Table S1. Toxic effects of microplastic exposure to environmental organisms.

Samples	Properties of MPs/NPs	Toxicity	Reference
Soil		A significant relationship between microplastic concentration and microbial activity The microbiota activity of the polyacrylic and polyester group was significantly lower than that of the control group	[50]
Soil	Polypropylene microplastics (<180μm)	The higher the concentration of microplastics, the higher the nutrient content in the solution of dissolved organic matter Promoting enzyme activity and facilitates the accumulation of dissolved organic C, N, and P	[10]
Mixed leaf litter	Polystyrene microplastics （10μm）	Causes detritivore mortality, but does not affect growth The decomposition of leaf litter decreases with increasing microplastic concentration (more pronounced in the presence of harmful substances) Microbially mediated decomposition decreases with increasing microplastic concentration	[51]
Freshwater ecosystem	microplastics	Significant reduction in root length of duckweed and biomass of Phytoplankton The abundance of New Zealand mud snails (Potamopyrgus antipodarum) increased	[52]
Soil	Plastic film residue	PAE concentrations increased with increasing plastic film residues The soil microbial carbon and nitrogen, enzyme activities, and microbial diversity decreased significantly	[53]
Cress (*Lepidiumsativum*)	Fluoro-Max Green Fluorescent Polymer nanospheres (50、500、4800nm)	The germination rate of cress decreased after 8h of microplastics treatment: from 78% to 1.7% after 4800nm microplastic treatment, and there was no difference in germination rate after 24h of exposure	[54]

		Differences in root growth emerged after 24 h of exposure, and the differences were not significant after 48 and 72 h	
Marine microalgae (Skeletonema costatum)	Polystyrene nanoplastics （110nm）	Alteration of chloroplast fatty acid content affects the structure of photosynthetic complexes in microalgae, thus affecting microalgal growth	[55]
Marine microalgae (*Skeletonema costatum*)	pure polyvinyl chloride micro-plastics(1mm)	It has a significant inhibitory effect on the growth of microalgae, with a maximum inhibition rate of 39.7% after 96 hours of exposure High concentration of mPVC reduces chlorophyll content and photosynthetic efficiency of algae	[56]
Earthworm (*Eisenia foetida*)	Polypropylene microplastics (<150μm）	Accumulation in earthworm Decreased growth rate and increased mortality Increased GSH levels in the body in a dose-dependent manner, with an increasing trend of GSH levels over time	[57]
Earthworm (*Eisenia fetida*)	Polystyrene nanoplastics（100nm and 1300nm）	Accumulation in intestinal tissues and damage to intestinal cells Significantly altered GSH and SOD levels Caused DNA damage	[58]
Wedge clam (*Donax trunculus*)	Polyethylene and polypropylene nanoplastics（100nm-400nm）	Gills are the first target organ for microplastic accumulation Significant inhibition of total AChE activity in gills and digestive glands Caused oxidative stress	[59]
Oyster	Polystyrene microplastics（2μm and 6μm）	Significantly higher consumption and uptake efficiency of microalgae in the exposed group and disturbed energy metabolism Significantly lower oocyte number, diameter, and sperm velocity in the exposed group Decreased larval production and development in the progeny of parents in the exposed group	[60]

Table S2. Toxic effects of microplastic exposure to marine invertebrates and vertebrates.

Samples	Properties of microplastics used	Toxicity	Reference
Zebrafish (*Danio rerio*)	Polystyrene nanoplastics (average diameter of 51 nm)	• Accumulated in the yolk sac 24 h after fertilization and migrates to the gastrointestinal tract, bile, liver, pancreas, heart, and brain during the whole development process • Decreased accumulation in all organs during purification • Did not result in significant death, malformation, or changes in mitochondrial bioenergetics, but decreased heart rate • Altered larval behavior, as evidenced by insufficient swimming activity	**[21]**
Zebrafish (*Dani rerio*)	Polystyrene nanoplastics （42nm）	• Significantly reduced GSH reductase activity in F0 generation brain, muscle, and testis, but did not affect mitochondrial functional parameters in heart and gonads • Polystyrene accumulates in the yolk sac, gastrointestinal tract, liver, and pancreas in the F1 generation, and bradycardia occurs in the F1 generation • Reduced GSH peroxidase activity and thiol levels in the F1 generation	[61]
Seabirds		• The presence of anthropogenic particles in fecal precursors of both Fulmarus glacalis and Uria lomvia • It is estimated that fulmars and murres deposit 3.3-45.5 million artificial particles into the environment respectively during the breeding period	[62]
Thick-billed murre (*Uria lomvia*)		• About 11% of the birds had at least one piece of plastic debris in their gastrointestinal tract	[63]

Carp (*Cyprinus carpio*)	polyvinyl chloride microplastics	● Significantly inhibited the growth and weight gain of juvenile fish ● GSH peroxidase activity increases and then decreases with increasing exposure concentration ● A negative correlation between SOD and catalase activities ● Significant reduction in malondialdehyde levels ● Transcript levels of cytochrome P450 1A and GSH Stransferase increase and then decrease in the liver ● Cytoplasmic vacuolation in the liver	[64]
Zebrafish (*Danio rerio*)	Polystyrene micro- and nanoplastics (5μm, 20μm, 70nm)	● After 7 d of exposure, microplastics with a diameter of 5 μm accumulated in the gill, liver, and intestine, and 20 μm microplastics accumulated only in the gill and intestine of the fish ● Causes liver inflammation and lipid accumulation ● Significantly elevated SOD and catalase activities, caused oxidative stress ● Changes in the metabolic profile of fish liver and disruption of fat and energy metabolism	[23]
Marine medaka (*Oryzias melastigma*)	Polystyrene microplastics (10μm)	● Accumulation of microplastics in gills, intestine, and liver, leading to oxidative stress and histological changes ● Eased gonadal maturation in females and reduces female fecundity ● Significant negative regulation of hypothalamic-pituitary-gonad in female fish ● Delayed hatching time of offspring, reduced hatching rate, heart rate, and body length of offspring	[65]
Zebrafish	Polystyrene microplastics（5 μ m）	● Inflammatory response and oxidative stress in the intestine ● Significant changes in the gut microbiome and tissue metabolic characteristics, mostly associated with oxidative stress,	[66]

		inflammation, and lipid metabolism	
Zebrafish （*Danio rerio*） and nematode (*Caenorhabditis elegans*)	PA, PE, PP, PVC and PS (70μm)	● Microplastic exposure for 10 d, no or low lethality of D. rerio ● Caused intestinal damage, including villi rupture and intestinal cell division ● Exposure to 2d significantly inhibited nematode survival, body length, and fecundity ● Decreasing calcium levels in the intestine and increasing GSH Stransferase expression	[67]
Larval zebrafish (*Danio rerio*)	Polystyrene nanoplastics (468nm and 508nm)	● After fertilization 4h begins exposure and first attaches to the embryonic chorion and then enters the larval gastrointestinal tract ● Reduced swimming speed and swimming distance ● Upregulation of inflammation and oxidative stress-related gene expression	[68]
Larval zebrafish	Polystyrene microplastics (5μm and 50μm)	● Altered abundance and diversity of the gut microbial community ● Changes in metabolic profile, and differential metabolites involved in energy metabolism, glucolipid metabolism, inflammatory response, neurotoxic response, nucleic acid metabolism, and oxidative stress ● Hydrogen peroxidase activity and GSH content were significantly reduced ● Changes in genes related to glycolysis and lipid metabolism	[25]
Fathead minnow （*pimephalespromelas*）	Polystyrene nanoplastics (41nm), Polycarbonate nanoplastics (158.7nm)	● Significantly increased degranulation of primary granules and release of neutrophil extracellular traps ● Interfere with the disease resistance of fish populations	[72]
African catfish (*Clarias gariepinus*)	Polystyrene microplastics (<60μm)	● Significant increase in the degree of liver tissue changes ● Significantly reduced transcript levels of tryptophan hydroxylase 2	[73]

	in brain tissue ● Regulation of gill tissue changes, plasma cholesterol, HDL, total protein, albumin and globulin concentrations, liver glycogen reserves, and transcript levels of Fushitarazu factor 1, Gonadotropin-releasing hormone, and 11β-hydroxysteroid dehydrogenase type 2

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