microplastics

MDPI

Supplementary Table S1. Analytical characteristics of the 66 included studies.

No.	Country / region	System / matrix	Species / tissue	Abundance or frequency	Morphotypes / colours	Polymers	Digestion / separation	Identification	Identified or suggested sources	Main results / effects	Reference
1	Mexico (controlled super-intensive system)	Super-intensive culture / shrimp of different ages	*Litopenaeus vannamei* / organism and GIT depending on stage	PL25: 0.2 ± 0.0 MP/ind.; 1-7 months: ~10.0 ± 0.3 to 40.3 ± 3.6 MP/ind.	Fibres 42.1-68.7%; transparent 46.1-65%; sizes 15-4686 µm	PE 37.4%, nylon 21.1%, PET 18.5%; also PS, PP and PA	Tissue processing according to the study protocol	Chemical identification of polymers	Plastic infrastructure and surroundings of the culture system	MP abundance and size increased with culture age/stage	[5]
2	China (laboratory experiment)	Controlled exposure / shrimp	*Litopenaeus vannamei* / hepatopancreas and other tissues	Not applicable as environmental abundance; experimental doses according to the article	PS MP; shape/colour: NR	PS	Not applicable (controlled exposure)	Tissue quantification + histology + metabolomics	Not applicable (controlled exposure)	Accumulation mainly in the hepatopancreas; oxidative stress, lipid peroxidation, hepatopancreatic injury and metabolomic changes	[10]
3	China (laboratory experiment)	Controlled exposure / shrimp	*Litopenaeus vannamei* / gills, intestine and metabolic responses	Experimental doses/sizes according to the article; not an environmental abundance	Microspheres of different sizes; colour: NR	PS	Not applicable (controlled exposure)	Histomorphology, microbiome and metabolomics	Not applicable (controlled exposure)	Smaller sizes caused more intense oxidative stress responses and damage to gills/intestine, with microbial and metabolic alterations	[11]

No.	Country / region	System / matrix	Species / tissue	Abundance or frequency	Morphotypes / colours	Polymers	Digestion / separation	Identification	Identified or suggested sources	Main results / effects	Reference
4	Mexico (Huizache-Caimanero Lagoon)	Coastal lagoon / wild shrimp	*Litopenaeus vannamei* / gastrointestinal tract, gills and exoskeleton	GIT: 114.7 ± 33.2 MP/g; gills: 13.7 ± 5.3 MP/g; exoskeleton: 3.0 ± 0.5 MP/g; 13.3 ± 1.1 MP/shrimp	Fibres 92.3%, fragments 6.0%, films 1.0%; transparent particles dominant	Comprehensive polymer identification was not performed	Acid digestion (HNO3:HClO4, 4:1)	Stereomicroscopy + Nile Red fluorescence	Fishing and agricultural/urban activities discussed as potential sources	Highest load in the gastrointestinal tract; 1066 particles in 80 shrimp	[23]
5	Thailand (Nakhon Pathom)	Aquaculture pond / surface water and shrimp tissues	*Litopenaeus vannamei* / GIT, hepatopancreas, muscle and exoskeleton	66.17 ± 29.19 MP/ind.; GIT 137.78 ± 16.48 MP/g; HEP 16.31 ± 1.87; muscle 1.69 ± 0.13; exoskeleton 4.37 ± 0.27	Fragments 62.07%, fibres 37.31%; blue 43.69%	PET, PVAc and CAB among the most frequent polymers	30% H2O2 + flotation with potassium formate	Stereomicroscopy + FTIR	Aquaculture, pond infrastructure, nearby settlements and runoff	MP in 105/105 shrimp; highest load in the gastrointestinal tract	[24]
6	China (laboratory experiment)	Controlled exposure / shrimp	*Litopenaeus vannamei* / intestine and haemolymph	14-day exposure to five types of MP (experimental concentration according to the article)	MP powders; shape/colour not comparable with environmental particles	PE, PS, PVC, PTFE and PP	Not applicable (controlled exposure)	Microbiome, proteomics and metabolomics	Not applicable (controlled exposure)	Lactic acid/SCFA-producing bacteria decreased, and haemolymph proteins and metabolites were altered, including the alpha-linolenic acid pathway	[25]
7	Taiwan (laboratory experiment)	Controlled exposure / shrimp	*Litopenaeus vannamei* / muscle, hepatopancr	0.1, 0.2, 0.5 and 1.0 μg/g of shrimp	Red fluorescent microspheres	PE	Not applicable (controlled exposure)	Fluorescence microscopy + histological/biochemical analysis	Not applicable (controlled exposure)	Tissue accumulation, oxidative stress, histopathological damage and reduced	[26]

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			eas, gills and histological evaluation	(experimental doses)						survival at higher exposures	
8	South Korea (laboratory experiment)	Controlled exposure / shrimp	*Penaeus vannamei* / intestine and physiological-molecular responses	21-day exposure to fragments of 9.09, 49.00 and 158.59 µm	PET fragments of three sizes; colour: NR	PET	Not applicable (controlled exposure)	Histology, physiology and RNA-seq	Not applicable (controlled exposure)	Small and medium sizes caused greater impairment of growth/movement, intestinal damage and oxidative/inflammatory responses	[27]
9	India (Andhra Pradesh and Gujarat)	Coastal and inland ponds / shrimp, feed, water and sediment	*Litopenaeus vannamei* / shrimp; associated culture matrices	4.07 MP/ind. (1.24 MP/g); 93.7% of shrimp positive; MP in all environmental matrices	Fragments and fibres dominant; particles <100 µm frequent in shrimp	PE and PP dominant; PP highest in shrimp and PE frequent in all matrices	Matrix-specific processing	µFTIR	Feed identified as the main source; higher load in coastal ponds	Shrimp load decreased with culture time; there was temporal variation and variation among matrices/systems	[31]
10	Vietnam (Cau Hai Lagoon)	Lagoon / wild and farmed shrimp	*Metapenaeus ensis*, *Penaeus semisulcatus*, *Litopenaeus vannamei* and *Penaeus monodon* /	*L. vannamei*: 8.6 ± 3.5 MP/ind. and 1.1 ± 0.4 MP/g; other species 2.3-7.7 MP/ind.	Fibres 42-69%, fragments 22-57%, pellets 0-27%	Rayon 61.9%, PA 10.5%, PET 6.7%, PE 5.7%, polyacrylic ~5%, PS 3.8%	KOH digestion; separation/filtration according to protocol	ATR-FTIR	Farming conditions and sources from the lagoon environment	Farmed shrimp had more MP than wild shrimp; GIT > tissues	[32]

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			GIT and tissues								
11	Italy (Venice Lagoon)	Lagoon / surface sediment	Not applicable (environmental matrix)	672-2175 MP/kg (dry weight); MP in 100% of samples	Shape/colour: NR; 93% of particles between 30-500 μm	PE and PP (>82% of the total; 10 polymer types identified)	Density separation from sediment	μFTIR with chemical mapping	Continental inputs and anthropogenic gradient; aquaculture, industry and urban centres considered in the study design	Higher abundance at interior sites; relationship with the fine sediment fraction and with the metal pollution index	[33]
12	Republic of Korea (laboratory experiment)	Controlled dietary exposure / shrimp	*Litopenaeus vannamei* / intestine and nutritional-microbial response	Not applicable as environmental abundance; 21-day exposure	Nanoplastics delivered via the trophic route; shape/colour: NR	PS (nanoplastic)	Not applicable (controlled dietary exposure)	Defined exposure material; analysis of microbiota and biochemical parameters	Not applicable (controlled exposure)	Altered the nutritional value and gut microbiota; changes in antioxidant enzymes and nutritional components were observed	[34]
13	Mexico (Urías coastal lagoon, Sinaloa)	Lagoon beach / surface sediment	Not applicable (environmental matrix)	317 ± 153 to 1100 ± 750 particles/kg; mean 654 ± 326 particles/kg	Fibres 99 ± 1.52%; blue and transparent dominant	Cotton and polyester ≥81% combined; also acrylic, rayon, nylon 6, PEU, PP, PE, PU, etc.	Extraction of microparticles from sediment according to protocol	Morphological and chemical characterisation of polymers	Wastewater discharge, fishing, aquaculture, industry and a thermoelectric power plant; textiles as the main source of fibres	High densities in areas of lower exchange; strong signal of fibres associated with clothing/laundering	[35]

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14	India (laboratory experiment)	Controlled aquatic exposure / shrimp	*Penaeus vannamei* / whole organism and stress responses	Not applicable as environmental abundance; exposure to weathered PE according to the experimental design	Weathered PE MP; shape/colour: NR	Weathered PE (wPE)	Not applicable (controlled exposure)	Monitoring of ingestion, growth and biomarkers	Not applicable (controlled exposure)	wPE was ingested and caused impaired growth and time-dependent oxidative stress responses	[37]
15	Mexico (Santa María-La Reforma Lagoon, SAMARE)	Coastal lagoon / wild shrimp	*Litopenaeus vannamei* / exoskeleton, gills, GIT and muscle	5.5 ± 0.5 MP/ind.	Fibres 74.7%, fragments 22.7%; transparent 61.4-72.2% and blue 3.2-36.4%	Cotton and PET predominant	Tissue processing according to the study protocol	Polymer identification + metal analysis	Textile and plastic origin; interaction with metal contaminants	Significant positive relationship between MP and Zn in gills; human exposure estimated from shrimp consumption	[38]
16	Central Thailand	Culture pond / shrimp	*Litopenaeus vannamei* and *Macrobrachium rosenbergii* / gastrointestinal tract	*L. vannamei*: ~11.00 ± 4.60 MP/ind.; *M. rosenbergii*: ~33.3 MP/ind. (values per individual as reported in the study)	Fibres, fragments, films and other shapes; white/transparent frequent	PE predominant; also PCL, PVA and ABS in the FTIR subsample	Digestion/filtration according to the study protocol	Stereomicroscopy + FTIR	Aquaculture and materials associated with the pond/feed	MP detected in 100% of the specimens analysed; *M. rosenbergii* showed a higher load than *L. vannamei*	[39]
17	South Korea	Commercial shrimp / different sizes and	*Litopenaeus vannamei* / head, intestine and	1.73-3.80 MP/10 g depending on size; with head+intestine 11.83 MP/10 g vs	<100 μm = 77-92%; blue predominant	PE, PP, PET, PS, nylon and PVC; PE/PP dominant	Tissue preparation according to the study protocol	FTIR + digital microscopy	Marine sources associated with plastic waste; the study did not attribute a single source	Head and intestine concentrated the highest load; removing these parts	[40]

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		evisceration status	rest of the body	3.16 MP/10 g without them						reduced potential exposure	
18	India / Arabian Sea (Kerala)	Wild marine shrimp / gastrointestinal tract	*Fenneropenaeus indicus*, *Penaeus monodon*, *Penaeus semisulcatus* and *Metapenaeus affinis* / GIT	*F. indicus* 1.08 ± 2; *P. monodon* 0.74 ± 2; *P. semisulcatus* 1.25 ± 2; *M. affinis* 1.91 ± 2 MP per species/sample as reported	Spheres 33.38%, pellets 32.4%, fibres 31.8%, fragments 2.47%; black, blue, red and transparent	PE, PVC, nylon 66, ABS and PS confirmed; some non-plastic particles	Alkaline digestion	Microscopy + ATR-FTIR + Raman	Coastal and fishing sources; specific attribution not confirmed	Ingestion varied among species; the study also assessed particle retention/depuration	[41]
19	Turkey (Küçükçekmece Lagoon)	Coastal lagoon / sediment	Not applicable (environmental matrix)	2922.32 ± 517.35 MP/kg	Fibres 59%; black 42%; ~50% between 1-100 μm	NR (no confirmed polymer identification in the synthesis reviewed)	Sediment processing according to the study protocol	Stereomicroscopy / morphological classification	Urban and fluvial inputs to the lagoon	Described the spatial and temporal distribution of a high MP load in sediments	[42]
20	China (Pearl River Estuary)	Mangrove / sediment	Not applicable (environmental matrix)	100-7900 MP/kg; mean 851 ± 177 MP/kg	Fibres and fragments; <500 μm = 69.4%; green and black colours frequent	PP-PE copolymer reported as dominant	NR	Spectroscopy for polymer identification	Population density and economic activity; urban/industrial inputs	Abundance correlated with indicators of human pressure and with halogenated flame retardants	[43]

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21	Egypt (Lake Burullus)	Protected lagoon / water + territorial/GIS variables	Not applicable (environmental matrix)	Mean 452.4 ± 606.2 MP/m³; open water 165.0 ± 199.6; near drains 835.6 ± 758.1 MP/m³	Fragments and other shapes; colours: NR in the audited synthesis	Eight thermoplastics identified by thermal/spectroscopic analysis according to the study	Water processing according to protocol	Stereomicroscopy + instrumental polymer identification	Drains, wastewater, agriculture and urban development	Vulnerability was higher near drains; the GIS model integrated territorial pressure and MP contamination	[44]
22	Mexico (coastal lagoons of Veracruz)	Coastal lagoons / sediment	Not applicable (environmental matrix)	MP detected in the samples analysed; the original table reported 16/16 positive	NR (do not retain the generic morphotypes/colours of the previous version without verification)	NR in the audited evidence	NR	NR	Anthropogenic pressure on coastal lagoons; co-occurrence with BPA	Jointly studied microplastics and bisphenol A in lagoon sediments of Veracruz	[45]
23	Mexico (Alvarado Lagoon, Veracruz)	Coastal lagoon / fish	*Dormitator maculatus* / digestive tract and gills	1134 MP in 127 fish; 561 in digestive tract and 573 in gills; 8.9 MP/ind.; 100% positive	Fibres 97.53%; pellets, films and fragments a minor fraction; blue 62%, transparent 12%	NR	Tissue processing according to the study protocol	Microscopy / morphological classification	Textile laundering and fishing, linked to nearby populations	All fish had MP in gills and digestive tract; no clear relationship with most biological parameters	[46]
24	Malaysia (Setiu Wetlands, Terengganu)	Mangrove / sediment	Not applicable (environmental matrix)	2292 MP/kg (dry weight)	>80% fibres; mainly transparent and black; high proportion <1 mm	PP was the most common polymer	Sediment extraction according to the study protocol	Morphological and polymer characterisation	Aquaculture; degradation of containers, nets and ropes	Higher abundance in areas influenced by aquaculture; PP dominant and evidence of surface weathering	[47]

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25	Brazil (tropical reservoir, Minas Gerais)	Lentic environment / sediment and shrimp	*Macrobrachium amazonicum* / gills and stomach	MP identified in 90.9% of samples	Morphotypes/colours: NR in the primary abstract reviewed	NR	Standardised extraction and identification protocols; detail: NR in abstract	MP identification with contamination control	Sediment as a reservoir and potential exposure pathway	Higher concentrations in sediment and gills than in stomach; temporal variation in gills and stomach	[48]
26	China (laboratory experiment)	Controlled exposure / shrimp	*Litopenaeus vannamei* / exoskeleton, muscle and haemolymph	Environmentally realistic MP levels; not applicable as environmental abundance	MP embedded in the exoskeleton surface; shape/colour of the exposure material: NR	NR in the primary abstract reviewed	Not applicable (controlled exposure)	Nanoindentation, SEM-EDS, chitin FTIR, transcriptomics and metabolomics	Not applicable (controlled exposure)	Increased exoskeleton hardness and modulus but produced fractures and reduced chitin acetylation, Ca2+-ATPase and haemolymph Ca; altered chitin biosynthesis pathways	[49]
27	China (laboratory experiment)	Controlled exposure / shrimp	*Litopenaeus vannamei* / feeding behaviour, olfaction, intestine and microbiota	PS of 50 nm and 5 μm; experimental exposure according to design	Nanoplastics of 50 nm and microplastics of 5 μm; spherical shape of the model material	PS	Not applicable (controlled exposure)	Feeding/olfactory behaviour, microbiota and digestive analyses	Not applicable (controlled exposure)	Feed consumption dropped to ~64-70% of the control; olfactory response, digestion and microbial balance were impaired	[50]

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28	Republic of Korea (laboratory experiment)	Short controlled exposure / shrimp	*Penaeus vannamei* / transcriptomic response	Not applicable as environmental abundance; short-term exposure according to design	Experimental microplastics; size/polymer: NR in the audited source	NR	Not applicable (controlled exposure)	RNA-seq / transcriptomics	Not applicable (controlled exposure)	Exposure altered gene expression, suppressed processes associated with cardiac muscle development and activated stress/immunity responses	[51]
29	China (laboratory experiment)	Controlled co-exposure / shrimp	*Litopenaeus vannamei* / hepatopancreas	Not applicable as environmental abundance; PS and HBCD alone/combined according to design	PS MP; shape/colour: NR	PS	Not applicable (controlled exposure)	Toxicological, histological and biochemical analyses	Not applicable (controlled exposure)	PS and HBCD altered metabolism/detoxification; co-exposure increased oxidative damage and HBCD accumulation	[52]
30	Laboratory experiment (authors with affiliations in Thailand/Poland)	Controlled co-exposure / shrimp	*Litopenaeus vannamei* / histological, oxidative and immune responses	96 h oral exposure to weathered PE and a glyphosate-based herbicide, alone and combined	Weathered PE MP; shape/colour: NR	Weathered PE	Not applicable (controlled exposure)	Biomarkers of oxidative stress, immunity and histology	Not applicable (controlled exposure)	Weathered PE produced moderate effects; the herbicide generated more pronounced effects and co-exposure modified some responses	[53]

No.	Country / region	System / matrix	Species / tissue	Abundance or frequency	Morphotypes / colours	Polymers	Digestion / separation	Identification	Identified or suggested sources	Main results / effects	Reference
31	China (laboratory experiment)	Controlled exposure to MP and nitrite / shrimp	*Litopenaeus vannamei* / intestine	14-day exposure; experimental concentrations of nitrite and MP according to design	Microspheres; colour: NR	PE	Not applicable (controlled exposure)	Histology, digestion, immunity and gut microbiota	Not applicable (controlled exposure)	Intestinal accumulation, histological damage, oxidative stress, alteration of immune/detoxification genes and dysbiosis; combined effects with nitrite	[54]
32	China (laboratory experiment)	Controlled aquatic exposure / shrimp	*Litopenaeus vannamei* / immune response and microbiota	0, 50, 500 and 5000 μg/L for 48 h	Exposure MP; shape/colour: NR in the abstract	NR in the primary abstract reviewed	Not applicable (controlled exposure)	Analysis of ingestion, immune expression and microbial community	Not applicable (controlled exposure)	High concentrations induced an immune response, microbial alteration and reduced survival; low doses altered bacterial balance	[55]
33	China (Jiulong River Estuary)	Estuary / shrimp	*Penaeus vannamei* / organism or gastrointestinal tract depending on protocol	0.46 ± 0.03 MP/g; range 0.35-0.81 MP/g	Irregular particles, fragments and films (1-200 μm); foam predominant at 200-1000 μm	PP, PE, PS, PET and PVC; PS+PE+PET = 73.85%	Shrimp processing and separation with hypersaline solution according to protocol	Polymer identification + risk assessment	Estuarine contamination associated with farming and the mangrove environment	Polymer risk grade III; H index=593.66, dominated by the contribution of PVC despite its low proportion	[56]
34	China (Haizhou Bay Marine Ranch)	Edible wild shrimp / organisms	Three dominant shrimp species /	1277 MP confirmed in 189 shrimp; 40.93% of the particles	Fibres 86.30%, fragments 11.20%; blue 57.32%, black 22.55%	PET 79.17%, PP 11.20% (>90% combined)	Digestive tract processing according to protocol	ATR-FTIR + hot needle test	Sources from the marine culture area and coastal activities; specific attribution variable	Higher number of MP in stomach than in intestine; also assessed the risk of human exposure	[57]

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			stomach and intestine	evaluated were identified as MP							
35	Southern North Sea / English Channel	Shallow coastal waters / wild shrimp	*Crangon crangon* / gastrointestinal tract	1.23 ± 0.99 MP/ind.; 0.68 ± 0.55 MP/g (wet weight); 63% positive	Synthetic fibres of 200-1000 μm; colours: NR	NR (reported as synthetic fibres)	NR in the primary abstract reviewed	NR in the primary abstract reviewed	No specific spatial source was confirmed	No spatial pattern; higher ingestion in October than in March; particles >20 μm showed no translocation to tissues	[58]
36	Indonesia / California, USA	Commercial fishery products / biota	Fish and bivalves / digestive tract or edible tissue depending on taxon	28% of fish positive in Indonesia; 25% of fish and 33% of bivalves positive in the USA	Plastic debris and fibres, including textile fibres; colours: NR	NR; complete polymer assignment of all particles was not performed	Digestion with 10% KOH	Microscopic inspection of recovered particles	Plastic waste and textile-derived fibres	Documented anthropogenic debris in seafood intended for human consumption	[59]
37	France (Greater Paris)	Urban environment / atmospheric deposition, wastewater and River Seine	Not applicable (environmental matrices)	Deposition: 29-280 particles/m²/d; influent: 260-320×10³ particles/m³; effluent: 14-50×10³; Seine: 3-108 particles/m³ (80 μm net)	Predominance of fibres; greater diversity with manta net; colours: NR	NR; study focused on particles/fibres rather than on overall polymer composition	Filtration/mesh sampling; no biological digestion	Microscopic inspection / morphological classification	Wastewater, urban activity and atmospheric deposition	Demonstrated the presence of microplastics in air, wastewater and freshwater of an urban environment	[60]

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38	MadeiraPortugal (controlled experiment)	Seawater / metal adsorption experiment	Not applicable; experimental plastic material	Not applicable as environmental abundance; 14-day exposure	Virgin PS beads (0.7-0.9 mm) and weathered PVC fragments	PS and PVC	Not applicable (controlled exposure)	Polymers defined a priori; Cu and Zn quantified during the experiment	Antifouling paint as a source of Cu and Zn	PS and PVC adsorbed Cu and Zn; Cu adsorption was higher on PVC than on PS, supporting the vector role of MP	[61]
39	Spain (Mallorca and Cabrera, western Mediterranean)	Shallow coast / sediment	Not applicable (environmental matrix)	0.10 ± 0.03 to 0.90 ± 0.10 MP/g of dry sediment	Filaments more frequent near populated areas; fragments more common in marine protected areas; colours: NR	NR in the primary source reviewed	Sieving/separation of sediment according to the study protocol	Microscopic classification; polymer composition not confirmed in the evidence reviewed	Urbanisation and transport/deposition towards receiving areas	MP present in shallow sediments; no clear trend with grain size was observed	[62]
40	Scotland, United Kingdom	Wastewater treatment plant / influent, process stages and effluent	Not applicable (environmental matrix)	15.70 ± 5.23 MP/L in influent; 0.25 ± 0.04 MP/L in final effluent; overall removal 98.41%	Fibres and other particles; microspheres detected at the grease stage; colours: NR	NR for the whole set; FTIR used to characterise selected particles	Physical separation through the treatment stages; NR for digestion	Microscopy and FTIR on selected particles	The treatment plant itself constitutes an emission pathway to the aquatic environment	High percentage removal, but the effluent still discharged a large number of particles daily	[63]
41	Hong Kong, China	Mudflats and sandy beaches / intertidal sediment	Not applicable (environmental matrix)	0.58-2116 MP/kg of sediment; mudflats ~10 times higher than beaches	Fibres, fragments and other shapes depending on shore height; colours: NR	PE 46.9%; PP 13.8%; PET 13.5%; EPS prominent at the strandline	Density separation with ZnCl2	FTIR on selected samples + morphological classification	Local discharges from treatment plants and input from the Pearl River	Mudflats retained much more MP than beaches; PE, PP and PET together accounted for >70%	[64]

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42	Global (oceans and coasts)	Marine surface water / 1 L grab samples	Not applicable (environmental matrix)	11.8 ± 24.0 particles/L (global average)	Microfibres predominant (~91%); colours: diverse/NR in the synthesis	57% synthetic, 12% semi-synthetic and 31% non-synthetic in the characterised subsample	Water filtration; digestion not applicable	Microscopy and characterisation of the material in a subsample	Fibres from multiple origins, including textile sources	Showed global patterns and cautioned that not all observed microparticles were synthetic polymers	[65]
43	Spain (Mar Menor lagoon)	Coastal lagoon / beach sand and sediment	Not applicable (environmental matrix)	Reported average for microlitter: 105.4 ± 9.2 particles/kg; 51.1% confirmed as MP; microlitter range 8.2 ± 0.6 to 166.3 ± 1.7 particles/kg	Fragments, fibres, films, pellets and foams	Various; LDPE associated with films; identification by FTIR	NR in the source reviewed for digestion; separation and selection of microlitter	FTIR	Runoff/urban activity, tourism and fishing activities	Higher concentration in the north-western sector; FTIR showed that approximately half of the microlitter was plastic	[66]
44	China	Coastal mangrove / sediment	Not applicable (environmental matrix)	8.3-5738.3 MP/kg (dry weight)	Foams 74.6% and fibres 14.0% among the dominant shapes; colours: diverse/NR	PS 75.2%, PP 11.7%, rayon 4.6%, polyester 3.4%, PE 2.8%, acrylic 2.4%	Sediment separation according to the study protocol	FTIR/μFTIR	Coastal anthropogenic inputs and retention by mangroves	High spatial heterogeneity; the mangrove acted as a sink for microplastics	[67]
45	China (Beibu Gulf)	Mangrove / sediment	Not applicable (environmental matrix)	273 ± 23 to 3520 ± 107 MP/kg	NR in the primary evidence reviewed	NR in the primary evidence reviewed	NR	NR	Tidal dynamics and anthropogenic pressure	Distribution increased from sea towards land and was related to	[68]

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										current velocity and tidal range	
46	China (Jiaozhou Bay)	Bay / sediment cores	Not applicable (environmental matrix)	2.5-27.5 MP/kg (dry weight)	NR in the primary synthesis reviewed	Rayon, PET and PE among the dominant polymers; six types in total	Sediment separation according to the study protocol	Spectroscopy for polymer identification	Sedimentation, hydrodynamics and anthropogenic activities	Vertical distribution reflected both sedimentary processes and human influence	[69]
47	Iran (Gorgan Bay, Caspian Sea)	Bay / sediment, fish and benthic organisms	Fish and benthos / tissues or digestive contents depending on organism	Sediment: 80 ± 25 to 740 ± 105 MP/kg; fish: up to 39 MP/g; bivalves: up to 19.8 MP/g	Predominance of fibres; transparent particles frequent; small sizes (0.5-1 mm) abundant	Various; characterisation by FTIR	Matrix-specific processing; NR in the synthesis reviewed	FTIR	Coastal and urban/industrial activities around the bay	Showed simultaneous contamination in sediment, fish and benthos, with spatial variation and variation among matrices	[70]
48	Iran (southern coast of the Caspian Sea)	Coast / sediment	Not applicable (environmental matrix)	25-330 MP/kg; mean 107.6 MP/kg	Dominant fibres; black frequent	PE and PS among the main polymers	NR	Raman + microscopy	Fishing and tourism suggested as relevant sources	Confirmed MP in coastal sediments and differences among sites	[71]
49	Ghana	Coastal lagoons / sediment cores	Not applicable (environmental matrix)	MP present in 100% of samples	NR in the primary evidence reviewed	NR	NR	NR	Greater influence of large urban centres	Abundance showed spatial variation and a gradient associated with urbanisation	[72]

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50	Spain (La Mancha Húmeda)	Artificially recharged lagoons / sediment	Not applicable (environmental matrix)	Up to 24.4 ± 5.2 MP/g in lagoons receiving wastewater inputs; <1 MP/g in lagoons without such inputs	Fibres and fragments dominant in receiving lagoons; films more frequent in non-recharged lagoons	PE, PP, polyester and acrylic fibres among the main polymers; 11 plastics identified	NR	µFTIR / FTIR	Treated wastewater as the main pathway of entry	Artificially recharged lagoons showed orders of magnitude more MP than non-recharged ones	[73]
51	Ireland	Coast / intertidal and subtidal sediment	Not applicable (environmental matrix)	0-548 MP/kg (intertidal) and 0-184 MP/kg (subtidal)	Fibres, fragments and pellets; predominance of colourless fibres	PE and PP among the main polymers	Organic matter digestion + density separation	Polymer identification	Wastewater and other coastal sources; distance to sources	More MP in intertidal and fine sediments; abundance decreased with distance from sources	[74]
52	Iran (Qarasu Estuary, Gorgan Bay)	Estuary / sediment	Not applicable (environmental matrix)	40-460 MP/kg (dry weight); reported mean 182 ± 111 MP/kg	Fibres 72%, fragments 26%, films 2%; black 48%, white 29%	PP 33%, PE 24%, PA 21%, PS 14%	Density separation	Stereomicroscopy + FTIR	Estuarine inputs and surrounding human sources	Concentration was positively related to the clay content of the sediment	[75]
53	China (laboratory experiment)	Controlled aquatic exposure / freshwater shrimp	Adult *Macrobrachium nipponense*	0, 0.04, 0.4, 4 and 40 mg/L for 21 days	Nanoparticles of ~500 nm; colour: NR	PS (nanoplastic)	Not applicable (controlled exposure)	Moulting and oxidative stress biomarkers	Not applicable (controlled exposure)	4 and 40 mg/L reduced the moulting rate; oxidative stress and changes in moulting-related genes were induced	[76]

No.	Country / region	System / matrix	Species / tissue	Abundance or frequency	Morphotypes / colours	Polymers	Digestion / separation	Identification	Identified or suggested sources	Main results / effects	Reference
54	Japan (Kochi)	Estuarine wetland / sediment and intertidal crabs	Intertidal crabs / digestive tract; reedbed and mudflat sediments	NR in the audited synthesis; reedbeds ~2.6 times more MP than mudflats	Predominance of particles ≤1 mm; varied morphotypes	Low-density polyolefins ~45-50%	Sediment/tract processing according to the study protocol	Polymer identification + microscopy	Sedimentary habitat and feeding mode	Abundance varied among habitats and decreased with coarser sediments; intestinal load depended on feeding mode	[77]
55	Mexico (Estero de Urías, Sinaloa)	Low-exchange estuary / surface sediment + hydrodynamic modelling	Not applicable (environmental matrix)	0-2247 ± 71 particles/kg of sediment (suspected/identified particles according to protocol)	Fibres 85-100%; fragments <10% at several sites; pellets a minor fraction; colours blue, white, black and red	NR in the audited synthesis	Extraction/separation of particles from sediment	Nile Red/inspection and analysis according to the study protocol	Urban discharges and estuarine hydrodynamics	Most of the discharged MP tended to remain in the lagoon; circulation controlled their transport and export	[78]
56	Indonesia	Mangroves / sediment cores and adjacent mudflats	Not applicable (environmental matrix)	NR in the audited synthesis; abundance 6-10 times higher in areas of high anthropogenic pressure	NR	NR	Sediment core processing according to the study protocol	NR in the audited synthesis	Urbanisation/industrialisation; gradient among Surabaya, Jakarta and less impacted sites	MP decreased with depth, although they appeared in layers predating mass plastic production, suggesting vertical migration	[79]
57	Mauritius	Estuaries / water and sediment	Not applicable (environmental matrices)	Water: 249-412 MP/L (mean ~303); sediment: 74-235 MP/kg (mean ~135)	Fibres 52% in water and 81% in sediment; colours: NR	Cotton-polyamide dominant; also PE, PP and other polymers	Separation/filtration depending on matrix	FTIR + Raman + microscopy	Wastewater and multiple coastal activities	Confirmed simultaneous contamination of water and sediment, with a strong	[80]

No.	Country / region	System / matrix	Species / tissue	Abundance or frequency	Morphotypes / colours	Polymers	Digestion / separation	Identification	Identified or suggested sources	Main results / effects	Reference
										predominance of fibres	
58	Mexico (Términos Lagoon)	Coastal lagoon / water, sediment and commercial oyster	*Crassostrea virginica* / whole organism; associated environmental matrices	Concentrations in water and sediment were much higher than in protected reference areas; estimated human ingestion: up to 806.1 MP per 237.1 g of oyster cocktail	Diverse morphotypes; colour data: NR in the audited synthesis	PE 21.1%, poly(butadiene) diol 12.6%, PET 9.5%; also PVC/SBR/Silopren associated with specific sources	Specific processing of water, sediment and oyster	Chemical identification of polymers	Artisanal fishing and urban activities; land traffic (SBR) and petroleum industry (Silopren)	The oyster did not reproduce the environmental spatial pattern; a potential human exposure through consumption was estimated	[81]
59	Mexico (Estero de Urías, Sinaloa)	Coastal lagoon / sediment cores dated with 210Pb	Not applicable (environmental matrix)	Variable historical abundance; no MP before 1950 and accelerated increase since the 1990s	Fibres 66-89%; fragments 11-34%	PET was the most frequent synthetic polymer (up to 50%); abundant semi-synthetic cellulosic fibres	Density separation with NaCl; Nile Red staining	Stereomicroscopy (visible/UV) + FTIR on ~10% of suspected particles	Historical urbanisation and lower current velocity in the inner sector	MP fluxes and abundances increased markedly since the 1990s; hydrodynamics favoured interior accumulation	[82]

No.	Country / region	System / matrix	Species / tissue	Abundance or frequency	Morphotypes / colours	Polymers	Digestion / separation	Identification	Identified or suggested sources	Main results / effects	Reference
60	Sri Lanka (Negombo Lagoon)	Lagoon / commercial shrimp	*Penaeus monodon* and *Penaeus indicus* / gastrointestinal tract and gills	*P. monodon*: 4.72 ± 2.72 MP/ind. (8.29 ± 4.63 MP/g); *P. indicus*: 3.13 ± 2.04 MP/ind. (5.52 ± 3.78 MP/g)	Fibres 93%, fragments 7%; blue 61%, red 15%, black 9%; >1000 µm frequent	PS, PA, polyester, PP and rayon	Alkaline digestion + filtration	Stereomicroscopy/imaging + FTIR	Urban inputs and lagoon activities	Both species accumulated MP; blue fibres were dominant	[83]
61	Mexico (Sontecomapan Lagoon, Veracruz)	Coastal lagoon / surface water, zooplankton and sediment	Copepods, luciferids and chaetognaths / whole organism; environmental matrices	Water 7.5 ± 5.3 MP/L; sediment 8.5 ± 12.5 MP/kg; zooplankton: 0.002 ± 0.005 to 0.019 ± 0.016 MP/ind.	Fibres, fragments and foams	Polyester, acrylic and rayon, among others	Matrix-specific extraction	Morphological and polymer identification according to protocol	Local anthropogenic inputs, although the overall level was low for impacted systems	Contamination was low compared with sites of high human influence, but present in all three compartments	[84]
62	China	Inland mariculture systems / water and shrimp	Farmed shrimp / organisms and system water	NR in the audited synthesis; the study compared stages and system types	NR	NR	Specific processing of water and organisms	MP characterisation according to the study protocol	Aquaculture and system infrastructure	Shrimp farming showed progressive MP accumulation; pond systems showed higher contamination than industrial systems	[85]
63	Sri Lanka (Negombo Lagoon)	Coastal lagoon / macrophytes, associated	*Gracilaria sp.*, *Chaetomorpha sp.* and *Halodule pinifolia* /	Macrophytes: 6 ± 1 to 9 ± 3 MP/g (wet weight); water: 24 ± 7 to 42 ± 14 MP/L;	Fragments >47% in macrophytes; fibres >60% in sediment and water; blue and	Several polymers identified; full list according to the article	Sediment: NaBr + 30% KOH; water: direct filtration; Nile Red staining	Stereomicroscopy + ATR-µFTIR / ATR-FTIR	Lagoon inputs and retention by macrophytes; no single specific source	MP present in water, sediment and macrophytes; differences between	[86]

No.	Country / region	System / matrix	Species / tissue	Abundance or frequency	Morphotypes / colours	Polymers	Digestion / separation	Identification	Identified or suggested sources	Main results / effects	Reference
		sediment and water	leaf and root surfaces; sediment and water	sediment: 228 ± 51 to 412 ± 80 MP/kg	transparent dominant					leaves/roots and among species	
64	India (laboratory experiment)	Controlled chronic exposure / shrimp postlarvae	*Litopenaeus vannamei* / postlarvae and antioxidant biomarkers	Exposure to wHDPE-MP (including 0.2 mg/L) for 15-45 days + depuration	Weathered HDPE MP; shape/colour: NR	Weathered HDPE	Not applicable (controlled exposure)	Assays of SOD, CAT, GPx, GST, GSH, lipid peroxidation and other biomarkers	Not applicable (controlled exposure)	Exposure modulated antioxidant enzymes and increased oxidative stress/peroxidation in a concentration- and time-dependent manner	[87]
65	Peru (Piura)	Fishing terminal / commercial shrimp	*Litopenaeus vannamei* / intestine	83/90 individuals positive; 177 MP in total; 83/90 = 92.2% (the article reports 94%)	Fibres and fragments; colours blue, black, white and red	NR in the audited article	KOH	Microscopy / visual classification	Fishing, commercial handling and the local environment as potential sources	High frequency of MP in the intestine; the discrepancy between the calculated percentage and the percentage stated in the article is retained	[88]
66	China	Mangrove / sediment	Not applicable (environmental matrix)	0-3123 MP/kg (dry weight)	Dominant fibres; white/transparent frequent; sizes of 1000-5000 μm prominent	PP and PE among the main polymers	NR	Spectroscopy for polymer identification	Terrestrial/urban inputs and vertical retention in sediment	Described the accumulation and vertical distribution of MP in mangrove sediments	[89]

Abbreviations: MP = microplastics; GI = gastrointestinal tract; HP = hepatopancreas; PE = polyethylene; PP = polypropylene; PET = polyethylene terephthalate; PS = polystyrene; PVC = polyvinyl chloride; PA = polyamide; PTFE = polytetrafluoroethylene; ABS = acrylonitrile butadiene styrene; FTIR = Fourier-transform infrared spectroscopy; μFTIR = micro-FTIR; NR = not reported / not confirmed.