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Quantification and Characterization of Microplastics in Wildlife Feces: Case Study from Buffer zones of Western Ghats, Tamil Nadu

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Abstract: Wildlife is greatly impacted by the presence of microplastics in the environment, which has become a global concern. In order to clarify their possible effects on ecosystem health, this study examines the frequency of microplastics in the feces of wild animals. Indian Elephants (Elephas maximus indicus), sambar Deer (Rusa unicolor), Gaurs (Bos gaurus), and Rabbits (Lepus nigricollis) were the main subjects of this investigation. In Tamil Nadu's Coimbatore district, we gathered wild animal excrement from the buffer zones of the Western Ghats range. Twelve animal feces samples included 127 Micro Plastic Particles (MPs) in total. A trinocular microscope was used for qualitative investigation, which showed that MPs came in a variety of colors and forms. Transparent (46 particles) was the most commonly detected color, followed by white (30), blue (15), red (6), light blue (4), brown (3), and pink (3). Fibers (70), pieces (36), and sheets (21) were among the MP shapes that were detected. To determine the kinds of polymeric components contained in the particles, FT-IR analysis was performed using Origin software. Correlations between the overall number of MPS in various animal samples and their colors and shapes were examined using SPSS software.
Keywords: Micro Plastic Pollution", Wild Animal Feces, Western Ghats, Trinocular Microscope, FT-IR, SPSS Software and Origin Software.

I. INTRODUCTION

In recent years, microplastic (MP) contamination has become a significant global concern, with studies documenting the widespread presence of MPs across various environments, including marine ecosystems, rivers, lakes, beaches, estuaries, and terrestrial ecosystems [Barnes et al.,2009],. Microplastics are dispersed globally through atmospheric conditions, tides, and ocean currents, and are found in diverse ecosystems such as freshwater systems [Fendall & Sewell, 2009], Polar Regions [Boucher & Friot, 2017], and extreme locations like Mount Everest and the Mariana Trench [Martins & Sobral, 2011; Bakir, A., Rowland & Thompson, 2012],. Additionally, MPs have been detected indoors, including in air [Zarfl & Matthies, 2010], as well as in drinking water [Nizzetto& Langaas, 2016], alcoholic beverages, sea salt [Dowarah, & Devipriya, 2019], and various food items like fish fillets [Kihara et al., 2021],

In humans, MPs have been identified in the lungs [Mancia et al., 2023], and placentas [Liu et al., 2021], The fate of macro- and microplastics in the environment is largely influenced by their sources, geographic locations, and environmental factors like wind patterns and water currents. Single-use plastics and insufficient waste management play a significant role in the accumulation of plastics in both aquatic and terrestrial environments, with larger plastic items degrading under UV light into microplastics (termed secondary MPs).

Primary microplastics, meanwhile, directly enter the environment from sources like cosmetics. These particles can travel through the air and reach marine ecosystems via runoff. MPs have been found in multiple environmental compartments, including soil, air, sediments, tap water, groundwater, bottled water, and various biological samples (e.g., mollusks, human blood, feces, and breast milk), further confirming their ubiquity [Cole et al., 2011], .Defined as particles smaller than 5 mm, MPs are now recognized as a significant pollutant with serious ecological implications.

These particles originate from a range of sources such as cosmetics, clothing, and industrial processes, posing threats to both marine and terrestrial organisms. Although much research has focused on the impacts of MPs on aquatic species, there is limited information on their presence in wild animal feces.

This study aims to address this knowledge gap by investigating the prevalence of MPs in the feces of wild animals and evaluating potential ecosystem health impacts [Sarkar et al., 2023; Jung et al., 2018],.Given their small size and widespread contamination, MPs are a serious pollutant across water, salt, food, air, and milk. MPs bioaccumulate within the food chain, resulting in elevated concentrations at higher trophic levels.

This study examines MP levels in wild animals within the Southwestern Ghats buffer zone. Samples from six different locations, encompassing four animal species, revealed MP ingestion from diverse sources like air, water, and food. Waste mismanagement in the area contributes to MP ingestion by animals, who consume these particles along with their food [Sarkar et al., 2023; Beriot. ,et al; Ng et al ., 2018],.Due to their microscopic nature, MPs are invisible to the naked eye but significantly affect aquatic and terrestrial animals. They have already contaminated various resources, including water, salt, food, air, and milk. MPs are transferred within the food chain, accumulating at higher levels among tertiary consumers. This study assesses MP contamination in wild animals in the Southwestern Ghats buffer zone, where urbanization has led to reduced natural food sources, compelling animals to consume both plastic and organic materials containing MPs. This dietary shift has adversely affected habitat-dependent species like rabbits, deer, and peacocks, all impacted by MP ingestion [Sarkar et al., 2023; Nithin et al., 2021; O'Brien et al., 2023],.

STUDY AREA

Coimbatore, the second largest city in Tamil Nadu, is situated by the Noyyal River, with the Western Ghats to the west and north. It has a tropical climate with three seasons, and post-monsoon temperatures range between 9.8°C and 35.9°C. Key locations for this study including IOB Colony (11°02'74" N, 76°90'34" E), Maruthamalai foothills (11°03'86" N, 76°86'78" E), Bharathiar University (11°02'14" N, 76°52'37" E), Anna University (11°02'32" N, 76°53'10" E), Narasimhanaickenpalayam (11°06'52.7076" N, 76°56'8.52" E), and Kalappanaickenpalayam (11°03'24.8616" N, 76°53'53.628" E). Wildlife from the Western Ghats, such as Elephants and Leopards, Wild Boar, Deer and Rabbit are frequently entering the surrounding areas. Due to the proximity of temples to the Western Ghats, above said many wild animals, often wander into the foothills and surrounding residential areas for their food and water.

II. MATERIALS AND METHODS

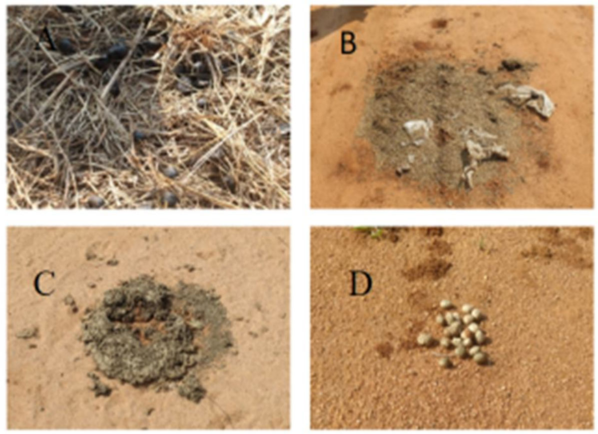
A. *Study Area*

Coimbatore is a prominent city in the Indian state of Tamil Nadu. Situated on the banks of the Noyyal River and surrounded by the Western Ghats, it ranks as the second largest city in the state, following Chennai, and is the 16th largest urban agglomeration in India. Coimbatore is bordered by the Western Ghats Mountain range to the west and north, with reserve forests from the Nilgiri Biosphere Reserve situated on its northern side. The climate in Coimbatore is classified as tropical wet and dry, characterized by three distinct seasons: pre-monsoon (March to May), monsoon (June to November), and post-monsoon (December to February). During the post-monsoon season, when the samples were collected, the mean maximum temperature ranges from 29.2°C to 35.9°C, while the mean minimum temperature ranges from 9.8°C to 24.5°C. The study area includes IOB Colony(Latitude of 11°02'74" N and Longitude of 76°90'34" E), Maruthamalai foothills (Latitude 11°03'86" N, Longitude 76°86'78" E), Bharathiar University (Latitude 11°02'14"N, Longitude 76°52'37"E), Anna University (Latitude 11°02'32"N, longitude 76°53'10"E), Narasimhanaickenpalayam (Latitude 11°06'52.7076"N, Longitude 76°56'8.52"E), and Kalappanaickenpalayam (Latitude 11°03'24.8616"N, Longitude 76°53'53.628"E). Due to the proximity of temples to the Western Ghats, many wild animals, including elephants, leopards, deer, rabbits, gaur, and wild boars, often wander into the foothills and surrounding residential areas

B. *Sample Collection*

The samples of animal feces were collected (Fig.2) from the above listed study areas. Sampling was conducted during the pre-monsoon period from March 5nd to 20th, 2024. Animal feces samples were collected from all six locations: IOB Colony, Maruthamalai foothills (latitude 11°03'86" N, longitude 76°86'78" E), Bharathiar University (Latitude 11°02'14"N, Longitude 76°52'37"E), Anna University (Latitude 11°02'32"N, longitude 76°53'10"E), Narasimhanaickenpalayam (Latitude 11°06'52.7076"N, Longitude 76°56'8.52"E), and Kalappanaickenpalayam (Latitude 11°03'24.8616"N, Longitude 76°53'53.628"E). We collected the samples using gloves, wrapped them in aluminum foil, and sealed them in Zip lock covers. After allowing the samples to dry in the shade, we stored them in a dark chamber. Subsequently, we analyzed the samples using digestion methods to isolate and characterize the presence of microplastics [Pérez-Guevara et al., 2021]

Figure _2, Field sample collection of wild animals' feces



A:Deer Feces , B:Elaphant Feces , C:Gaur Feces , D:Rabbit Feces.

C. Sample Digestion

About 5g of feces samples were placed in 1L sterilized glass beakers covered with aluminum foil to prevent contamination. We prepared Fenton's reagent, consisting of 30% hydrogen peroxide (H_2O_2) and an iron catalyst solution prepared by dissolving 20g of iron (II) sulfate heptahydrate in 1L of distilled water. We added the iron catalyst solution and H_2O_2 into the glass beakers sequentially, following a volume ratio of 1:2.5. This solution was then added to the 1L beakers containing 150ml of the sample. The digestion process lasted less than 5 hours at temperatures below 40°C [12]. After digestion, the samples were transferred to 1L glass beakers, and 65% nitric acid (HNO_3) was added. The beakers were then incubated in a 50°C water bath for 30 minutes. We then increased the temperature to 70°C and maintained it for 10 minutes to digest more resistant solids in the feces, ensuring complete digestion by HNO_3. For filtration, we diluted the solution at a 1:2 ratio with distilled water and filtered it through cellulose nitrate (CN) filter paper (47mm diameter, 0.45μm pore size). The used CN filters were then placed into 1L glass beakers for the next extraction analysis [Yan et al. , 2020],.

D. Sample Extraction

After digestion, we added 100 mL of absolute ethyl alcohol to the 1L glass beakers containing the used CN filters. This was followed by ultrasonic treatment at 100 KHz for 10-15 minutes [Yan et al., 2020],

E. Density Separation

After removing the CN filters, we centrifuged the remaining solution at 2000 rpm for 20 minutes. The supernatant was then vacuum filtered using a new CN filter paper, which was subsequently used for further identification and characterization [Pérez-Guevara et al., 2021]

F. Sample Identification

We observed the extracted particles on the filter paper under a trinocular microscope to identify plastics and note the shape, size, and color of the microplastics in different samples. Additionally, the extracted particles on the CN filters were analyzed using Fourier-transform infrared spectroscopy (FT-IR). The results from the FT-IR analysis were used to characterize the microplastics based on their chemical composition in the collected samples [Pérez-Guevara et al., 2021; Jung et al. , 2018],

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III. RESULTS AND DISCUSSION

A. *Animals*

We analyzed microplastics in the feces (Table 1) of animals such as elephants, gaur, rabbits, and deer. The collected feces samples were digested and subsequently subjected to qualitative and quantitative analysis to determine the presence of microplastics. Microplastics were observed in all collected samples, appearing in various shapes and sizes, with a total of 127 microplastics found in 12 different animals. The highest number of microplastics was observed in elephants at Maruthamalai foothills (31), while the lowest number was found in deer at Maruthamalai foothills and IOB Colony (2). Different types of microplastics, based on chemical composition, were identified and characterized through FT-IR analysis [Teampanpong et al.,2024],

Table 1: wild animals feces analysis microplastics

S. No	Site	Animals	No. of Plastics	Colour	Shapes	Types of Polymers
1	IOB Colony	Deer	11	Black-2, Blue-2 White-1, Red-1 Transparent-5	Fiber	PETE, HDPE, LDPE,
		Rabbit	2	Blue-1, White-1	Fiber Fragment	LDPE, PP, CA, PMMA.
2	Kalapa naickenpalayam	Gaur	9	Black-1, White-2, Transparent-3, Blue-1, Light blue -2	Fiber, Fragment	PETE, HDPE, LDPE, PP, PS, EVA, NYLON, , PC, PU,
		Deer	22	Transparent-9, Black-5, Brown-2 White-6	Fragment Sheet Fiber	PETE, HDPE, LDPE, PP, PS, EVA, NYLON,
3	Anna University	Elephant	11	Black-1, Blue-2, Transparent-2, Light blue-2, Red-3, Brown-1	Fiber Fragment	PETE, HDPE, LDPE, EVA, NYLON, ABS, CA, PC, PU, PTFE, PMMA.
4	Maruthamalai	Deer	2	Black-1 Blue-1	Fiber Fragment	PP, PS, NYLON, PMMA.
		Rabbit	4	Blue-1, Black-6, Blue-4, Pink-2, Transparent-3	Fiber	LDPE, PP, PS, EVA, NYLON, CA, PMMA.
		Elephant	31	White-7, Transparent-12	Fragment Sheet Fiber	PETE, HDPE, LDPE, PP, PS, EVA, NYLON, PVC, PU, PTFE, PMMA.
5	Narasimha naickenpalayam	Elephant	6	Transparent-2, Black-3, Blue-1	Fiber	PETE, HDPE, LDPE, PP, PS, EVA, NYLON, PVC, ABS, PC, PU, PTFE CA, PMMA.
		Gaur	11	Transparent-6, White-3, Black-2	Sheet Fiber	PVC,PTFE ,CA,PMMA
6	Bharathiar University	Rabbit	4	Transparent-3, Red-1	Fiber	HDPE, LDPE, PP, PS, EVA, PTFE, CA, PMMA.
		Gaur	16	Transparent - 5, White-2, Black-2, Red-1, Blue-5, Pink-1	Fiber Fragment Sheet	HDPE, PP, PS, EVA, PTFE, CA, PMMA.

B. Quantitative Analysis Of The Samples

The samples were quantitatively analyzed (fig 3) using a trinocular microscope to identify and count the total number of microplastics (fig 4) in each collected sample. The number of microplastics observed in the analyzed animals were as follows: Elephant (48), Gaur (36), Deer (35), and Rabbit (10).

The images of microplastics observed in the samples using a trinocular microscope are detailed below:

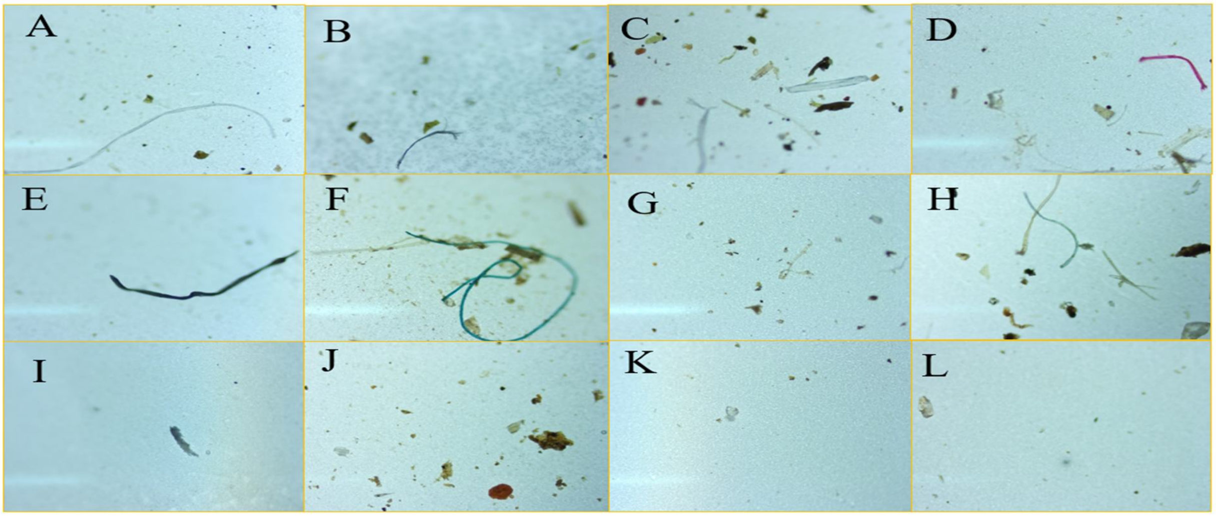

Figure _3, Microscopic images of microplastics

A:Transparent (Fiber), B:Black (Fiber),C:Whit(Fiber),D:Pink (fiber),E:Back(Fiber),F:Bule(Fiber), G:whit(Fiber),H:LightBlue(Fiber),I:Black(Fiber),J:Red(fragment),K:Transparent(Fragment),L:Whit(Fragment)

C. Qualitative Analysis of the Samples

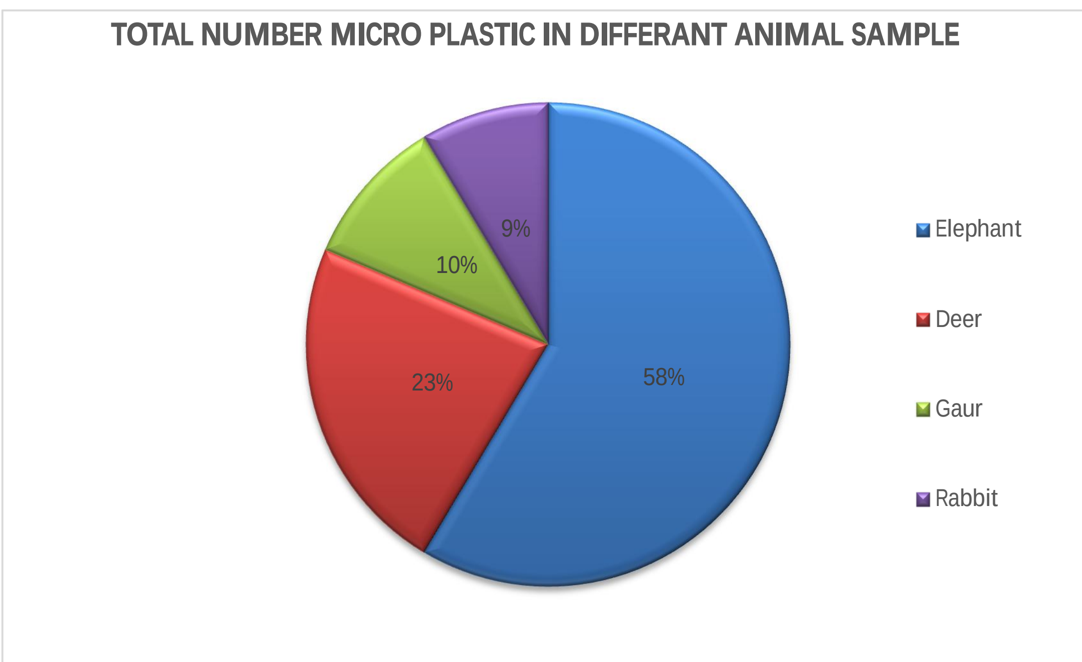

Figure_4, Total Number Micro plastic

The distribution of observed total number microplastic using a trinocular microscope is as follows: Elephant (48), Deer (33), Gaur (36), and Rabbit (10).

D. Different colours and shapes of microplastics were noted

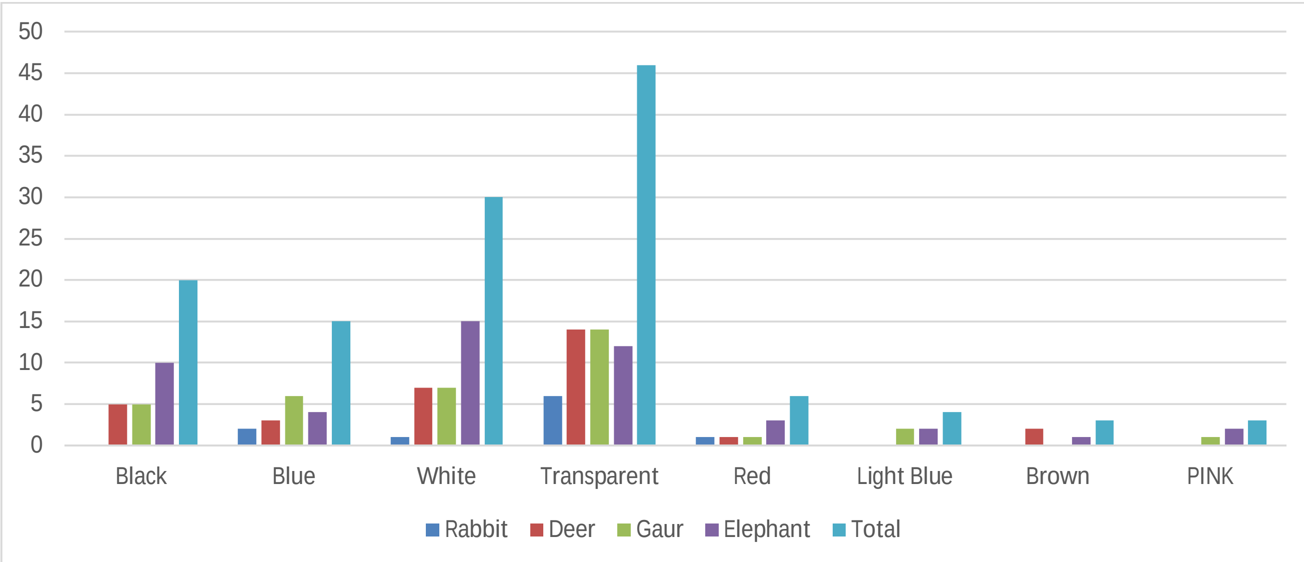

Figure_5, Total Colours Microplastic;The distribution of observed microplastic colors using a trinocular microscope is as follows: Transparent (46), White (30), Black (20), Blue (15), Red (6), Light Blue (4), Pink (3), and Brown (3).

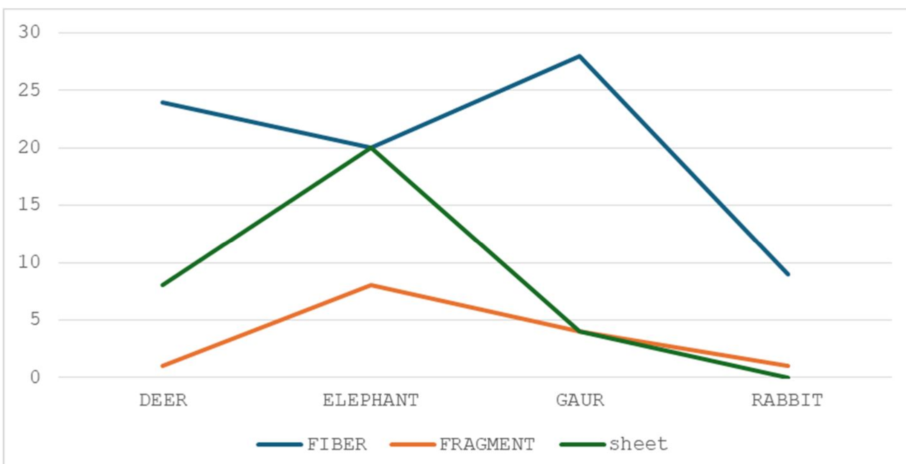

Figure_6, Total Shape Microplastic :Two distinct structures of microplastics, fibers and fragments, were identified during the analysis. Among these types, fibers were observed in the highest number (70), followed by fragments (36) and sheets (21).

E. FT-IR Analysis

FT-IR analysis was carried out to identify the type of polymeric material present in the particles. The FT-IR analysis was carried out using JASCO FT-IR – 4x. The wavelength range of the sample is between 4000-400 cm^{-1} and the resolution is 96.42%. Fifteen commonly used virgin plastic spectra were kept as standards and the plastic particles that were separated was used to compare functional groups within the sample FIR spectra. The comparison of the polymer spectra was done using the previously published article [21]. FT-IR analysis was identified different types of polymer used in origin software (2019) 1. Polyethylene Terephthalate (PETE): Peaks at 1713.44 cm^{-1}, 719.318 cm^{-1} ,1710.55 cm^{-1}, 1226.5 cm^{-1},1713.44 cm^{-1} , 1226.5 cm^{-1} and 718.354 cm^{-1} . 2. High Density Polyethylene (HDPE): Peaks at 2916.81 cm^{-1}, 2848.35 cm^{-1}, 1462.74 cm^{-1} and 719.318 cm^{-1} 2918.73 cm^{-1} , 2851.24 cm^{-1} and 1457.92 cm^{-1}at 2915.84 cm^{-1} , 2847.38 cm^{-1}, 1461.78 cm^{-1} ,718.354 cm^{-1}. 3. Polyvinyl Chloride (PVC): Peak at 1462.74 cm^{-1} 1461.78 cm^{-1} and 1226.5 cm^{-1}. 4. Low Density Polyethylene (LDPE): Peaks at 2916.81 cm^{-1},2848.35 cm^{-1},1462.74 cm^{-1} , 719.318 cm^{-1} 2918.73 cm^{-1},2851.24 cm^{-1},1457.92 cm^{-1} and 1393.32 cm^{-1} . 5. Polypropylene (PP): Peaks at 2916.81 cm^{-1} ,2848.35 cm^{-1} ,1462.74 cm^{-1} and 799.35 cm^{-1} ,2918.73 cm^{-1} ,2851.24 cm^{-1},1457.92 cm^{-1} , 1393.32 cm^{-1} , 2915.84 cm^{-1} ,2847.38 cm^{-1} ,1461.78 cm^{-1}

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and1375.96 cm^{-1}. 6. Polystyrene (PS): Peaks at 2916.81 cm^{-1},2848.35 cm^{-1} ,1641.13 cm^{-1} ,1462.74 cm^{-1}, 1049.09 cm^{-1} , 686.53 cm^{-1} , 2915.84 cm^{-1},2847.38 cm^{-1} ,1461.78 cm^{-1}, 1045.23 cm^{-1} and 664.357cm^{-1} . 7. Acrylonitrile Butadiene Styrene (ABS): Peaks at 2916.81 cm^{-1}, 1553.38 cm^{-1}, 1462.74 cm^{-1} and 686.34 cm^{-1}. 8. Cellulose Acetate (CA): Peak at 1713.44 cm^{-1}, 1713.44 cm^{-1} and 1375.96 cm^{-1} . 9. Ethylene Vinyl Acetate (EVA): Peaks at 2916.81 cm^{-1}, 2848.35 cm^{-1}, 1713.44 cm^{-1}, 1462.74 cm^{-1}, 1049.09 cm^{-1} and 719.318 cm^{-1} ,2915.84 cm^{-1}, 2847.38 cm^{-1}, 1713.44 cm^{-1}, 1461.78 cm^{-1}, 1226.5 cm^{-1} ,1045.23 cm^{-1} and 718.354 cm^{-1}. 10. Nylon: Peaks at 2916.81 cm^{-1}, 2848.35 cm^{-1}, 1641.13 cm^{-1}, 1563.99 cm^{-1}, 1553.38 cm^{-1}, 686.534 cm^{-1} 2915.84 cm^{-1}, 2847.38 cm^{-1} , 1543.74 cm^{-1} ,1461.78 cm^{-1} and 1375.96 cm^{-1} . 11. Polycarbonate (PC): Peaks at 2916.81 cm^{-1}, 1713.44 cm^{-1}, 1553.38 cm^{-1}, 1049.09 cm^{-1} and 799.35 cm^{-1}. 12. Poly (Methyl Methacrylate) (PMMA): Peaks at 2916.81 cm^{-1}, 2848.35 cm^{-1}, 1713.44 cm^{-1} and 1462.74 cm^{-1}13. Polyurethane (PU): Peaks at 2916.81 cm^{-1}, 2848.35 cm^{-1}, 1713.44 cm^{-1}, 1563.99 cm^{-1}, 1553.38 cm^{-1} and 1462.74 cm^{-1} [Jung et al ., 2018].The FT-IR results (fig-7)confirm the presence of microplastics in the collected animal samples. Analysis focused on primary consumers in the food chain suggests that if microplastics are present in these organisms, they may transfer to secondary and tertiary consumers as they progress up the food chain. This phenomenon leads to bioaccumulation of microplastics within specific animals and biomagnification throughout the food chain [15, 16].

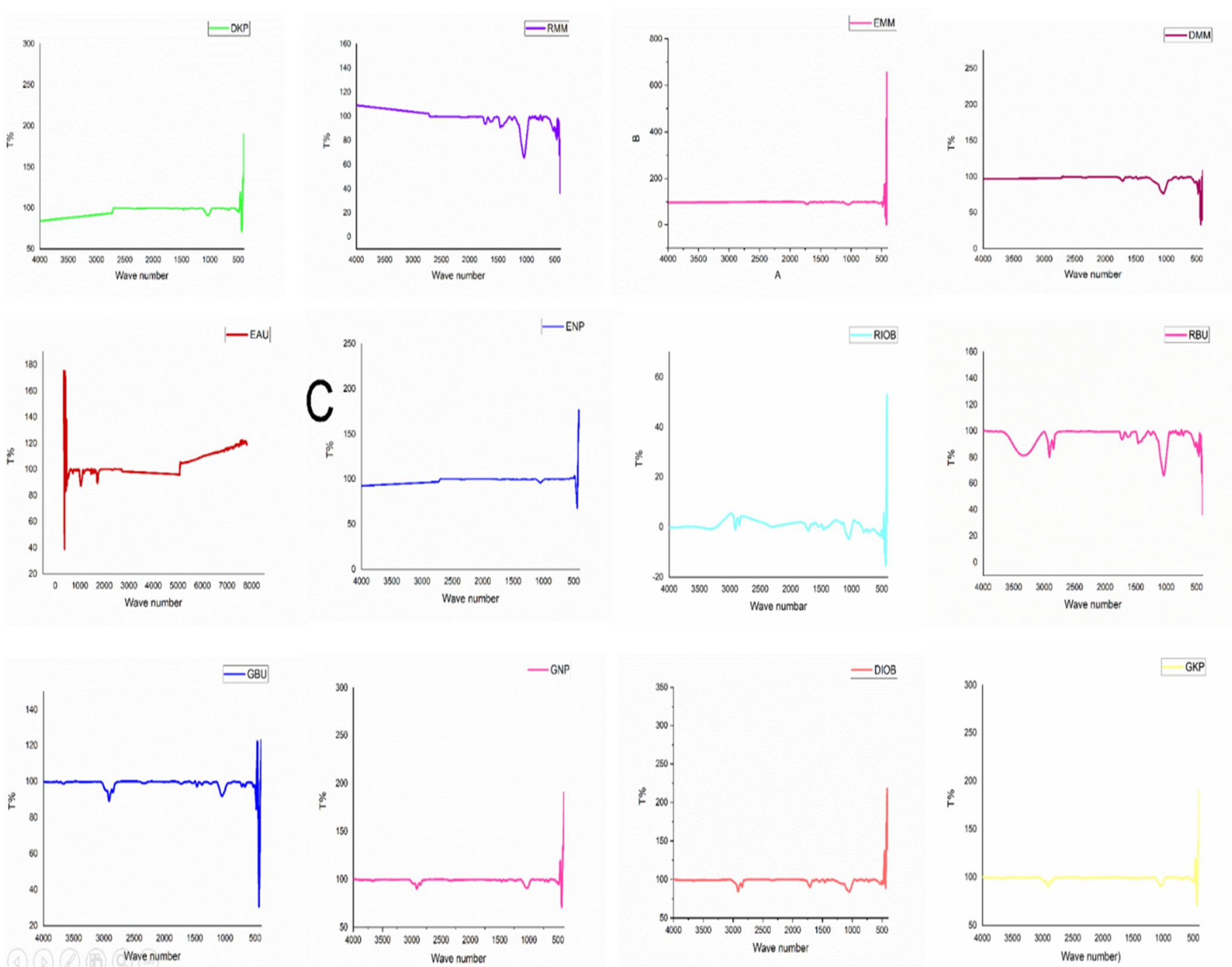

Figure_7, FT-IR Results

DKP**:** Deer in Kalappanaickenpalayam, RMM: Rabbit in Maruthamalai foothills, EMM: Elephant in Maruthamalai foothills, DMM: Deer in Maruthamalai foothills, EAU: Elephant inAnna university, ENP: Elephant in Narasimhanaickenpalayam, RIOB: Rabbit in IOP Colony, RBU: Rabbit in Bharathiar University, GNP: Gaur in Narasimhanaickenpalayam, DIOP: Deer in IOP colony, GBU: Gaur in Bharathiar University, GNP: Gaur in Narasimhanaickenpalayam.

F. Statistical Analysis

Statistical analysis of the results was conducted using correlation analysis. This involved assessing the relationship between the shapes and colors of MPs observed in the samples. Using SPSS software, correlations between the total of MP_S in different animal samples and their shapes and colors were analyzed to understand potential patterns or associations. The correlation between the total number of MPS in different animal samples shapes and colors of the MP_S was analyses using SPSS software. Almost all of the analyses data showed perfect correlations (Fibber and black) strong correlation between (Fibber and blue), (Sheet and transparent, light blue) weak correlation between (Fibber and transparent) negative correlation between (Fibber and light blue), (Fragment and black), (Fragment and blue), (Fragment and black, blue, transparent, light blue), and (Sheet and black). Insignificant (Fibber and white, red, brown, pink), (Fragment and white, red, pink, brown), (Sheet and red, pink, brown). The relationship of positively correlated data was significant but had strong as well as weak relationships between number of MPS and different shapes and colors.

G. Discussion

In our current study, we evaluated the levels of MPS in animals inhabiting the buffer zones of the Maruthamalai region. In total, 12 samples were collected from 4 terrestrial vertebrate species. **IUCN** Red List status for the species (2024): Indian elephant (*Elephas maximus indicus*) Species Endangered (EN), Gaur (Bos gaurus) and sambar deer (*Rusa unicolor*) Species Vulnerable (VU) Rabbit (*Lepus nigricollis) Least concern(LC)* . Samples were from inside protected areas and fecal samples of 4 mammal species. Our study provides the evidence of plastic excretion in the feces of terrestrial vertebrate species in India. While potential plastics were found in the feces. The high of potential MPs in the feces of Indian elephants, despite their large body size and potential for greater exposure to plastics, could be due to the ability of larger mammals to defecate potential MPs along with other inedible and indigestible items. Although Indian elephants are known to ingest large pieces of plastics and excrete them in their feces and large mammals are believed to retain plastics longer in their digestive systems. In our study, fibers were the most abundant type of MPs, predominantly in transparent and White. This sample site occurrence of potential plastics in the feces of terrestrial vertebrate species was influenced by the MP abundance in soils and the human population size of the nearest village. These findings suggest that MPs in vertebrate feces are primarily originating from MP contaminated in the environmental, particularly near human-dominated landscapes. Here, MPs can be released from activities. Open dumps were identified as the main sources of MPs in the Maruthamalai foothills. Higher MPS concentrations in soils near villages with large human populations, especially in agricultural areas, might result from plastic-derived human activities, including wastewater discharge, landfill operations, and agricultural mulching.Due to human habitation encroaching into forest zones and the depletion of forest vegetation, animals are compelled to migrate in search of food. This migration underscores the urgent need to assess the impact of MPS pollution on wildlife in these vulnerable ecosystems. During their migration from forest zones to buffer zones, where humans discard garbage, including plastics, animals may inadvertently ingest plastics along with their food, leading to the accumulation of MPS in their bodies. The escalating production and consumption of plastics have resulted in significant impacts on wildlife. However, the extent of MPS presence in wild animal's remains inadequately assessed. This emphasizes the importance of studying and understanding the implications of MPS pollution on these animals' health and ecosystems.This study is MPS on the quantification and characterization of MPS particles. Nearly all samples examined in this investigation were found to contain MPs. The elephant sample exhibited the highest number of MPs observed under a trinocular microscope. Elephants predominantly forage on the upper parts of plants, including leaf blades, stems, seeds, and flowers of grass species. This research contributes to understanding the presence and dispersion of MPS in these animals, offering insights into their potential pathways of exposure and ecological ramifications. FT-IR analysis was identify different types(fig 7) of MPS taken into consideration for analysis in the animal samples are Polyethylene Terephthalate (PETE), High Density Polyethylene (HDPE), Low Density Polyethylene (LDPE), Poly Vinyl Chloride (PVC), Polypropylene (PP), Polystyrene (PS), Acrylonitrile Butadiene Styrene (ABS), Cellulose Acetate (CA), Ethylene Vinyl Acetate (EVA), Nitrile, Nylon, Polycarbonate (PC), Poly (methyl methacrylate) (PMMA), Poly-tetra fluoroethylene (PTFE) and Polyurethane(PU).This implies that the plastics that elephants eat might have come from piles of plastic waste or from lightweight plastics that might have been transported by the wind and stuck to the higher parts of plants. The study evaluated the different MPS colors and forms found in the samples. Additionally, the FT-IR study suggests that the animal samples may contain a variety of polymer types. This knowledge aids in determining the origins of the plastics that animals eat. Rubber, PVC, PP, PE, and PET are examples of thermoplastics, which are also regarded as a type of plastics. There were 12.6 million tons of natural and 14.6 million tons of synthetic rubber in the 26.9 million ton rubber market in 2016.The primary sources of rubber emissions. One of the main sources of microplastic has been identified as agricultural soils.

Other sources of MPS-accumulating agricultural soil. One source of greenhouse shedding has been plastic films. The 4 million tons of agricultural plastic films sold globally in 2016 will have grown in value by 5.6% a year by 2030. Additionally, the construction industry, packaging, littering, and municipal solid waste landfills have released MPS into the environment. Reports state that landfills hold between 21 and 42 percent of the world's plastic waste. MPS was found in the leachate of both active closed landfills. For nearly 20 years, PE MPS has been breaking down in landfills.Packaging and consumer goods contribute significantly to MPS in the environment. PET and PES were the two main polymers present in plastic bottles since PET made up the bottle and PP made up the caps. In addition to WWTPs, MPs can also reach the environment through sewage sludge. Sewage water contained MPS, PES, and PA.Furthermore, the bioaccumulation of MPS within individual animals can increase over time, potentially leading to biomagnification of MPs throughout the food chain and food web, thereby escalating ecological impacts. In conclusion, the presence of MPS in animal feces underscores the pervasive nature of plastic pollution and its extensive impacts on ecosystems and human health. Addressing this issue requires concerted efforts at local and global scales to mitigate plastic pollution and safeguard the health of our planet and its inhabitants. Collaborative action is crucial to effectively reduce plastic contamination and promote sustainable practices for the benefit of current and future generations.

IV. CONCLUSION

To assess the presence of MPS in wild animal feces, samples were collected from various mammalian species across different habitats. These samples underwent established methods for MPS extraction and analysis, confirming the presence of MPS in every sample tested. The predominant types of MPS identified included synthetic fibers, fragments, and sheets, varying in size from a few microns to several millimeters. This study highlights the widespread contamination of natural environments with MPS and underscores the need for comprehensive mitigation strategies to address this global issue.These findings highlight the widespread presence of MPS in the environment and their potential uptake by wild animals through ingestion of contaminated food or water. The presence of MPs in wild animal feces raises significant concerns for ecosystem health, as these particles can accumulate in the food chain and adversely affect the health and reproduction of wildlife. Moreover, the detection of MPs in wild animal feces suggests potential human exposure to these contaminants through consumption of wildlife or ingestion of contaminated water sources. Addressing this issue requires concerted efforts to mitigate plastic pollution and safeguard both environmental and human health.This suggests the necessity for comprehensive research and management strategies to mitigate the impacts of MPS on both wildlife and human health. Our study emphasizes the urgent need for further investigation into the sources, distribution, and effects of MPS in wild animal feces. By gaining a deeper understanding of the extent of contamination and its potential consequences, we can advance efforts to develop solutions that reduce the release of MPS into the environment and safeguard vulnerable wildlife populations.In conclusion, the presence of MPS in animal feces serves as a poignant reminder of the widespread nature of plastic pollution and its extensive impacts on ecosystems and human health. Addressing this issue requires concerted efforts at both local and global levels to mitigate plastic pollution and safeguard the health of our planet and its inhabitants. Collaborative actions are essential to effectively reduce plastic contamination and promote sustainable practices for the benefit of current and future generations.

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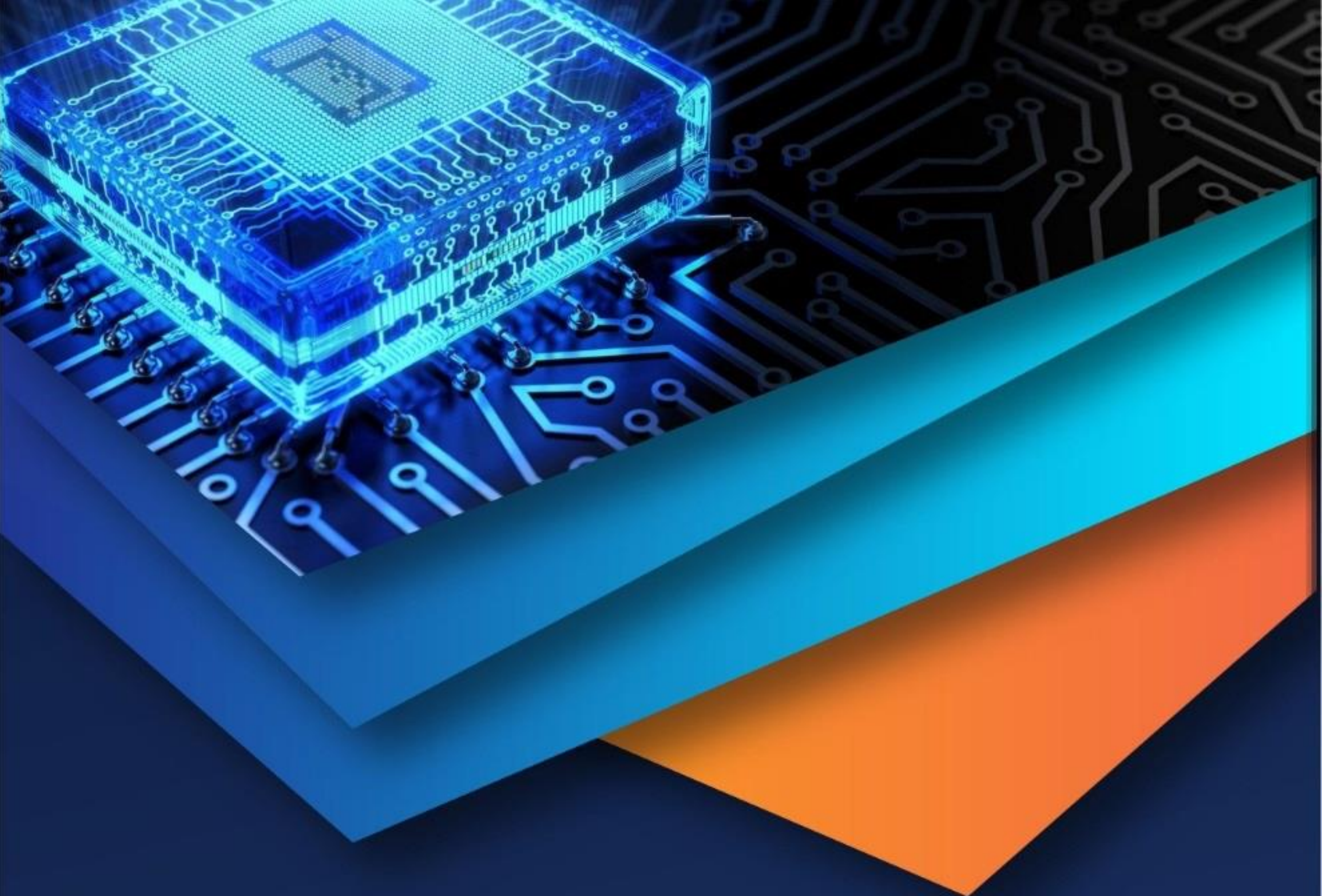

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