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Effect of Micro Plastics and Nano Plastics in Terrestrial Animals, Birds, Human and Implications on Integrated Functional Ecosystem

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Abstract: The impact of micro plastics (MPs) on the bivalve larvae at different developmental stages throughout their life history, especially for the metamorphic stage is not at all available. In organisms, consequences of plastic ingestion include exposure to environmental pollutants and toxin accumulation, causing endocrine disruption, inflammatory and physiological stress. The transfer of micro plastics has been shown to transfer across food webs, however, the micro plastic accumulations across terrestrial food webs have examined but it has limited studies only. The different type of micro plastic exposure, exposure time, as well as physiological and behavioral differences among organisms exposed to micro plastics can show some of these differences in effects. If the organism ingested by the micro plastics, its interact within the gastrointestinal tracts differently in terms of the anatomy and structure of the tract, its mechanical action, transit time and chemical enzymatic action. Further, the characteristics of micro plastics such as size, shape, solubility, and surface properties also play an important role in the toxicity of micro plastics. Micro plastic pollution in the soils harms the fitness of multiple soil organisms, animals and birds underscoring the ecological risk posed by micro plastics within terrestrial ecosystems.

Keywords: Micro plastics and Nano plastics, Terrestrial animals, Terrestrial birds, Human-beings and Ecosystem

Over the past 50 years, mass production and population growth have resulted in the explosion of micro plastics, both as marketable products and the humiliation of larger plastic materials, the various sources and unique properties of primary and secondary micro plastics will abode tasks on an underprepared waste infrastructure. In addition to reducing or replacing primary micro plastics and the large plastics from which secondary micro plastics are formed, the release of micro plastic fibres, tire fragments, and abrasives must also be addressed. One of the most abundant types of micro plastics in the environment is polyester fiber. A major fraction of the fibres inflowing to wastewater treatment plants completion in sewage sludge and used as soil fertilizer in many countries. As their effects in the terrestrial environment are still unwell understood, Still fibres have been recognized as one of the major type of plastics in soil. Their adverse effects on soil invertebrates and possible entry into terrestrial food webs are still unknown. Recent reports of micro plastics and the effects on soil invertebrates generally studied are polyethylene (PE), polystyrene (PS) and polyvinylchloride (PVC) non-fibrous particles (micro beads, films, pellets, fragments). With the massive ingesting of plastic products, global plastic manufacture currently has beaten 290 million tons annually and will touch 33 billion tons by 2050 (Rochman et al 2013). Due to the low reclamation rate (<5%) and high environmental persistence, plastic debris consists of the major marine litter (c.a., 80–85%) (Auta et al 2017). As a result, plastic pollution in the marine environment has been familiar as a primary environmental issue (Wright et al 2013a, 2013b), resulting in an economic loss of $US13 billion annually around the world (UNEP 2015). Acting as the universal component of plastic litter (Andrady 2011, Auta et al 2017), MPs can be of primary (industrially manufactured to be micro and/or nanosized) and/or secondary (breakdown from large plastic items) origin, their surfaces can be familiarized with different functional groups (e.g., -COOH, -NH_2) upon photo degradation and biodegradation (Andrady 2011). Secondary MPs are small plastic fragments which decomposed from larger plastics (Rillig et al 2017). Since their size range closely conforms to plankton (e.g. Algae) at the bottom of the marine food web, MPs thereby could be available to a wide range of marine biota (e.g. Copepods, crustaceans, fish and mammals) via feeding and trophic transfer (i.e., consumption of prey containing MPs) along the food chain (Wright et al 2013a, 2013b, Galloway et al 2017, Luan et al 2019).

Several investigational studies have been completed with high concentrations of micro plastics regarding those found in nature. However, Duis and Coors (2016) pointed out that micro plastics are highly persistent and their concentration is very likely going to rise considerably in the next decades. Some hotspots in which micro plastics are present at tremendously high concentrations already present. The future potential higher plastic levels, the results obtained in studies not using significant environmental concentrations should not be rejected. Elements affecting MP behaviour and passage in the atmosphere may also be comparable to those of fine particulate matter including vertical pollution concentration gradient (higher concentrations close to the land), wind speed (increasing of wind speed lead to a decrease in concentration), wind direction (downwind, upwind, and parallel directions), precipitation, temperature and humidity. Also, urban topography (e.g. tall buildings, trees and space between buildings) can disturb wind modulation and distribution of air pollutants in urban environments. Lighter polymers can be transported easily by the wind and additional contaminate the terrestrial and marine environments (Horton et al 2017, Karbalaei et al 2018).

Most plastics received in the oceans were manufactured, used, and often disposed on land. Hence, it is surrounded by terrestrial systems that micro plastics influences first interact with biota producing ecologically relevant impacts. The pervasive micro plastic contamination as a potential agent of global change in terrestrial systems highlights the physical and chemical nature of the respective observed effects, and the broad toxicity of nano plastics derived from plastic breakdown. The fate of micro plastics in aquatic continental systems, insights into the mechanisms of effects on terrestrial geochemistry, the biophysical environment, and ecotoxicology. General changes in continental environments are likely even in particle-rich habitats such as soils. The growing body of evidence indicating that micro plastics interact with terrestrial organisms that mediate essential ecosystem services and functions, such as soil-dwelling invertebrates, terrestrial fungi, and plant-pollinators (de Souza Machado et al 2018).

The crucial pollution which is widely distributes in the environment is the micro plastics (MP). Recently, the studies of MP have increased rapidly due to increasing awareness of the potential and growing risks of biological effects during storage and disposal. Still, due to the limitations in analytical methods and the methods of environmental risk assessment, the distribution and biological effects of MP are still debatable issues (Zhang et al 2019). This review focuses on the occurrence, sources, and transport of MPs in terrestrial environments and applicable regulations to mitigate the impacts of MPs. This study also highlights the importance of personality traits and cognitive ability in reducing the entry of MPs into the environment.

Microplastics: Micro plastics are nominally divided into two distinct sources, primary micro plastics, which are those produced below five (or one!) millimeters in size, and secondary micro plastics, those made due to the fragmentation of bigger macro plastics or “parent material”. Sources of primary micro plastics include the feedstock for the plastic manufacturing process (nibs, nurdles, and powder), scrubbing particles in cosmetic goods, household cleaning products, glitter, and shot blasting media. Secondary micro plastics may be divided into those formed from plastics during the useful life span of the parent material and those formed after its beating to the environment. Secondary micro plastics sources include abrasion of car tires, the wear of boat rigging and fishing gear during operation and the establishment of microfibers during domestic clothes washing. The latter has only recently come to light as a significant contributor to global micro plastic pollution. Man-made fibres are common in the production of clothing throughout the world and the action of washing results in the shattering of fibres within the garment.

Production of plastics has been growing for more than 60 years, as the durable, primarily petroleum-based material gradually substitutes materials like glass and metal. Nowadays, plastics are used widely in a growing range of applications such as packaging industry, building and construction, automotive industry, textiles, electrical and electronics, agriculture, household applications, health, and safety equipment (Dehghani et al 2017). Analysis of micro plastics from different environmental samples requires a sequence of procedures including sampling, separation, clean-up and identification. Although several studies on method development and/or comparison for sampling, separation, clean-up and identification have been carried out, it is still critical to improving methods to yield more precise and accurate results. Among these identification methods, the most widely used should be evaluated for their relevance to future studies. Recently, small-sized micro plastics have been found in the marine environment and the abundance of micro plastics increased exponentially with decreasing particle size. The smaller micro plastics are more difficult to identify. Ambiguous characteristics of non-plastics (resembling plastics) and plastics (resembling non-plastics) make it difficult to accurately identify micro plastics (Song et al 2015).

Micro plastics (MPs) pollution is an emerging environmental and health concern. Micro plastic influences on benthic organisms could shake higher trophic levels (e.g., trophic energy transfer or trophic interactions). Similar waves may also occur in pelagic habitats where micro plastics can reach densities higher than naturally occurring planktonic organisms (Lechner et al 2014). Micro plastics in freshwater may have carry-over various effects to terrestrial systems, as many freshwater organisms are prey to terrestrial insects, amphibians, reptiles, and birds. Some forest birds receive up to 98% of their resources from aquatic prey. Potential exists for micro plastic transfer across habitats via animal migrations, much the way anadromous fish transfer marine nutrients to freshwater systems. Other habitat-related effects of micro plastics include their role as a substrate for egg-laying organisms or as habitat for encrusting organisms, rafting communities and microbial communities (Carson 2013, Zettler et al 2013). Micro plastics serve as novel ecological habitats for microbes and may provide a substrate for opportunistic pathogens.

MPs are entering the human digestive system via several sources such as drinking water (Eerkes –Medrano et al 2018, Koelmans et al 2019), table salt (Yang et al 2015), seafood products (Li et al 2016a, Jabeen et al 2017, Barboza et al 2018), and even tea bags (Hernandez et al 2019). Consequently, there is growing concern about the intake of MPs and the related health risks to the human being (Carbery et al 2018). The alternative possible for the entry of MPs into human is the land- dwelling animal material, which is consumed broadly as well as used in making traditional medicine (Lu et al 2020) and also stated that micro plastic contaminants can be existing in chicken meat and feces (Yan et al 2020). The micro plastic content was observed in human lungs and stools (Schwabl et al 2019). The quantity of micro plastics in an organism's tissues or organs has so far been recognized as a challenging factorin the present situation (Lee et al 2019, Huang et al 2020).

Origin and distribution of micro plastics: In early 1940s, itself humans have been mass-producing plastics since and production has increased widely in subsequent years. Approximately 240–280 million tonnes of plastic have been produced annually since 2008, compared to an annual production rate of 1.5 million tonnes in 1950 (Cole et al 2011, Wright et al 2013b). About 50% of plastic produced as a main contributor is the packaging materials which is disposed after one time use. The plastics entering the natural environment has intermediate life spans and come from durable consumer products, such as electronics and vehicles is the another 20–25% (Hopewell et al 2009). Most plastics are extremely durable and can persist from decades to millennia in their polymer forms (Thompson et al 2004,Hopewell et al 2009). The durability of plastics causes to persist and contaminate environments worldwide. Marine habitations are mostly affected (Lithner et al 2011). Micro plastics constitute plastics that are <5 mm, as classified by the National Oceanic and Atmospheric Administration (NOAA), and they are present in a heterogeneous array of shapes and sizes (Betts 2008, Hidalgo-Ruz et al 2012, Wright et al 2013b). Some of them classify the micro plastics with an upper size limit of 1 mm (Browne et al 2009) and, upper size limits of 1 mm and 5 mm are currently acceptable to describe micro plastics in the studies. The most noticeable micro plastic forms contaminating the marine environment are spheres, pellets, irregular fragments, and fibres (Wright et al 2013b). They are universal throughout the global oceans, and micro plastics (<1 mm) in the water column and seabed have been detected to weigh 100 times and 400 times more than macro plastic debris (Van Cauwenberghe et al 2013). In water column, sediments, and the deep sea, with highest concentrations along populated coastlines and within mid-ocean gyres micro plastics are distributed (Cole et al 2011, Wright et al 2013b). The spatial distribution of micro plastics discovered that accumulation is higher at downwind sites and in areas with decreased water flow. A relationship has yet to be observed between micro plastic concentrations and grain size distribution and the extent of micro plastic contamination to the marine environment is still largely unknown (Browne et al 2008, 2011, 2021). Plastics are synthetic organic polymers, created by polymerization of monomers extracted from crude oil and gas (Cole et al 2011). Some of the most prominent plastic polymers found in the environment include polystyrene (most commonly used in packaging and industrial insulation), acrylic, polyethylene (used in facial scrubs), polypropylene (commonly used in fishing gear), polyamide (nylon), polyvinyl chloride (PVC), and polyester fragments (Browne et al 2008, 2011). Primary micro plastics are produced at a microscopic size and are integrated into a variability of facial exfoliating cleansers, air-blasting boat cleaning media, and are increasingly used in medicine as vectors for drugs (Cole et al 2011). Secondary micro plastics from when macro plastics undergo mechanical, photolytic, and/or chemical degradation, resulting in fragmented micro plastic pieces and fibres. There is evidence that a primary source of micro plastics is synthetic fibres from garments. The study quantifying micro plastic concentrations at 18 sites worldwide showed that a single synthetic clothing garment can release >1900 micro plastic fibres per wash. These microfibers enter the marine environment via wastewater discharge contain proportions of polyester and acrylic micro plastic fibres resembling proportions used in synthetic clothing (Browne et al 2011, Mathalon and Hill, 2014). In natural environment the plastic pollution is unavoidable. One of the most enduring threats faced by wildlife is the plastic pollution, because of their small size; MPs may presumably also enter the food web and thus potentially end up in human food. The risk that is not yet predictable, because the interaction of MPs with tissue and cells is poorly understood. Investigation of the interaction is further complicated by the fact that MPs are not single compounds but constitute mixtures of different plastic types, each often consisting of a blend of synthetic polymers, residual monomers, and chemical additives. In addition, their morphology may influence their effects.

Effects of micro plastics in terrestrial invertebrates: The micro plastic and nanoplastic pollution is a growing environmental concern that affects the wildlife because of the vast amount of plastic waste emitted into the environment and the increasing concern of potential harm. It has the potential to cause both physical and chemical harm to wildlife directly or via sorption, concentration, and transfer of other environmental contaminants to the wildlife that ingests plastic. Small particles of plastic pollution, termed micro plastics (>100 nm and or nanoplastics (<5mm) can form through fragmentation of larger pieces of plastic. These small particles are especially concerning because of their high specific surface area for sorption of contaminants as well as their potential to translocate in the bodies of organisms. These are challenging to separate and identify in environmental samples because their small size makes handling and observation difficult (Nguyen et al 2019).

The secondary micro plastics are more common in the natural environment; both the primary and secondary micro plastics have increased in frequency over time, bringing potentially injurious effects to wildlife (Andrady 2011, Tanaka and Takada 2016). The ingestion of micro plastics in wildlife has become familiar. The ingestion of micro plastics, organisms is exposed to toxic materials and it cause adverse effect on organisms from ingested plastics is of increasing concern. In marine ecosystems, wide research is currently being shown and in the terrestrial wildlife there is limited research on micro plastic abundance and diversity is shown. Furthermore, in top predatory animals there is lack of research in micro plastic presence. Through passing awareness to plastic pollution in both marine and terrestrial ecosystems, checking that how it is affecting to top predators in the food web and also further conservation efforts can be made to decrease micro plastic presence to other wildlife in similar habitats (Carlin 2020).

In terrestrial environments micro plastics are widespread contaminants but comparatively little is known about interactions between micro plastics and common terrestrial contaminants such as zinc (Zn). The experiments in adsorption fragmented HDPE bags c. one mm^2 in size showed similar sorption characteristics to soil. However, the combination with soil, concentrations of adsorbed Zn on a per mass basis were over an order of magnitude lower on micro plastics. Desorption of the Zn was minimal from both micro plastics and soil in synthetic soil solution (0.01 M $CaCl_2$), but in synthetic earthworm guts desorption was higher from micro plastics (40−60%) than soil (2−15%); suggesting micro plastics could increase Zn bioavailability. *Lumbricus terrestris* earthworms experimented for 28 days in mesocosms of 260 g moist soil containing 0.35 wt % of Zn-bearing micro plastic (236−4505 mg kg−1) ingested the micro plastics, but there was no evidence of Zn accumulation, mortality, or weight change. Digestion of the earthworms showed that they did not retain micro plastics in their gut. These findings indicate that micro plastics could act as vectors to increase metal exposure in earthworms, but that the associated risk is unlikely to be significant for essential metals such as Zn that are well regulated by metabolic processes (Hodson et al 2017).

On soil invertebrates little research has focused. The recent research reported that exposed the soil springtail, *Folsomia candida* to artificial soils contaminated with polyethylene MPs (<500 mm) for 28 d to explore the effects of MPs on avoidance, reproduction, and gut micro biota. Springtails exhibited avoidance behaviors at 0.5% and 1% MPs (w/w in dry soil), and the avoidance rate was 59% and 69%, respectively. Reproduction was inhibited when the concentration of MPs reached 0.1% and was reduced by 70.2% at the highest concentration of 1% MPs compared to control. The half-maximal effective concentration (EC50) value based on reproduction for *F. candida* was 0.29% MPs. At concentrations of 0.5% dry weight in the soil, MPs significantly altered the microbial community and decreased bacterial diversity in the springtail gut. Specifically, the relative abundance of Wolbachia significantly decreased while the relative abundance of Bradyrhizobiaceae, Ensifer and Stenotrophomonas significantly increased. The results also demonstrated that MPs exerted a significant toxic effect on springtails and can change their gut microbial community (Ju et al 2019). The studies found that micro-sized plastic particles moved into bio-pores within seconds and that this influx disrupted the movement of springtails (*Lobellas okamensis*). In the soil system the springtails moved to avoid becoming trapped, and this behaviour created bio-pores. The springtails within the influx of plastic particles into these cavities subsequently immobilized. This phenomenon was experimental at low concentration of plastic particles (8 mg/kg), and it likely occurs in actual soil environments. The findings of the study indicates that the behaviour of plastic particles in the soil not only disrupts the movement of springtails but also has wider implications for effective management of soils (Kim and An 2019). There is an evidence for the translocation to tissues and micro plastic spheres of 0.5 µm have been shown to translocate to the haemolymph and tissues of crab (Farrell and Nelson 2013). The food consumption and energy expenditure available for growth was reduced after crabs (*Carcinus maenas*) ingested food containing microfibers for 4 weeks. The ingestion of MPs may facilitate transfer of persistent organic pollutants to the organism as a secondary effect (Watts et al 2014). Medaka exposed to a mixture of polyethylene and PBTs (persistent bioaccumulative and toxic substances) bioaccumulated the chemicals and suffered liver toxicity including glycogen depletion, fatty vacuolation, and single cell necrosis (Rochman et al 2013). The recent experiments indicated that the MPs were detected in surface water, sediment, and tadpoles with abundances of fibres and fragments of polyester (PES) and polypropylene. Further the distribution of MPs in tadpoles resembled that of water rather than sediment and MPs supplier was also found to be from surrounding water. Such high abundances of MPs in resident tadpoles strongly support that MPs may transport through the food chain to higher aquatic or terrestrial tropic levels (Hu et al 2018).

As per Song et al (2019), the uptake of appreciable burdens of PET microfibers (MFs) and depuration through the digestive tract in snails, following the appearance of cracks and deterioration on micro plastic surfaces. The prolonged exposure to MFs inhibited feeding and excretion of snails and caused pathological damage in the gastrointestinal tract and also, MFs exposure can reduce T-AOC and GPx activity, but elevate MDA levels, which indicate that oxidative stress is involved in the toxic mechanisms. The findings recommend that in terrestrial ecosystems micro plastic pollution in soils harms the fitness of soil organisms, and highlight ecological risks of micro plastic fibres. The polystyrene of 5µm and 70nm at environmentally relevant concentrations are accumulated in zebrafish liver and gut, producing oxidative stress and inducing alterations of metabolic profiles and disturbing lipid and energy metabolism and similar effects were detected in mice, in one of the very few toxicity studies of micro plastics performed in rodents (Deng et al 2017).

The earthworms are the model organisms of the soil ecosystems, they have been predominantly used as the test species in investigating the effects of soil plastic pollution on organisms (Chae and An 2018). The exposure experiments in the micro plastics present in soils is observed that it can be ingested, transferred, and cause toxic effects (Rillig et al 2017) but in terrestrial invertebrates few studies have reported the accumulation of micro plastics. Rodriguez-Seijo et al (2017) reported that damage in the gut of the earthworm *Eisenia andrei,* causing damage in the epithelium and inflammation of the gut wall, which may be an indicator of accumulation of PE micro plastics (250-1000 mm) that due to the big size of the particles induced harm in the organism. Bioaccumulation of polybrominated diphenyl ethers (PBDEs) was observed in *Eisenia fetida* after 28 days of exposure to polyurethane foam (Gaylor et al 2013) Hepatic stress was detected in Japanese medaka exposed to polyethylene pellets (Rochman et al 2013) and histological alterations of the intestine were detected in European sea bass exposed to polyvinyl chloride pellets (Pedá et al 2016). The effect of plastic covers on soil microbes can propagate in different ways to higher tropic levels of the food web. E.g. by positively affecting overall arthropod diversity and doubling omnivorous insect but decreasing springtail, predatory nematode, ground beetle or earthworm abundances (Steinmetz et al 2016).

Nematodes can ingest MP particles which might adversely affect their reproduction. The toxic properties of MP on nematode reproduction in soils cannot be ruled out. The toxicity risk for conventional and biodegradable MP particles is likely to be the same, as MP toxicity is rather attributable to physical and indirect nutritional effects rather than to chemical effects. Even though its negative effects of MP on the body length of nematodes, since nematodes as key members of the soil food web, may be at risk under MP exposure (Schöpfer et al 2020). Experimental studies in the effects of MP on mussels, lugworms, copepods, and oysters have documented reduced feeding, survival, and fecundity, as well as promoted polychlorinated biphenyl bioaccumulation connected to MP uptake (Lenz et al 2016). PET microfibers can be ingested and depurated throughout the digestive system of terrestrial snails, after transit through the digestive tract, MFs presented cracks and deterioration on the surfaces of MFs. Moreover, prolonged exposure to MFs had negative impacts on feeding and excretion of snails and caused visible villi damages in the stomach and intestine. It's found that MFs exposure can reduce T-AOC and GPx activity, but elevated MDA levels in the liver. These results found that the micro plastic pollutants in the soil are transferred by land snails and that they have physiological effects.

A recent study has found that larvae of *Galleria mellionella* are capable of biodegrading low density PE film. Significant mass loss of plastic was witnessed over a 21-day period with own consumption of 0.88 and 1.95 g by 150 larvae fed only either PS or PE. The formation of C = O and C – O containing functional groups and long chain fatty acids as the metabolic intermediates of plastic in the residual polymers indicated depolymerisation and biodegradation. The changes in the gut microbiome revealed that Bacillus and Serratia were significantly associated with the PS and PE diets. Therefore, the supplementing the c-diet affected the physiological properties of the larvae and plastic biodegradation and shaped the core gut microbiome. The recent study indicated that MPs were detected in surface water, sediment, and tadpoles with abundances of fibres and fragments of polyester (PES) and polypropylene. Moreover, the distribution of MPs in tadpoles resembled that of water rather than sediment and MPs supplier was found to be from surrounding water. Such high abundance of MPs in resident tadpoles strongly support may transport through the food chain to higher aquatic or terrestrial trophic levels.

The effects of micro plastics of *Eriocheir sinensis* show the growth, accumulation and oxidative stress response in the liver. The accumulation of fluorescent micro plastic particles (diameter = 0.5 µm) in the gill, liver and gut tissues of *E. sinensis* were observed when crabs were exposed to a concentration of 40000 µg/L for 7 days. The toxicity test suggested that the rate of weight gain, specific growth rate, and hepatosomatic index of *E. sinensis* decreased with increasing micro plastic concentration (0 µg/L, 40 µg/L, 400 µg/L, 4000 µg/L and 40000 µg/L) for 21 days. The activities of AChE and GPT in crabs exposed to micro plastics were lower than those in control group. GOT activity increased significantly after exposure to a low concentration of micro plastics and then decreased continuously with increasing micro plastic concentrations. The activities of superoxide dismutase (SOD), aspartate transaminase (GOT), glutathione (GSH), and glutathione peroxidase (GPx) increased in specimens exposed to low concentrations of micro plastics (40 and 400 µg/L) compared to the control and decreased in organisms exposed to high concentrations (4000 and 40000 µg/L). The activities of acetylcholinesterase, catalase (CAT), and alanine aminotransferase were significantly lower in the organisms exposed to micro plastics compared to control animals. Upon the exposure of micro plastic concentrations increases, so the expression of genes encoding the antioxidants SOD, CAT, GPx and glutathione S-transferase in the liver decreased after first increasing. The study demonstrates that the accumulation in the tissues of *E. sinensis* and negatively affect the growth. In addition, the exposure to micro plastics causes damage and induces oxidative stress in the hepatopancreas of *E. sinensis* (Yu et al 2018)

The investigators reported that the ingestion of anthropogenic waste, primarily plastic bags and rope by gromedary camels in the United Arab Emirates (UAE) which has led to a regional mortality rate of 1%. The ingested waste was found to be a polybezoar, a collection of tightly packed indigestible materials which can include plastics, ropes, other litter and salt deposits trapped in the stomach or digestive tract forming a large stone-like mass. Further, polybeozars lead to gastrointestinal blockages, leak toxins and sepsis from increased gut bacteria, dehydration and malnutrition give camels a false sense of fullness, so they stop eating and slowly starve to death (Eriksen et al 2021).

Plastic have been observed in digestive tracts of cattle, sheep and goats (Jebessa et al 2018). Plastic materials cannot be digested and may take a long time to pass through the digestive tract or be retained indefinitely when caught in complex digestive tracts. Consequences of plastic ingestion include ruminal impaction, where indigestible plastic foreign bodies accumulate in the rumen which leads to indigestion, the formation of bezoars containing primarily synthetic materials, trumas, poor body condition, immune suppression, reduced health status, and mortality and death within two to three weeks due to organ failure. The ingested plastic rubbish release toxins into the circulatory system, which causes liver values (glutamate oxaloacetate transaminase-GOT (AST), gamma-glutamyl transferase (Y-GT), glutamate –pyruvate –transaminase-GPT (ALT) and kidney values (blood urea nitrogen –BON, creatine 0 to increase steadily, culminating in organ failure. The plastic mass or polybezoar can affect feeding behaviour, resulting in camels eating less until they stop eating completely, as the camel always feels full resulting in a false sense of satiation. The polybezoars which containing poly ethylene, poly propylene and ethylene vinyl acetate also reported. MPs refer to micro beads used in personal care products (PCPP) and plastic products (Jambeck et al 2015), such as shampoos, shower gels, lipsticks, facial masks, and various synthetic textiles. PE or PP are usually used as micro beads or glitter in cosmetics (He et al 2018). Synthetic fibres such as ester and nylon are often used in synthetic textiles (Gong and Xie, 2020). Micro beads used by humans can flow into the sewage and produce primary MPs as the fibres wear and fall off when washed in the laundry or home for synthetic textile clothing (He et al 2018). Therefore, the large-scale use of synthetic textiles and personal care products is also the way for MPs to enter the soil.

Generally the effects of polyester fibres on the soil invertebrates were slight. Energy reserves of the isopods were slightly affected by both fibre types, and enchytraeid reproduction decreased up to 30% with increasing fibre concentration, but only for long fibres in soil. The low ingestion of long fibres by the enchytraeids suggests that this negative impact arose from physical harm outside the organism, or indirect effects resulting from changes in environmental conditions. The short fibres were ingested by enchytraeids and isopods, with the rate of ingestion positively related to fibre concentration in the soil. The study shows that polyester fibres are not very harmful to soil invertebrates upon short-term exposure. The studies found clear evidence for fibre uptake in enchytraeids and isopods, indicating the entry of polyester fibres into terrestrial food webs and potential long-term risks for these organisms and their predators (Selonen et al 2020).

The most of the plastic litter originate from land based sources is considered to entering the aquatic system. That includes recreational activities on shores, inappropriate or illegal dumping of domestic and industrial litter, plastic manufacturing facilities, transportation as well as sewage treatment and surface runoff of street litter (Gesamp 2010). Plastics are also present in the wastes, which can be categorized as municipal, industrial, agricultural, construction and demolition waste. Plastic waste generated by 192 coastal countries worldwide in 2010 was estimated to 275 million tons out of which 2-5% were assumed to be mismanaged and ending up in the oceans (Jambeck et al 2015). Fate of plastic waste in the terrestrial environment is probably not different but not well studied or analysed (Karman et al 2016).

Effects of micro plastics on birds: Numerous studies have dealt with the ingestion of marine debris by seabirds, where micro plastics, essentially pellets and fragments, have been isolated from birds targeted for dietary studies, cadavers, regurgitated samples, and feces (Van Franeker and Law 2015, Herzke et al 2016). Kuhn and van Franeker (2012) found more plastic in the intestines of juveniles than in adults. Its indicate that possibly micro plastics contamination in birds occurs mostly between generations and that the regurgitation process may lead to a breakdown of micro plastics into even smaller particles. The majority of birds examined did not die as a direct result of micro plastic uptake and can be concluded that micro plastic ingestion does not affect seabirds as severely as macro plastic ingestion (Lusher 2015). Most studies of micro plastics in seabirds only analyse micro plastics in the digestive tract (Herzke et al 2016) and feces (Reynolds and Ryan 2018) and thus, at this stage, there is no evidence that micro plastics can cross the intestine barrier and/or enter the bloodstream and accumulate in different organs. No studies have demonstrated nanometre-sized micro plastics in seabird guts or feces and also in respect to terrestrial birds, so far only two papers reported the ingestion of micro plastics. Zhao et al (2016) found fibres and fragments of millimeters in length in the gastrointestinal tract of 17 terrestrial birds. They also observed a decrease in the proportion of natural fibres from the esophagus to the stomach and subsequently to the intestine, which suggests that they may be digestible, although further research in this field is still necessary.

Studies on marine bird species recognized that at least 44% ingest plastics and research recording plastic ingestion in shorebirds (Amélineau et al 2016, Lourenco et al 2017, Provencher et al 2018). The micro plastic accumulation in birds of prey is not in published research. Birds of prey offer interesting insights for potential conservation efforts dealing with plastic pollution. The raptors searching habitats also have the potential to serve as indicators as to where plastic pollution is of greatest concern. Comparing osprey, whose primary diet comes from fish, to red-shouldered hawks, whose primary food source is small mammals and amphibians, can show differential plastic abundances in either the marine, freshwater, or terrestrial ecosystem. Beyond that, this research can shed light on the ability of micro plastics to transfer along with food webs. Studies have shown that higher trophic level organisms have a greater chance of deleterious effects due to accumulation of toxins in micro plastics along with the food web (de Sa et al 2018). As top predators, birds of prey can expand our current understanding on potential bioaccumulation of toxins via micro plastic accumulation.

The diversity of predatory birds' diets suggests that micro plastics will therefore also be present in birds of prey. The majority of literature on micro plastic prevalence in the environment focuses on aquatic ecosystems (Andrady 2011,Li et al 2016b, M'Rabet et al 2018,). Therefore, hypothesized that *Pandion haliaetus* (osprey), which forages primarily on fish from both fresh and saltwater ecosystems, would have the greatest mean abundance of micro plastic per gram of gastrointestinal (GI) tissue when compared to other species. A common source of marine plastic pollution comes from the fragmentation of boat ropes, and therefore polypropylene, nylon, and PET fibres are expected to be most commonly found in *P. haliaetus* (Mathalon, and Hill, 2014). *Buteo lineatus* (red-shouldered hawk), *Strixvaria* (barred owl), *Mega scopsasio* (eastern-screech owl), *Bueto jamaciensis* (red-tailed hawk), and *Accipiter cooperii* (cooper's hawk) diet is composed predominantly of small rodents and terrestrial reptiles and therefore a greater mean abundance of “user plastics” (i.e. trash, recyclable materials) can be expected to be found in the gastrointestinal tract of such species (Carlin 2020).

The studies say that terrestrial birds of prey may experience the bioaccumulation of micro plastics than aquatic species foraging at comparable trophic levels. It was conducted in a highly urbanized environment where rodents have a higher likelihood of relying on sources of anthropogenic waste for sustenance, therefore, increasing their chance of exposure to micro plastics. As a result, birds of prey feeding within such terrestrial food webs may experience the higher levels of bioaccumulation of micro plastics in anthropogenic materials. Fish and their food sources may be exposed to lower concentrations of micro plastics than rodents because rodents experience a direct source of anthropogenic litter from foraging in trash-cans and landfills. Furthermore, terrestrial birds of prey are not only exposed to micro plastics through secondary sources but are often exposed directly from foraging in landfills (Karbalaei et al 2018).

Chickens seem to take up plastics mainly from the plastic residues on the soil surface and therefore, MP found in soils and those found in Chicken feces were not correlated. Earthworms seem to bio concentrate MPs stronger in casts if the MP content in soil is low. This fact was well described by Lwanga et al 2016. The small number of MPs found in soil (0–2 particles/g) led to a higher number of MP being detected in casts, chicken faeces, and chicken gizzards (ratios of 12.7, 105, and 5.1 respectively). This bio concentration could explain the higher concentration of larger MPs being found in casts than in soil. Further studies are required to better understand this behaviour. Under natural conditions, earthworms ingest the equivalent of their weight each day (Lavelle and Spain 2001). MPs measuring between 0.1 and 5 mm were found in the gizzard and feces. In Mexico, chicken consumption per capita is around 15 chickens per person per year (Gallardo Nieto 2004). This translates into annual possible ingestion of 840 plastic particles per person. Consumption of domestic chickens (gizzards) around the world in traditional dishes (Fischer 2010) may potentially expose humans to high concentrations of MPs, either directly by consuming gizzards such as in their study, or indirectly through bio augmented MPs from the chicken's digestive system into their tissues (Lwanga et al 2017).

Transferring of micro plastics: Transferring of micro plastics from the intestinal tract to the surrounding tissue or circulatory system after ingestion, it can remain in the digestive tract, be excreted, or absorbed from the digestive tract into the body tissue (Browne et al 2007, 2008). Lugworms (*Arenicola marina*) exposed to sediment containing pre-production PS particles (400–1300 µm, 7.4 % of sediment dw) ingested these micro plastics. However, no translocation of the relatively large PS particles from the gut to the tissue was recorded (Besseling et al 2013). Hämer et al 2014 fed marine isopods (*Idotea emarginata)* with food containing fluorescent PS microspheres (10 µm), PS fragments (1–100 µm), or acrylic fibres (0.02–2.5 mm). Micro plastics were detected in the stomach and intestine, but not in the midgut where nutrients are reabsorbed. Passage of the micro plastics to the midgut was most likely impeded by filter structures in the isopods' proventriculus. In *D. magna*, fluorescent-carboxylated PS nano- and microspheres (20 nm and 1 µm diameter) were mainly observed in the gastrointestinal tract, but also in structures assumed to be oil storage droplets. It was concluded that PS spheres can cross the gut epithelium (Rosenkranz et al 2009). Inshore crabs (*C. maenas*), which were fed with mussels (*Mytilus edulis*) pre-exposed to PS microspheres, translocation from the intestinal tract to hemolymph, hepatopancreas, ovary, and gills were demonstrated for microspheres with 0.5 µm diameter (Farrell and Nelson, 2013). By contrast, larger microspheres (8–10 µm diameters) were only detected in the intestine but not in the hemolymph of shore crabs (Watts et al 2015, Browne et al 2008) when kept mussels (*M. edulis*) for 3 h in a suspension of fluorescent PS microspheres (3.0 and 9.6 µm, 4.3 × 104 items/L). Microspheres were detected in the hemolymph and inside the hemocytes. The smaller microspheres occurred in significantly higher abundance in the hemolymph than the larger ones. Von Moos et al 2012 exposed mussels for 3–96 h to 2.5 g/L of HDPE fluff consisting of non-uniformly shaped particles with a size between 0 and 80 µm. The concentration of HDPE fluff corresponds to approx. 2.7×10^7 to 3.6×10^7 items/L (NR von Moos, personal communication). HDPE micro particles were detected on the gill surface and in blood lacunae of the gills, as well as in the intestine, digestive gland, and connective tissue. In a very recent study, mullets (*Mugilcephalus*) were held for 7 days in water containing 33.8 mg/L of PE or PS particles with a size of 0.1–1 mm (nearly 2500 particles/L Avio et al 2015). Micro plastics were not only found in the gastrointestinal tract (approx. 10 PE particles and 90 PS particles per fish) but also the liver of the fish (approx. 1–2 particles per fish for both PE and PS). Thus, based on the results of laboratory experiments, translocation from the intestinal tract to the circulatory system or surrounding tissue depends on the size of the micro plastics with an upper size limit for translocation that appears to be specific for the species or taxonomic group (Duis and Coors 2016).

Micro plastics and antimicrobials are widely spread environmental contaminants and more research on their toxicity is needed. In *Corbicula fluminea* were investigated that the uptake and effects of the antimicrobial florfenicol, micro plastics, and their mixtures. Micro plastics were found in the gut, lumen of the digestive gland, connective tissue, hemolymphatic sinuses, and gills surface of animals. Florfenicol caused a significant inhibition of cholinesterase (ChE) activity (~32%). Animals exposed to 0.2 mg/l of micro plastics showed ChE activity inhibition (31%), and no other significant alterations. Mixtures caused feeding inhibition (57–83%), significant ChE inhibition (44–57%) and of isocitrate dehydrogenase activity, and increased anti-oxidant enzymes activity and lipid peroxidation levels (Guilhermino et al 2018).

In a tropical home garden in Mexico, it is possible to find earthworm biomass of 5 to 31 gm^{-2}, (Huerta and Wal 2012), which means that 5 to 31 gm^{-2} of soil is taken up daily by earthworms. The earthworm casts then concentrate the MPs present in the soil as a consequence of direct ingestion of the soil and the MPs probably accumulate in earthworm tissues (Lwanga et al 2016). Small particle selection by earthworms seem to be always present (Shipitalo and Protz 1989, Barois et al 1993) and reflected the highest concentration of MP per gram of cast were found within the size of 10–50 µm. Chickens mainly ingest macro plastics found on the soil surface since plastic debris >5 mm was present in the chicken crops and gizzards. Nevertheless, MPs measuring between 0.1 and 5 mm were found in the gizzard and faeces. Therefore, we assume that MPs in chickens may originate from the transformation of MaPs (macro plastics) to MPs during the passage through the digestive canal, ending up in the gizzard as a mixture of MaPs and MPs and resulting in the excrement as MPs. Under laboratory conditions, plastics ingestion by chickens reduced food consumption and the volume of the gizzards since plastic particles are well retained in the gizzards. The second study found micro plastics in the chicken crop, gizzards and faeces (Lwanga et al 2017) the presence of micro plastics in the crop or gizzards is not surprising since the earthworms also contained micro plastics in their digestive tract. On the other hand, the presence of micro plastics in feces is an indicator that these particles are excreted. More research is required to confirm if the totality of particles is excreted or if a portion can accumulate in bird bodies (Ribeiro et al 2019). The presence of MPs and/or MaPs in chicken organs (i.e. gizzards) may have negative consequences for human health (Duis and Coors 2016). This carries a potential risk to human health when local people consume polluted gizzards that are not thoroughly cleaned. Even thoroughly cleaning the gizzards would not guarantee that all of the plastic debris and chemical residues would be removed because of hydrophobic and hydrophilic interactions. In studies of aquatic birds, some plastic-derived chemicals (i.e. polybrominated diphenyl ethers) were biomagnified in their tissues (0.3–186 ng/g-lipid) while plastic debris was found in their stomachs (0.04–0.59 g/bird), Tanaka et al (2013).

Physically, micro plastics can interfere with the digestive process of aquatic animals and cause intestinal blockage, reducing animal feeding and energy assimilation (Besseling et al 2013). Furthermore, the high intake of plastics might diminish the uptake of nutritious food, thus leading to reducing energy and fertility, as demonstrated by Lee et al 2013 and Cole et al 2015 in copepods. This situation might represent a problem for species of commercial interest, due to yield reduction and the consequent economic loss. These effects are generally related to the size of micro plastics. Particles with size above 150µm are probably not absorbed and might produce local inflammatory effects, in contrast, particles of smaller sizes might induce systemic exposure, and the smallest fractions as small as 1.5µm, might penetrate the organs (EFSA 2016). In this perspective, nano plastics represent the most concerning problem as pointed out by Bouwmeester et al 2015.

Impact on human-beings: The concern of micro plastics pollution is a key whether they represent a risk to ecosystems and human health. However, there is much uncertainty associated with this issue. Data on the exposure and effect levels of micro plastics are therefore required to evaluate the risk of micro plastics to environments and human health. The adverse effects on organisms that are exposed to micro plastics can be separated into two categories: physical effects and chemical effects. The former is related to the particle size, shape, and concentration of micro plastics and the latter is related to hazardous chemicals that are associated with micro plastics. Though data on micro plastic exposure levels in environments and organisms have rapidly increased in recent decades, limited information is available on the chemicals that are associated with micro plastics. The combination of various kind of polymers of different sizes and shapes that are joined to the action of a large amount of additives that originate from plastics results in a cocktail of contaminants that not only alter the nature of plastic but can leach into the air, water, food, and, potentially, human body tissue during their use or their disposal, thus exposing us to several chemicals together (Campanale et al 2020).

“World Health Organization” (WHO 2019) emphasized the ubiquitous micro plastics presence in the environment and aroused great concern regarding the exposition and effects of nano and micro plastics on human health (Sharma and Chatterjee 2017,Revel et al 2018, Rist et al 2018, Bradney et al 2019, Lehner et al 2019, Campanale et al 2020). One of the major nano and micro plastic entry points into the human system is represented by the ingestion of contaminated food (Silva-Cavalcant et al 2017, Wright and Kelly, 2017, Waring et al 2018, Toussaint et al 2019 Humans could also assume an estimated intake of 80 g per day of micro plastics via plants (fruits and vegetable) that accumulate MPs through uptake from polluted soil (Ebere et al 2019). The presence of micro plastics in marine species for human consumption (fish, bivalves and crustaceans) is now well-known (Smith et al 2018). As an example, in *Mytilus* *edulis* and *Mytilus galloprovincialis* of five European countries, the micro plastic number has been found to fluctuate from 3 to 5 fibers per 10 g of mussels (Nelms et al 2016). Therefore, following exposure via diet, uptake in humans is plausible, as evidenced by the capacity for synthetic particles smaller than 150 µm to cross the gastrointestinal epithelium in mammalian bodies, which causes systemic exposure. However, scientists speculate that only 0.3% of these particles are expected to be absorbed, while a lower fraction (0.1%) that contains particles that are bigger than 10 µm should be capable of reaching both organs and cellular membranes and passing through the blood–brain barrier and placenta (Barboza et al 2018). Exposure concentrations are predicted to be low, although data about micro and nanoplastics into the environment are still limited due to the analytical and technical complications to extract, characterize, and quantify them from environmental matrices (Campanale et al 2020).

The uptake of plastic particles by humans can occur through the consumption of terrestrial and aquatic food products, drinking water, and inhalation (Vethaak and Leslie, 2016). Despite seafood being a recognized source of contaminants to the human diet, the occurrence of micro plastics in seafood is neither quantified nor regulated (Ziccardi et al 2016). Seafood may be contaminated with micro plastics through the ingestion of natural prey, adherence to the organism's surface, or during the processing and packaging phase (Cole et al 2013, EFSA 2016). Organisms that are eaten the whole present a greater risk of exposure compared with those having had the digestive tract removed. With plastics already present in a diversity of seafood items, there is strong support for the transfer of micro plastic particles to humans. Potential health effects resulting from the bioaccumulation and biomagnification of micro plastics and chemical contaminants in the human body. The translocation of PS and PVC particles <150 µm from the gut cavity to the lymph and circulatory system. Very fine particles are capable of crossing cell membranes, the blood-brain barrier and the placenta, with documented effects including oxidative stress, cell damage, inflammation and impairment of energy allocation similar to that reported for marine organisms (Vethaak and Leslie 2016).

There is mounting evidence of the occurrence of plastic particles in marine organism that are part of the human food chain and this might also represent a potential threat to human health via biomagnification. A possible exposure pathway of humans to micro plastic is represented by the diet, especially since there are studies available that demonstrate the presence of micro plastic in commercially important fishes, shrimps and mussels (Devriese et al 2015, Romeo et al 2015, Van Cauwenberghe and Janssen 2014). Microscopic fibers ranging from 200-1500 µm have been found in mussels (average 3.5 fibres/10 g mussel) from Belgian stores which was in the same range as wild caught mussels in the same study (De Witte et al 2014). Furthermore, synthetic fibers were reported in 63% of commercially important brown shrimp caught in the Southern North Sea and Channel area (Devriese et al 2015). There are also studies that reported non-marine sources of micro plastic in the food chain. For example nineteen honey samples were analyzed for colored fibres and fragments and colored material was found in all of the samples (Liebezeit and Liebezeit 2013). Exposure to hydrophobic contaminants can be a direct result of the ingestion of contaminated micro plastic particles, while secondary exposure can occur by ingesting fish, birds or other organisms that have accumulated contaminants within their tissue from previously egested micro plastics (Ziccardi et al 2016). Once inside the human digestive tract, intestinal uptake of the ingested particles may occur. Translocation of various types of micro-particulates across the mammalian gut has been demonstrated in multiple studies involving rodents (particle size 0.03- 40 mm), rabbits (particle size 0.1-10 mm), dogs (particle size 3-100 mm) and humans (particle size 0.16-150 mm). Using 2 mm latex microspheres in rodents, it was shown that intestinal translocation of micro plastics is low (0.04-0.3%) (Carr et al 2012). However, contrasting reports exist on the upper size limit of particles capable of being translocated and the magnitude of this type of transport. Through the M-cells micro plastics can enter the lymphatic system. This transport is governed by particle size: in rats, larger particles (5-10 mm) remained in Peyer's patches, while smaller particles

As potential sources of the contamination natural and synthetic fibers in clothing that become airborne, materials that were used during the production process and bottles that might have been already contaminated or became contaminated during the cleaning process were pointed out. A study on 15 different table salts in China demonstrated the presence of micro plastics in the samples (Yang et al 2015). The amount of micro plastics ranged from 550 – 681 particles/ kg in sea salts, 43 – 364 particles/kg in lake salts and 7 – 204 particles/kg in rock/well salts. Sea salts were found to be significantly higher contaminated with micro plastics than other salts which underline the contamination of marine products. In sea salts particles measuring less than 200 µm were detected to be the predominant type of micro plastic, accounting for 55% of the particles with PET as the most abundant polymer type followed by PE and cellophane.

Furthermore, a few studies have demonstrated the presence of micro plastics in freshwater systems which might be a reason to raise concern about the presence of micro plastic in drinking water since human population is highly dependent on freshwater systems for drinking water supply and food resources (Eerkes-Medrano et al 2015).

The interaction of plastic particles themselves with tissues and cells in humans is still poor. However, the physical effects of particles observed to date in human cells and tissues and animal models give insight into the possible risks of particle exposure in humans. The studies show that plastic particles can cause lung and gut injury, and especially very fine particles can cross cell membranes, the blood-brain barrier, and the human placenta. Observed effects include oxidative stress, cell damage, inflammation, and impairment of energy allocation functions. very fine plastic particles carrying chemical substances can cross cell membranes and may enhance the chemicals' bioavailability, analogous to nano-sized polymeric drug delivery vehicles that facilitate uptake, distribution, and delivery of pharmaceutical agents in human systems (Vethaak and Leslie 2016). Although the effects of consuming MPs on human health are largely unknown, potential pathways for harm have been suggested (Wright et al 2017, Prata 2018).Once MPs are in the gut, they can release constituent monomers as well as additives and absorb toxins, which can cause physiological harm ranging from oxidative stress to carcinogenic behaviour (Wang et al 2018). The MPs can further penetrate the human body via cellular uptake in the lungs or gut as well as by paracellular transport in the gut (Wright and Kelly 2017). The degree of uptake will vary according to the shape, size, solubility, and surface chemistry of MPs. Particles on the scale of a few microns or less may be directly taken up by cells in the lungs or gut, while particles up to 10 μm may be taken up by specialized cells in the Peyer's patch of the ileum (Powell et al 2010). Particles as large as 130 μm can enter tissue through paracellular transport in the form of perception, although the rate of particle transfer to blood over 24 h may be as low as 0.002% Given the data limitations surrounding the size classes of micro plastic particles present in consumed items, it is still unclear to what extent our estimate of human consumption of MPs poses a risk to human health (Cox et al 2019). Once particulate plastics and associated trace elements enter marine organisms, they can then make their way up the food chain where humans eventually ingest them. Human exposure can occur not only through the consumption of seafood but also through consuming water, beer, or salt contaminated with particulate plastics. Once in the gut, particulate plastic may have the potential to affect the digestive and immune systems of humans. However, the effects surrounding the exposure of humans to trace element-sorbed particulate plastics are largely unknown (Bradney et al 2019).

The intake of micro plastics by humans is by now quite evident. The entry point may be through ingestion (through contaminated food or via trophic transfer), through inhalation, or through skin contact. Following the intake of micro plastics into the human body, their fate and effects are still controversial and not well known. Only micro plastics smaller than 20 μm should be able to penetrate organs, and those with a size of about 10 μm should be able to access all organs, cross cell membranes, cross the blood–brain barrier, and enter the placenta, assuming that a distribution of particles in secondary tissues, such as the liver, muscles, and the brain is possible. Not enough information is available to fully understand the implications of micro plastics for human health, however, effects may potentially be due to their physical properties (size, shape, and length), chemical properties (presence of additives and polymer type), concentration, or microbial biofilm growth. How toxic chemicals adsorb/desorb onto/from micro plastics is not well known, but plausible mechanisms include hydrophobic interactions, pH variations, the ageing of particles, and polymer composition. Furthermore, not enough studies have fully explained the primary sources of pollutants that are present on micro plastics and whether their origin is extrinsic from the surrounding ambient space, intrinsic from the plastic itself, or, more probably, from a combination of both and from a continuous and dynamic process of absorption and desorption that is related to the spread of the particles into the environment and to their consequent exposure to weathering (Campanale et al 2020).

Further effects related to the plastic polymer itself are not described however knowledge can probably be extracted from the field of medical transplants using polymer materials of different types. Another concern in regard of exposure of micro plastics to humans is the plastic-associated chemicals (PACs) such as bisphenol A and phthalates. These compounds are well-known as endocrine disruptors and interfere with the hormone system. In one population-based human study levels of BPA and several phthalate metabolites were associated with lipid infiltration of the vascular wall and therefore suggesting that these chemicals play a role in atherosclerosis (Lind and Lind 2011). Furthermore BPA was reported to be positively associated with cardio vascular disease and prevalent myocardial infarction in a cross sectional analysis of 1455 adults (Lind and Lind, 2012, Kärrman et al 2016).

CONCLUSION

The research is required to explain the terrestrial fate and effects of micro plastics due to the widespread presence, environmental persistence and various interactions with continental biota, micro plastic pollution might represent an emerging global change threat to terrestrial ecosystems. The studies indicated that micro-sized plastic particles may affect the soil environment, and this could be linked to the behaviour of plastics in the soil system and how these particles are influenced by biological responses. Soil-dwelling organisms play a key role in modifying the soil system by constructing bio-pores, and these structural changes are potentially related to the behaviour of plastic particles. Most plastic polymers have hydrophobic (unwatchable) characteristics which can cause changes in soil structure such as bulk density and particle aggregation. As these soil properties are directly linked to the behaviour of soil organisms, the relationship between biological behaviour and plastic contamination in soil systems should be determined. The effects of MP exposure on earthworms, *Lumbricus terrestris*, and showed that MPs significantly increased mortality and reduced the growth rate of the earthworms. Additionally, the bioaccumulation of the smallest MPs (smaller than 50 mm) by earthworms may influence the fate and risk of MPs in the terrestrial system. However, more information is needed to assess the risk of MPs in soils. Plastic debris is a prolific, long-lived pollutant that is highly resistant to environmental degradation, readily adheres to hydrophobic persistent organic pollutants and is linked to morbidity and mortality in numerous soil organisms. The prevalence of MPs within the natural environment is a symptom of continuous and rapid growth in synthetic plastic production and mismanagement of plastic waste. Humans have evolved with oral exposure to dietary micro particles and nanoparticles as a normal occurrence but the ever-growing exploitation of nanotechnology is likely to increase exposure further, both qualitatively and quantitatively. Moreover, unlike the situation with respirable particles, relatively little is known about gastrointestinal intake and handling of nanoparticles. Further, extensive experimental and in depth research investigations regarding the impact of long term micro plastics ingestion along with food/feed sources, trophic transfer and their metabolic implications on animal production such as poultry, goat, sheep and cattle and livestock management attributes in functional ecosystem are needed.

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