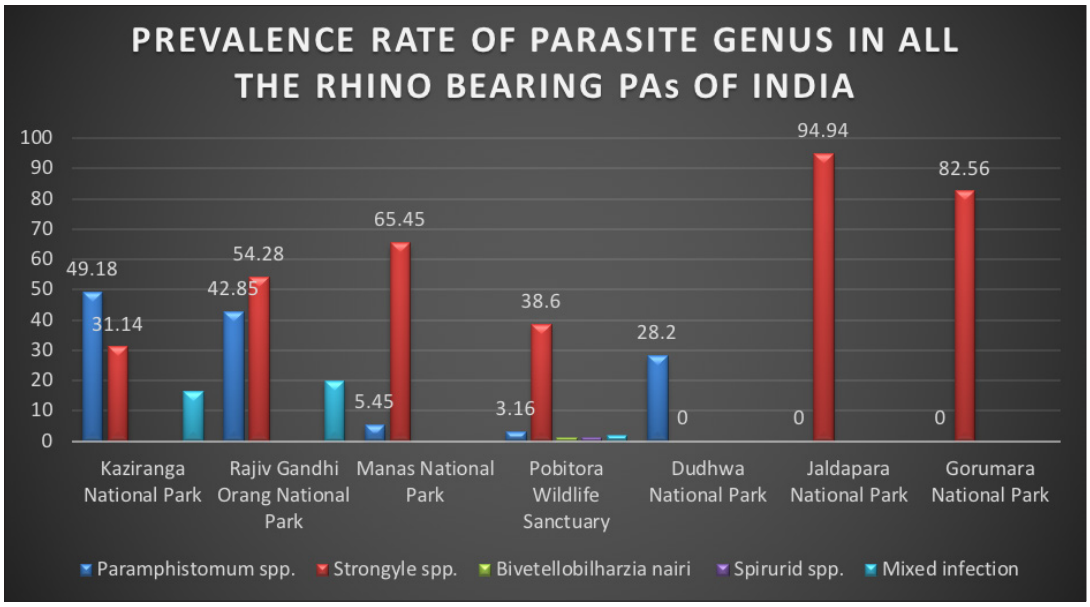
Table: 1: Overall prevalence of endoparasitic infection in GoH Rhinoceros in Gorumara and Jaldapara National Park, West Bengal.

Protected Area Name	Number of samples collected	Samples positive for parasites	Prevalence rate (%)	Species wise prevalence
				Strongyle spp.
Gorumara National Park	109	90	82.56 %	90
Jaldapara National Park	99	94	94.94 %	94
Overall prevalence in West Bengal	208	184	88.46 %	

To validate and offer a conclusive justification of the findings during the first phase of the studies across the rhino-bearing PAs in India, further sampling and quantification of the parasitic load is required. This will provide further insights into the finer details of parasitic epidemiology and their interactions with the GoH rhino in India.

Table 2: Prevalence of Parasite Genus in the rhino bearing PAs of India

PREVALENCE PERCENTAGE (%)					
Protected area	*Amphistome* spp.	*Strongyle* spp.	*Bivitellobilharzia nairi*	*Spirurid* spp.	Mixed infection
Kaziranga National Park	49.18	31.14	0	0	16.39
Rajiv Gandhi Orang National Park	42.85	54.28	0	0	20
Manas National Park	5.45	65.45	0	0	0
Pobitora Wildlife Sanctuary	3.16	38.6	1	1.26	1.89
Dudhwa National Park	28.2	0	0	0	0
Jaldapara National Park	0	94.94	0	0	0
Gorumara National Park	0	82.56	0	0	0



RECOMMENDATION FROM THE CURRENT STUDY

Based on strategies of the National Conservation Strategy for the GoH Rhinoceros and to secure the existing rhino population in India, we have drawn up the following recommendations based on the current study.

Recommendation 1: Detailed post mortem of rhino carcass:

The identification of the parasites up to the species level is very crucial and this can be possible if parasites are collected during post-mortem examination of the gastro-intestinal tract. The gastro-intestinal tract needs to be properly examined for presence of any helminths and collected in normal saline or 70 % alcohol and sent to the selected referral laboratory in the state for identification. The proper identification of the parasites will help us in determining whether the same parasites are shared by domestic livestock and is there any transmission from the domestic livestock to the wild animal population in the PAs. This can also give an indication of the parasitic load in the host and compare the findings with the dung examination. This will not only help us to understand the prevalence and effects of parasites but also detect and document other concurrent diseases in GoH rhinoceros.

Recommendation 2: Carry out disease surveillance in domestic animals in the adjoining village areas of PAs.

The interaction between domestic and wild animals always pose a risk of introduction and transmission of infectious diseases and parasites between both wild and domestic animals. That makes it even more necessary to carry out extensive disease surveillance of infectious diseases of domestic animals near the fringe areas and compare the subsequent laboratory findings with that of wild counterparts during opportunistic samplings and post mortem examination.

Recommendation 3: Repeat the study and conduct seasonal monitoring for parasites from rhino dung in both the PAs.

The findings from the current study indicate that the incidences of *Strongyle* spp. predominates the rhino population in both the PAs. The direct effect of these

parasites on the health of the rhinos is difficult to assess within the scope of the current study as there is no baseline data to compare or post mortem reports to refer to. Parasites have the ability to predispose their hosts to other concurrent diseases in case of heavy infection. Also, heavy infection with tapeworms can sometimes lead to intestinal obstruction and nutritional deficiencies. The wild animals are more vulnerable after the floods when faecal matters and pathogenic organisms are spread across the forests after the water recedes. Since pathogenic effects of endoparasites in GoH Rhinos are yet to be assessed in the wild, this necessitates further screening of dung samples and detailed post mortem analysis to gather more data and knowledge regarding the host-parasite interactions. With more studies on the same aspect, we can determine baseline for parasitic load for the GoH Rhino and any deviation from that can be used to formulate preventive and remedial measures to safeguard our rhino population in West Bengal.

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ANNEXURE-I

Detailed results of the dung study in Gorumara National Park
+: Light infection; ++: moderate infection; +++ and above: Heavy infection.

Sl No	Collection Date	Sample ID	Area	Result
1	12/02/2019	RW_19_1	*Ramsai Extension*,GNP	Negative
2	12/02/2019	RW_19_2	*Ramsai Extension*,GNP	*Strongyle* spp. ++
3	12/02/2019	RW_19_3	*Ramsai Extension*,GNP	*Strongyle* spp. +
4	12/02/2019	RW_19_4	*Ramsai Extension*,GNP	*Strongyle* spp. +
5	12/02/2019	RW_19_5	*Ramsai Extension*,GNP	*Strongyle* spp. ++++
6	12/02/2019	RW_19_6	*Ramsai Extension*,GNP	*Strongyle* spp. +++
7	12/02/2019	RW_19_7	*Ramsai Extension*,GNP	*Strongyle* spp. ++
8	12/02/2019	RW_19_8	*Ramsai Extension*,GNP	*Strongyle* spp. ++
9	12/02/2019	RW_19_9	*Ramsai Extension*,GNP	Negative
10	12/02/2019	RW_19_10	Medla C3,GNP	*Strongyle* spp. ++
11	12/02/2019	RW_19_11	Medla C3,GNP	*Strongyle* spp. +
12	12/02/2019	RW_19_12	Medla C3,GNP	*Strongyle* spp. ++
13	12/02/2019	RW_19_13	Medla compartment-3 central road boundary	*Strongyle* spp. ++
14	12/02/2019	RW_19_14	Medla compartment-3	*Strongyle* spp. +++
15	12/02/2019	RW_19_15	Medla C3	*Strongyle* spp. +++
16	12/02/2019	RW_19_16	Medla C3	*Strongyle* spp. +++
17	12/02/2019	RW_19_17	MedlaC3	*Strongyle* spp. +++
18	12/02/2019	RW_19_18	Medla compartment-3 central road boundary	*Strongyle* spp. +++
19	12/02/2019	RW_19_19	MedlaC3	*Strongyle* spp. ++
20	12/02/2019	RW_19_20	MedlaC3	*Strongyle* spp. ++
21	12/02/2019	RW_19_21	*Ramsai Extension*	*Strongyle* spp. ++
22	12/02/2019	RW_19_22	Medla C3	*Strongyle* spp. ++
23	12/02/2019	RW_19_23	MedlaC3	*Strongyle* spp. ++
24	12/02/2019	RW_19_24	MedlaC3	Negative
25	12/02/2019	RW_19_25	Medla compartment-3 central road boundary	Negative
26	12/02/2019	RW_19_26	*Ramsai Extension*	Negative
27	12/02/2019	RW_19_27	BH 3	*Strongyle* spp. ++
28	12/02/2019	RW_19_28	South Inngdone -15/GNP/GWLD	*Strongyle* spp. ++
29	12/02/2019	RW_19_29	16/GNP/GWLD,Tandu4A, Tandu4B	Negative

Sl No	Collection Date	Sample ID	Area	Result
30	12/02/2019	RW_19_30	16/GNP/GWLD,Tandu4A, Tandu4B	*Strongyle* spp. ++
31	12/02/2019	RW_19_31	16/GNP/GWLD,Tandu4A, Tandu4B	*Strongyle* spp. ++
32	12/02/2019	RW_19_32	14/GNP/GWLD, GHP 1B	*Strongyle* spp. +++
33	12/02/2019	RW_19_33	14/GNP/GWLD, GHP 1B	*Strongyle* spp. +++
34	12/02/2019	RW_19_34	14/GNP/GWLD, GHP 1B	*Strongyle* spp. ++
35	12/02/2019	RW_19_35	PNG/IC/Murti River Side	Negative
36	13/02/2019	RW_19_36	22/GNP/GWLD/Gorumara Beat	Negative
37	13/02/2019	RW_19_37	22/GNP/GWLD/Gorumara Beat	*Strongyle* spp. ++
38	13/02/2019	RW_19_38	22/GNP/GWLD/Gorumara Beat	*Strongyle* spp. ++
39	13/02/2019	RW_19_39	22/GNP/GWLD/Gorumara Beat	*Strongyle* spp. ++
40	13/02/2019	RW_19_40	22/GNP/GWLD/Gorumara Beat	*Strongyle* spp. +++
41	13/02/2019	RW_19_41	22/GNP/GWLD/Gorumara Beat	Negative
42	13/02/2019	RW_19_42	22/GNP/GWLD/Gorumara Beat	*Strongyle* spp. ++
43	13/02/2019	RW_19_43	22/GNP/GWLD/Gorumara Beat	*Strongyle* spp. ++
44	13/02/2019	RW_19_44	Gorumara beat Jaldhaba -IB	*Strongyle* spp. ++
45	13/02/2019	RW_19_45	Gorumara beat Jaldhaba -IB	*Strongyle* spp. +++
46	13/02/2019	RW_19_46	Gorumara beat Jaldhaba -IB	*Strongyle* spp. +++
47	13/02/2019	RW_19_47	Gorumara beat Jaldhaba -IB	*Strongyle* spp. +++
48	13/02/2019	RW_19_48	Gorumara beat Jaldhaba -IB	*Strongyle* spp. ++
49	13/02/2019	RW_19_49	Gorumara beat Jaldhaba -IB	*Strongyle* spp. ++
50	13/02/2019	RW_19_50	Gorumara beat Jaldhaba -IB	*Strongyle* spp. ++
51	13/02/2019	RW_19_51	Gorumara beat Jaldhaba -IB	*Strongyle* spp. ++
52	13/02/2019	RW_19_52	Gorumara beat Jaldhaba -IB	Negative
53	13/02/2019	RW_19_53	Gorumara beat Jaldhaba -IB	Negative
54	13/02/2019	RW_19_54	Gorumara beat Jaldhaba -IB	*Strongyle* spp. ++
55	13/02/2019	RW_19_55	Gorumara	Negative
56	13/02/2019	RW_19_56		*Strongyle* spp. ++
57	13/02/2019	RW_19_57		*Strongyle* spp. ++
58	13/02/2019	RW_19_58		*Strongyle* spp. +++
59	13/02/2019	RW_19_59		*Strongyle* spp. +++
60	13/02/2019	RW_19_60		*Strongyle* spp. ++
61	13/02/2019	RW_19_61		Negative
62	13/02/2019	RW_19_62		*Strongyle* spp. ++
63	13/02/2019	RW_19_63		*Strongyle* spp. ++
64	13/02/2019	RW_19_64		*Strongyle* spp. +
65	13/02/2019	RW_19_65		*Strongyle* spp. +
66	13/02/2019	RW_19_66		*Strongyle* spp. ++

Sl No	Collection Date	Sample ID	Area	Result
67	13/02/2019	RW_19_67		*Strongyle* spp. ++
68	13/02/2019	RW_19_68		*Strongyle* spp. ++
69	13/02/2019	RW_19_69		Negative
70	13/02/2019	RW_19_70		*Strongyle* spp. +++
71	13/02/2019	RW_19_71		*Strongyle* spp. ++
72	13/02/2019	RW_19_72		*Strongyle* spp. ++
73	13/02/2019	RW_19_73		*Strongyle* spp. ++
74	13/02/2019	RW_19_74		*Strongyle* spp. ++
75	12/02/2019	RW_19_75	Jaldhaka 1B Gorumara Beat	*Strongyle* spp. ++
76	12/02/2019	RW_19_76		*Strongyle* spp. ++
77	12/02/2019	RW_19_77	Borandanga Extn Gorumora Beat	*Strongyle* spp. ++
78	12/02/2019	RW_19_78	Jaldhaka 1A Gorumara Beat	*Strongyle* spp. ++
79	12/02/2019	RW_19_79	Gorumara Beat G-ii	Negative
80	12/02/2019	RW_19_80	DHP-IC	*Strongyle* spp. ++
81	12/02/2019	RW_19_81	DHP-IC	Negative
82	12/02/2019	RW_19_82	DHP-IC	*Strongyle* spp. ++
83	12/02/2019	RW_19_83	Takimari	*Strongyle* spp. ++
84	13/02/2019	RW_19_84	*Ramsai Extension*	*Strongyle* spp. ++
85	13/02/2019	RW_19_85	B.M.1	*Strongyle* spp. +++
86	13/02/2019	RW_19_86	Dhupjhara	*Strongyle* spp. +++
87	13/02/2019	RW_19_87	Dhupjhara	*Strongyle* spp. +++
88	13/02/2019	RW_19_88	Gorumara	*Strongyle* spp. +++
89	13/02/2019	RW_19_89	Gorumara	Negative
90	13/02/2019	RW_19_90	Gorumara	*Strongyle* spp. ++++
91	13/02/2019	RW_19_91	Gorumara	*Strongyle* spp. ++
92	13/02/2019	RW_19_92	Gorumara	*Strongyle* spp. ++
93	13/02/2019	RW_19_93	Gorumara	*Strongyle* spp. ++
94	13/02/2019	RW_19_94	Gorumara	Negative
95	13/02/2019	RW_19_95	Dhupjhara 1B	*Strongyle* spp. ++
96	13/02/2019	RW_19_96	Medla-comp-3	*Strongyle* spp. +
97	13/02/2019	RW_19_97	Medla comp-3	*Strongyle* spp. ++
98	13/02/2019	RW_19_98	Medla comp-3	*Strongyle* spp. ++
99	13/02/2019	RW_19_99	Medla comp-3	*Strongyle* spp. ++
100	13/02/2019	RW_19_100	Barahati-3	*Strongyle* spp. +
101	13/02/2019	RW_19_101	Barahati-3	*Strongyle* spp. ++
102	12/02/2019	RW_19_102	Gorumara Beat	*Strongyle* spp. ++++
103	12/02/2019	RW_19_103	Ramsai blook	*Strongyle* spp. ++
104	12/02/2019	RW_19_104	Ramsai blook	*Strongyle* spp. ++

Sl No	Collection Date	Sample ID	Area	Result
105	12/02/2019	RW_19_105	Jaldhaka blook	*Strongyle* spp. +
106	12/02/2019	RW_19_106	Chapramari Beat	*Strongyle* spp. ++++
107	12/02/2019	RW_19_107	Chapramari Beat	*Strongyle* spp. ++
108	12/02/2019	RW_19_108	Chapramari Beat	*Strongyle* spp. ++
109	12/02/2019	RW_19_109	Chapramari Beat	Negative

ANNEXURE-II

Detailed results of the dung study in Jaldapara National Park

Sl No	Collection Date	Sample ID	Area	Result
1.	14/02/2019	RW_19_110	Manikarji, JNP	*Strongyle* spp. ++
2.	14/02/2019	RW_19_111	Manikarji, JNP	*Strongyle* spp. ++
3.	14/02/2019	RW_19_112	Manikarji, JNP	*Strongyle* spp. ++++
4.	14/02/2019	RW_19_113	Mairdanga Tower, JNP	*Strongyle* spp. ++
5.	14/02/2019	RW_19_114	Mairdanga Tower, JNP	*Strongyle* spp. ++
6.	14/02/2019	RW_19_115	Mairdanga Tower, JNP	*Strongyle* spp. ++
7.	14/02/2019	RW_19_116	Bandaki,JNP	*Strongyle* spp. +++
8.	15/02/2019	RW_19_117	Siltorsa Road, JNP	*Strongyle* spp. +++
9.	15/02/2019	RW_19_118	Siltorsa Road, JNP	*Strongyle* spp. +++
10.	15/02/2019	RW_19_119	Siltorsa Road, JNP	*Strongyle* spp. +++
11.	15/02/2019	RW_19_120	Siltorsa Road, JNP	*Strongyle* spp. +++
12.	15/02/2019	RW_19_121	Siltorsa Road, JNP	Negative
13.	15/02/2019	RW_19_122	Siltorsa Road, JNP	*Strongyle* spp. ++
14.	15/02/2019	RW_19_123	Siltorsa Road, JNP	*Strongyle* spp. ++
15.	15/02/2019	RW_19_124	Siltorsa Road, JNP	*Strongyle* spp. ++
16.	15/02/2019	RW_19_125	Siltorsa Road, JNP	*Strongyle* spp. ++++
17.	15/02/2019	RW_19_126	Siltorsa Road, JNP	*Strongyle* spp. ++
18.	15/02/2019	RW_19_127	Siltorsa Road, JNP	*Strongyle* spp. +
19.	15/02/2019	RW_19_128	Siltorsa Road, JNP	*Strongyle* spp. +
20.	15/02/2019	RW_19_129	Siltorsa Road, JNP	*Strongyle* spp. ++
21.	15/02/2019	RW_19_130	JP East, JNP	*Strongyle* spp. ++
22.	15/02/2019	RW_19_131	JP East, JNP	*Strongyle* spp. ++
23.	15/02/2019	RW_19_132	JP East, JNP	*Strongyle* spp. ++
24.	15/02/2019	RW_19_133	JP East, JNP	*Strongyle* spp. +++
25.	15/02/2019	RW_19_134	JP East, JNP	*Strongyle* spp. +++
26.	15/02/2019	RW_19_135	JP East, JNP	*Strongyle* spp. +++
27.	15/02/2019	RW_19_136	JP East, JNP	*Strongyle* spp. ++
28.	15/02/2019	RW_19_137	JP East, JNP	*Strongyle* spp. ++++
29.	15/02/2019	RW_19_138	JP East, JNP	*Strongyle* spp. ++
30.	15/02/2019	RW_19_139	JP Tower, JNP	*Strongyle* spp. +++
31.	15/02/2019	RW_19_140	JP Tower, JNP	*Strongyle* spp. ++
32.	15/02/2019	RW_19_141	JP Tower, JNP	*Strongyle* spp. ++
33.	15/02/2019	RW_19_142	JP East, JNP	*Strongyle* spp. +
34.	15/02/2019	RW_19_143	Kodal Basti, JNP	*Strongyle* spp. ++

Sl No	Collection Date	Sample ID	Area	Result
35.	15/02/2019	RW_19_144	Kodal Basti, JNP	*Strongyle* spp. ++
36.	15/02/2019	RW_19_145	Malangi,JNP	*Strongyle* spp. ++
37.	15/02/2019	RW_19_146	Malangi,JNP	*Strongyle* spp. ++
38.	15/02/2019	RW_19_147	Malangi,JNP	*Strongyle* spp. ++++
39.	15/02/2019	RW_19_148	Malangi,JNP	*Strongyle* spp. ++
40.	15/02/2019	RW_19_149	Malangi,JNP	*Strongyle* spp. +
41.	15/02/2019	RW_19_150	Malangi,JNP	*Strongyle* spp. ++
42.	15/02/2019	RW_19_151	Malangi,JNP	*Strongyle* spp. +++
43.	15/02/2019	RW_19_152	Malangi,JNP	*Strongyle* spp. ++
44.	15/02/2019	RW_19_153	Malangi,JNP	*Strongyle* spp. ++
45.	15/02/2019	RW_19_154	Kochubari, JNP	*Strongyle* spp. ++++
46.	15/02/2019	RW_19_155	Kochubari, JNP	*Strongyle* spp. ++
47.	15/02/2019	RW_19_156	Kochubari, JNP	*Strongyle* spp. ++
48.	15/02/2019	RW_19_157	Kochubari, JNP	*Strongyle* spp. +++
49.	15/02/2019	RW_19_158	Kochubari, JNP	*Strongyle* spp. +++
50.	15/02/2019	RW_19_159	Kochubari, JNP	*Strongyle* spp. +++
51.	15/02/2019	RW_19_160	Kochubari, JNP	*Strongyle* spp. +++
52.	15/02/2019	RW_19_161	Kochubari, JNP	*Strongyle* spp. +++
53.	15/02/2019	RW_19_162	Malangi,JNP	*Strongyle* spp. +++
54.	16/02/2019	RW_19_163	Bansbari, JNP	*Strongyle* spp. ++
55.	16/02/2019	RW_19_164	JP East, JNP	Negative
56.	16/02/2019	RW_19_165	Malangi,JNP	*Strongyle* spp. ++
57.	16/02/2019	RW_19_166	Malangi,JNP	*Strongyle* spp. ++
58.	16/02/2019	RW_19_167	Malangi,JNP	*Strongyle* spp. +
59.	16/02/2019	RW_19_168	Malangi,JNP	*Strongyle* spp. ++
60.	16/02/2019	RW_19_169	Malangi,JNP	*Strongyle* spp. ++
61.	16/02/2019	RW_19_170	Malangi,JNP	*Strongyle* spp. ++++
62.	16/02/2019	RW_19_171	Malangi,JNP	*Strongyle* spp. +
63.	16/02/2019	RW_19_172	Malangi,JNP	*Strongyle* spp. ++
64.	16/02/2019	RW_19_173	Malangi,JNP	*Strongyle* spp. ++++
65.	16/02/2019	RW_19_174	Malangi,JNP	*Strongyle* spp. ++
66.	16/02/2019	RW_19_175	Malangi,JNP	*Strongyle* spp. +
67.	16/02/2019	RW_19_176	Malangi,JNP	*Strongyle* spp. ++
68.	16/02/2019	RW_19_177	Kochubari, JNP	*Strongyle* spp. ++
69.	16/02/2019	RW_19_178	Kochubari, JNP	*Strongyle* spp. +++
70.	16/02/2019	RW_19_179	Kochubari, JNP	*Strongyle* spp. ++
71.	16/02/2019	RW_19_180	Kochubari, JNP	*Strongyle* spp. +++
72.	16/02/2019	RW_19_181	Kochubari, JNP	*Strongyle* spp. ++

Sl No	Collection Date	Sample ID	Area	Result
73.	16/02/2019	RW_19_182	Kochubari, JNP	*Strongyle* spp. ++
74.	16/02/2019	RW_19_183	Kochubari, JNP	*Strongyle* spp. ++
75.	16/02/2019	RW_19_184	Kochubari, JNP	*Strongyle* spp. ++
76.	16/02/2019	RW_19_185	NEC Beat,JNP	*Strongyle* spp. ++++
77.	16/02/2019	RW_19_186	NEC Beat,JNP	*Strongyle* spp. +
78.	16/02/2019	RW_19_187	NEC Beat,JNP	*Strongyle* spp. +
79.	16/02/2019	RW_19_188	NEC Beat,JNP	*Strongyle* spp. ++
80.	16/02/2019	RW_19_189	Chilapata, JNP	*Strongyle* spp. ++
81.	16/02/2019	RW_19_190	Chilapata, JNP	*Strongyle* spp. +++
82.	16/02/2019	RW_19_191	Chilapata, JNP	*Strongyle* spp. +++
83.	16/02/2019	RW_19_192	Chilapata, JNP	*Strongyle* spp. ++
84.	16/02/2019	RW_19_193	Chilapata, JNP	*Strongyle* spp. ++
85.	16/02/2019	RW_19_194	Chilapata, JNP	*Strongyle* spp. ++
86.	16/02/2019	RW_19_195	Chilapata, JNP	*Strongyle* spp. ++
87.	16/02/2019	RW_19_196	Chilapata, JNP	*Strongyle* spp. +++
88.	16/02/2019	RW_19_197	Chilapata, JNP	*Strongyle* spp. +++
89.	16/02/2019	RW_19_198	Chilapata, JNP	*Strongyle* spp. ++
90.	16/02/2019	RW_19_199	Hollong, JNP	*Strongyle* spp. ++
91.	16/02/2019	RW_19_200	Hollong, JNP	*Strongyle* spp. ++
92.	16/02/2019	RW_19_201	Harindanga, JNP	Negative
93.	2/17/2019	RW_19_202	Malangi,JNP	Negative
94.	2/17/2019	RW_19_203	Malangi,JNP	*Strongyle* spp. ++
95.	2/17/2019	RW_19_204	Malangi,JNP	*Strongyle* spp. ++
96.	2/17/2019	RW_19_205	Malangi,JNP	*Strongyle* spp. +
97.	2/17/2019	RW_19_206	Malangi,JNP	Negative
98.	2/17/2019	RW_19_207	Malangi,JNP	*Strongyle* spp. ++
99.	2/17/2019	RW_19_208	Malangi,JNP	*Strongyle* spp. ++

ANNEXURE-III

Reagents and equipments used in the study

1. Plastic zip bags 10 X 8 inches.
2. Disposable hand gloves.
3. Water resistant marker.
4. Compound microscope.
5. Glass slide.
6. Saturated salt solution.
7. Plastic sieve.
8. Glass petridish.
9. Pestle and mortar.
10. Stirring rod.

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