INFORMATION DOCUMENT

Working Group on Marine litter plastics and microplastics and its POPs and EDC components: challenges and measures to tackle the issue.

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1.- TERMS OF REFERENCE

Resolution 2/11 of the second United Nations Environment Assembly of the United Nations Environment Programme (UNEA-2) that met from 23-27 May 2016 in Nairobi, Kenya, acknowledges marine litter as a rapidly increasing serious issue of global concern that needs an urgent global response, welcoming the activities of relevant bodies and organizations of the United Nations on the matter.

Further supporting this concern, during the joint annual meeting of the Regional Centres of the Stockholm Convention and Basel Conventions of 2016, different Centres expressed their interest in working on the impact of plastic waste and its toxic chemicals, in particular Persistent Organic Pollutants (POPs) and Endocrine Disrupting Chemicals (EDCs), ending up as marine litter. The Stockholm Convention defines POPs as substances that remain intact for exceptionally long periods of time; become widely distributed throughout the environment; accumulate in the fatty tissue of living organisms including humans; and are toxic to both humans and wildlife. The World Health Organization definition for EDC is: "an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub)populations" (Damstra *et al.,* 2002). After consulting with the Secretariat of the Stockholm Convention, the Stockholm Convention Regional Activity Centre in Spain (SCP/RAC) coordinated a working group of Stockholm and Basel Conventions Regional Activity Centres on "Marine litter plastics and microplastics and its POP and EDC components: challenges and measures to tackle the issue".

One of the main aims of this working group was to develop a document with recommendations in the frame of the Stockholm and Basel Conventions to the Parties, and also on possible future activities of the Regional Centers of the Basel and Stockholm Conventions to address the issue. In order to address the technical aspects of the proposal, the following experts in the field were invited to participate:

Frederic Gallo	Senior expert. SCP/RAC. Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. Stockholm Convention Regional Activity Centre in Spain.
Cristina Fossi	Full professor Ecology and Ecotoxicology. University of Siena. Italy.
Roland Weber	POPs Environmental Consulting. Germany.
David Santillo	Greenpeace Research Laboratories. United Kingdom.
Martin Scheringer	Dep. of Environmental Systems Science. ETH Zürich. Switzerland.
Joao Sousa	IUCN-Global Marine and Polar Programme.
Imogen Ingram	Marine litter expert. IPEN. Cook Islands.

Angel Nadal	Endocrine Society. Professor of Physiology, CIBERDEM, Miguel Hernandez University of Elche. Spain.
Carolina Pérez	EUCC Mediterranean Centre - ECNC Group. Spain.
Sandra Averous. Feng Wang	UN Environment Economy Division.
Frank Griffin	Director. Pacific Regional Environment Programme (SPREP)
Leila Devia	Director. Basel Convention Regional Centre for South America.
Dana Lapešová	Director. Basel Convention Regional Centre. Slovakia.
Dolores Romano	Working Group Coordinator and Chemicals consultant.

2.- BACKGROUND. PLASTICS IN THE OCEANS AND ITS HAZARDS: THE NEED FOR URGENT PREVENTIVE MEASURES.

2.1. Plastics in the ocean. Sources, volumes, trends.

Plastic marine litter is a mixture of macromolecules (polymers)[1] and chemicals ranging from macro to nano size. It has become ubiquitous in all the marine compartments, occurring on beaches; the seabed; in sediments; in water column and floating on the sea surface. The quantity observed floating in the open ocean represents only a fraction of the total input: quantifying only floating plastic debris seriously underestimates the amounts of plastics in the oceans (Andrady, 2011). There are major concentration patches of floating plastics in all the five big ocean gyres, and there is evidence that even the polar areas are acting as additional global sinks of floating plastics (van Sebille *et al*., 2016).

The global production of plastics is following a clear exponential trend since the beginning of mass plastic consumption and production in the 1950s, and from a global production of 311 million tonnes in 2014, it is expected to reach around 1800 million tonnes in 2050 (UNEP, 2016). The quantities of plastics leaking to the oceans on a global scale are largely unknown. Reliable quantitative estimations of input loads, sources, originating sectors represent a significant knowledge gap, but it is suggested that every year almost 8 million tonnes of plastic leak to the ocean and it is estimated that the ocean may already contain over 150 million tonnes of plastic (McKinsey Centre for Business and Environment, 2015), of which 5 trillion plastic pieces weighting 250,000 tonnes would be floating on the oceans surface (Eriksen *et al.*, 2014). It has been estimated that the global quantity of plastic in the ocean will nearly double to 250 million tonnes by 2025 (Jambeck, 2015).[2] This means that in a near future millions of tonnes of toxic chemicals contained in plastics may further pollute and threat the marine environment.

It is estimated that on average around 80 to 90 percent of ocean plastic comes from land-based sources rather than ocean-based sources such as fisheries, aquaculture and commercial cruise or private ships. Of that 80 percent, three-quarters comes from untreated waste due to the lack of efficient collection schemes and proper waste management facilities in the municipalities in many countries, and the remainder from careless littering and leaks from within the waste management system itself (like urban drains).

The most worrying environmental consequences of marine litter stem from microplastics (less than 5mm in diameter) and nanoplastics (less than 100 nm in at least one of its dimensions), which would potentially affect marine biota by toxic chemicals transfer. They are originated by the degradation from different pathways—i.e. photodegradation and other weathering processes (Andrady, 2011), of plastic leaked into the sea — e.g. bags, bottles, lids, food packaging, etc.; from plastic pellets leaked into the environment during production or freight process; from plastic microbeads used as scrubbing agents that can be found in personal care and

1 Most of the common polymers found in marine environment are low density Polyethylene (PE-LD), linear low density Polyethylene (PE-LLD), high density Polyethylene (PE-HD), Polypropylene (PP), Polyethylene terephthalate (PET), Polystyrene (PS) and Polyvinyl chloride (PVC).

2 The total estimated biomass of fish of 10 g and upwards in the oceans is 529 million tonnes (Jennings, 2008). This gives an inkling of the quantitative magnitude of the problem of plastics in the oceans.

cosmetic products washed away into the sea; or from textile fibers coming from washing machine runoff[3] (UNEP, 2016). In addition, it's been suggested that some wildlife can reduce the size of plastic particles in their muscular stomach and excrete them back into the environment in form of microplastics, e.g. fulmars (*Fulmarus glacialis*), a type of seabird, are estimated to reshape and redistribute annually about six tonnes of microplastics (Van Franeker, 2011).

Uptake of microplastics through different mechanisms by marine organisms, from zooplankton to whales, including mussels, crabs, fish, sea reptiles and seabirds has been demonstrated in more than 100 species, and in some species ingestion is reported in over 80% of sampled populations[4]. Organisms can uptake microplastics as food, unintentionally capturing it while feeding or intentionally choosing it and/or mistaking it for prey, or by ingesting prey containing microplastic, i.e. trophic transfer (GESAMP, 2016), or in some species by breathing in the microplastics which become trapped on its gills (Watts *et al*. 2014, Fernández *et al*., 2015). Microalgae attached to microplastics are assumed to be more easily captured by filter feeders than free microplastics in the water column (GESAMP, 2016). After microplastics are assimilated into the organism they either accumulate or are excreted depending on the size, shape and composition of the particles, e.g. fish fed with langoustines (*Nephrops norvegicus)* containing polypropylene filaments, were found to ingest but not to excrete the microplastic strands further corroborating the potential for trophic transfer and ecological impacts (GESAMP 2015; Avio *et al*., 2016, Murray and Cowie, 2011).

Various indirect evidences, including the use of thermodynamic approach[5] and of models simulating physiological conditions in the gut, suggest that chemicals in plastics might be released to organisms after ingestion. The first direct demonstration of a similar possibility was provided in mussels, *Mytilus galloprovincialis*, exposed to microplastics (polyethylene and polystyrene) contaminated with polyaromatic hydrocarbons, which revealed a marked bioaccumulation of chemicals in both digestive gland and gills (Avio, *et al*., 2015). Microplastics and nanoplastics fall well within the size range of the staple phytoplankton diet of zooplanktons, such as the Pacific krill. Endocytosis[6] of plastic nanoparticles by micro- or nanofauna can also result in adverse toxic endpoints (Andrady, 2011, GESAMP, 2015).

Microplastics move with currents, wave action and wind conditions, and can be found throughout all the marine compartments. There are major knowledge gaps on the understanding and modelling of the dynamics, fate and hot-spots of micro and nano plastics in the marine environment, since initially floating particles can sink to sediments, through different mechanisms like biofouling, aging, etc., and potentially being remobilized to water column by bioturbation, resuspension or hydrodynamic conditions. It is remarkable that benthic microplastics are far more widespread than previously assumed, with accumulation trends matching the increasing production of plastics worldwide (GESAMP, 2016; Avio *et al.*, 2016; Andrady, 2011).

As such, plastics in the marine environment play an important role in the global transport of toxic chemical contaminants encapsulated in the polymer matrix or adsorbed from the polluted environment. Their persistence in marine environment conditions is estimated in decades or even centuries, and thus can be transported long distances via ocean currents or by the migration of ocean life, thus representing a direct threat to fish populations, marine biodiversity richness and potentially to human health (Bergman *et al.*, 2015; Wrighta *et al.*, 2013; UNEP/MAP, 2015; McKinsey Center for Business and Environment, 2015; Watts A. *et al*., 2014).

In the Mediterranean Sea marine litter has become a critical issue (UNEP/MAP, 2015), as a region accumulating a high concentration of plastics. This is due to the hydrodynamics of this semi-closed sea where outflow mainly occurs through a deep water layer, with a lack or deficit of environmentally sound urban waste

3 There are other sources of polymers that are not considered in this paper like cigarette butts; tire and road wear; and artificial turf infill.

4 Particles of 1 mm size were found in 60% of plankton samples in North Atlantic Subtropical Gyre (Law *et al*, 2010)

5 i.e. the study of transformations of matter and energy in systems as they approach equilibrium.

6 i.e. the taking in of matter by a living cell by invagination of its membrane.

management and proper and efficient collection systems of much of the waste generated in many of its riparian countries and heavily populated coastal areas.

Other global areas of concern are some islands, mid-ocean islands and the Small Island Developing States (SIDS), where the situation has been depicted as "waste disaster" (Veitayaki, 2010). In addition to the challenge of marine litter, they face serious deficiencies in basic waste management capabilities, due mainly to small and sparse populations with limited potential economies of scale; a shortage of land for sanitary landfill, with waste being often disposed of casually by burial, burnt or discarded into the surrounding land and sea; with changing consumption patterns (with more plastic waste) and increasing number of tourists; the state and pace of economic and social development with growing population, urbanisation; and with limited institutional and human resources capacity with scarce resources and possibilities to combat this growing threat to their supporting ecosystems and means of life (UNEP, 2016).

2.2. Chemicals (POPs and EDCs) in marine litter plastics. Fate in the marine environment.

Besides the adverse physiological effects to marine organisms that arise from ingestion of pieces of plastic (Wrighta *et al.*, 2013), plastics in the marine environment also pose a chemical hazard (Rochman *et al*., 2013). The chemicals found in plastic marine litter can be classified in the following four categories: chemicals intentionally added during the production process (additives like flame retardants, plasticizers, antioxidants, UV stabilisers, pigments, etc); unwanted chemicals coming from the production processes, like monomers (vinyl chloride, BPA, etc.) [7] and catalysers, normally present in traces (ppm); chemicals coming from the recycling of plastic waste[8]; and finally hydrophobic chemicals adsorbed from a polluted environment in the plastic waste surface[9]. All these substances can leach to the marine environment when the plastic weathers or by the uptake of microplastics by marine biota.

Certain chemicals contained in the plastics present toxic properties and some of them have specific endocrine disruptor properties, a major concern for chemical hazard risk in the marine environment. A compilation of lists of chemicals recognised as Endocrine Disrupting Chemicals (EDCs) or suggested as Potential EDCs has been developed by the International Panel on Chemical Pollution (IPCP)[10]. The SINList [11] developed by ChemSec, compiles those chemicals with most urgent action needed.

Experimental research on animals shows that low-level, non-linear exposures to endocrine disruptor chemicals (EDCs) lead to both transient and permanent changes to endocrine systems, as EDCs can mimic, compete with, or disrupt the synthesis of endogenous hormones. This results in impaired reproduction and consequent low birth rates and potential loss of biodiversity, thyroid function, and metabolism, and increased incidence and progression of hormone-sensitive cancers (Gore *et al.*, 2015). The research suggests that embryo and developmental periods are critical sensitive periods to EDCs.[12] Many of the chemicals have been found at concentrations in sea waters that cause effects in cellular and/or animal models (Gore *et al.*, 2015).

Some of those intentional chemical additives in plastics with toxic and endocrine disrupting properties might be present at levels of 1,000 to 500,000 mg/kg (ppm). This is the case of polybrominated diphenylethers (PBDEs)

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7 Polymers can also be broken up into monomers by UV radiation, mechanical action, heat and other chemicals (Science for Environment Policy, 2011).

8 i.e. substances that were added intentionally in the virgin polymer and that are incorporated unknowingly or unwillingly when the plastic waste is recycled.

9 Hydrophobicity is a property common to most of the POPs (Nerland IL *et al*., 2014).

10 "A Compilation of Lists of chemicals Recognised as Endocrine Disrupting Chemicals (EDCs) or Suggested as Potential EDCs", International Panel on Chemical Pollution (IPCP), 2016. http://www.unep.org/chemicalsandwaste/SAICM/EndocrineDisruptingChemicals/tabid/130226/Default.aspx

11 The SIN (Substitute It Now!) List, developed by ChemSec, identifies 32 EDCs of high concern that would require immediate action towards substitution, and 14 more chemicals with ED properties and additional hazardous properties as well. http://chemsec.org/business-tool/sin-list/

12 A fact that should be taken into account when assessing EDCs effects in animal models.

used as flame retardants in plastics, polyurethane foams and textiles; tetrabromobisphenol A (TBBPA)[13] (Science for Environment Policy, 2011), used as flame retardant in epoxy, vinyl esters and polycarbonate resins; or hexabromocyclododecane (HBCDD), used in polystyrene foam (EPS/XPS) as well as in textile applications. For example, elevated HBCDD levels were found in oysters from aquaculture farms were EPS/XPS buoys containing HBCDD were present (Hong *et al*., 2013). In order to determine that the pollution comes from the plastic and not from the environment, high levels of y-HBCDD isomer levels detected in fish (Rüdel *et al*., 2012) demonstrate that direct exposure to technical HBCDD present in the polymer matrix can be a relevant fish exposure pathway, while for most waters the α-HCBDD isomer is dominant in fishes likely polluted from environmental exposure.

Other plastic additives of concern in the marine environment are chlorinated paraffins[14] (Zhang *et al.*, 2016) added as flame retardants; polychlorinated biphenyls (PCBs) and polychlorinated naphthalenes (PCNs) included in PVC coatings/paints, sometimes released as fine particles from abrasive blasting from e.g. bridges into waters in tonnes scale[15] (Jartun *et al.,* 2009, ELSA 2016); and per- and polyfluorinated compounds (PFCs)[16](Wang *et al*.,2017, Washington *et al*., 2009). Fluorinated polymers containing perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) precursors used in some textile fibers and in paper and paperboard articles (i.e. fast-food packaging and paper plates, cups, etc.) to provide grease and water resistance (Schaider *et al*., 2016), can become microplastics in the aquatic environment and release PFOS or PFOA when degrading or ingested.[17]

Recycled plastic/polymers can have as well a high content of these toxic chemicals, and lead to exposure of the marine environment[18] when leaked into the ocean. The fact that many plastics are recycled in countries with low legal requirements or technical capabilities on the control of the different types and concentrations of hazardous substances contained in the plastics[19] is an added source of concern, as the concentration of those toxic chemicals may increase in the recycled products.

With regard to the pollutants present in sea water and adsorbed onto the plastic surface, these chemicals are normally found in the marine plastics at low concentrations compared with the intentionally added chemicals. It has to be considered as well that other media present in the oceans, like suspended organic particulates, black carbon and natural diet and prey items, like phyto- and zooplankton species, have the capacity to adsorb hydrophobic organic chemicals (HOCs), and thus the fraction of HOCs adsorbed in marine plastics appears to be smaller when compared to that adsorbed fraction in other media in the ocean, and overall exposure of marine biota might be higher from those other matrices (Koelmans *et al*., 2016).

It is important also to mention that it has been estimated that fluxes of PCBs, PBDEs and PFOA to the Arctic caused by plastic debris was in the order of four to six times smaller than fluxes caused by atmospheric or seawater currents (Zarfl & Matthies, 2010). However, the researchers highlighted that the significance of pollutant transport routes does not only depend on the absolute amount of pollutants, but also on their impact from direct plastic ingestion and bioaccumulation in food chains (Science for Environment Policy, 2011).

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13 TBBPA degrades to Bisphenol A and to TBBPA dimethyl ether. Bisphenol A and phthalates are rapidly metabolised once ingested but their concentration within the tissues varies between species for the same exposure.

14 Short-chained chlorinated paraffins are candidate POPs in the Stockholm Convention (March 2017).

15 PCBs and PCNs have been used to some extent as flame retardants in cables and other polymers including PVC coatings for corrosion protection. Such coatings are sometimes removed from bridges and dams by abrasive blasting and end up in rivers and the sea

16 http://greensciencepolicy.org/highly-fluorinated-chemicals/

17 PFCs in the environment can last for millions of years.

18 Articles with any substance listed under the Stockholm Convention, like HBCDD used mainly in EPS/XPS polymers, are not allowed to undergo recycling processes, except articles (plastics) with Hexa-, Hepta-, Tetra- or Penta- bromodiphenyl ethers that would allow some countries to recycle them until 2030, under a exemption of the Convention.

19 E.g., the EU exports 50% of its plastic waste collected for recycling (source Plastic Recyclers Europe).

EDCs as well as POPs are transferred from microplastic litter to marine organisms by different mechanisms — ingestion and respiratory system, through all the various trophic levels, including the higher trophic levels representing a hazard to marine ecosystems, food availability and food security, and potentially to human health (GESAMP, 2015; Miller *et al.*,2016). These EDCs include substances like alkyl-phenols — i.e. octylphenol and nonylphenol used mainly as antioxidants, or bisphenol A (BPA) present in polycarbonate plastics as trace monomer; and phthalate esters, widely used as plasticizers to increase properties like flexibility, transparency or longevity, which can be up to 60% in weight of the plastic — i.e. di(2-ethylhexyl) phthalate (DEHP), diisodecyl phthalate (DIDP), diisononyl phthalate (DINP) and butyl benzyl phthalate (BPP); and organotin compounds (based on methyl, butyl or octyl groups, like tributyltin[20]) used as stabilizing additives in some PVC polymers.

Theoretically “non persistent” EDCs in microplastics may be potentially as harmful as listed POPs in terms of behaviour and consequences in the marine environment: this is due to the continuous flow of “fresh” plastic waste and also of wastewater and sediments into the oceans that may contain microplastics and associated chemicals from urban and industrial waste water treatment plants (Oehlmann *et al*., 2009, Nerland *et al*., 2014); from their mobility and fluxes through all the compartments of the marine environment (GESAMP, 2016); from their release from the microplastics matrices to the animals’ tissues after their uptake; from the potential bioaccumulation of microplastics in the food chain; and finally by the persistence of those chemicals contained in plastics in marine environmental conditions (temperature, absence of oxygen, absence of light in water column and sea-floor, etc). The overall result would be that those substances in plastics in the marine environment may have an activity level, widespread distribution, toxic risk and bioaccumulation comparable to that of POPs. In this regard, Takada *et al*. and Hirai *et al*. analysed a wide range of chemicals in marine plastics collected from urban and remote beaches and open oceans, including theoretically “non-persistent” additives like alkylphenols (i.e. nonylphenol, octylphenol) and BPA, which were detected in concentrations ranging from ng/g to µg/g in polyethylene and polypropylene debris. Moreover, it has been demonstrated (Baini *et al*., 2016; Fossi *et al*., 2012) a significant correlation among seven different phthalate esters (phthalates or PAEs) present in samples taken in the same area of microplastics, plankton and bubbler samples of different cetacean species[21] .

All these characteristics and evidence would allow equating EDCs in marine plastic waste with the defining properties of a POP. This is further discussed in point 3 of the document, on recommendations to the Stockholm Convention.

2.3. Potential impacts on marine biodiversity.

There is already scientific evidence of endocrine disruptor activity by the intake of microplastics via the filter-feeding mechanisms of animals like mussels or baleen whales (Fossi *et al.*, 2012), or via the magnifying effect of the food chain in top predators like the swordfish (Fossi *et al.*, 2001), which may pose a threat to the normal ability of wildlife to grow and reproduce.

There is still need of more studies for reliable estimates to be made as to the contribution to EDC exposure of marine species arising from microplastic ingestion, but it is an essential fact that the harmful effects of EDCs may be already present at very low doses[22], interfering with hormones action including estrogens, androgens and thyroid hormones (Diamanti-Kandarakis *et al*., 2009; Gore *et al*., 2015), which represents a serious hazard to the marine fauna, its biodiversity and its population

20 Marine painting containing tributyltin was forbidden by the International Convention on the Control of Harmful Anti-fouling Systems in Ships (enter into force in 2008), signed by most of the countries.

21 This finding suggests a new non-invasive method, which is to use the PAEs found in plankton as tracers of the exposure/ingestion in cetaceans or other endangered species.

22 EDCs effects are studied within the field of endocrinology, not classical toxicology.

In this regard, it has been demonstrated that PCBs, organochlorine pesticides and PBDEs are associated with reproductive hormones disruption in seals and polar bears. Moreover, POPs including PCBs and PBDEs have been shown to alter thyroid hormone levels and function in sea lions, polar bears and salmonids. In fish they cause alteration in several brain areas during development including reproductive-related areas such as the hypothalamus. PCBs and DDT also alter the adrenocortical system in marine mammals like seals as well as in birds and fishes.

Wildly used plasticizers — e.g. dibutyl phtaltate, dimethyl phthalate, butyl benzyl phthalate and BPA, can affect both development and reproduction in marine species: effect cconcentrations of plasticizers in laboratory experiments in some sensitive species like molluscs, crustaceans and amphibians (including disturbance in spermatogenesis in fish) coincide with measured environmental concentrations in the low nanogram/liter to microgram/liter range. It should be remarked that there are still basic knowledge gaps, including the long-term exposures to environmentally relevant concentrations and their ecotoxicity when part of complex mixtures (Oehlmann, 2009). Other EDCs, such as alkylphenols, have the capacity to derail male reproductive development leading to feminisation or demasculinization of the male form in fish and altered sex in molluscs. Others, as tin-containing plastic stabilisers, elicit immunological disorders in fishes and induce imposex in gastropods (Bergman *et al*., 2012).

As a reference for the magnitude of the problems posed by “on land” endocrine disruptor chemicals, according to a series of studies released by the Endocrine Society, and only taking into account medical costs[23], routine exposure to EDCs found in every day consumer items in homes costs only to the EU €157 billion annually (Trasande *et al.*, 20015) and $340 billions annually in the US (Attina TM *et al.,* 2016), a magnitude similar to the cost of smoking-related illness — the largest single cost coming from effects on children.

2.4. Potential impacts from marine plastics on human health.

It has to be stressed that there are no current scientific studies correlating the direct consumption of fish or shellfish contaminated with microplastics containing or polluted with EDCs and the consequent endocrine disruption effects on human health, although given the complexity of the issue, this is perhaps not surprising.

At this time, we can conclude that given the quantity of uncertainties and data gaps on this matter at the present state-of-the-art scientific research, including the lack of knowledge on the role and hazards of nanoplastics, potentially the most hazardous area of marine plastics (Bouwmeester, 2015; Koelmans, 2015), and given the unavoidable increase in the coming decades of micro and nanoplastics in the marine environment, there is insufficient evidence to draw firm conclusions on the overall human health risks posed by consumption of marine animals polluted with marine microplastics, and therefore refer this matter to the precautionary principle[24], and consider that until the weight of the scientific evidence is fully conclusive there is a risk that diets rich in small fish in whole (i.e. including the guts), or in bivalves and crustaceans containing microplastics or nanoplastics in significant quantities, could affect human endocrine systems— especially during embryo and infancy stages, or induce hepatic stress or other related health affections.

Further scientific research is needed with urgency on the potential impacts to endocrine systems and overall human health specially on developing stages by the direct or indirect ingestion of marine micro- and nanoplastics.

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23 The Endocrine Society has recently stated that: “... data reviewed in EDC-2 removes any doubt that EDCs are contributing to increased chronic disease burdens related to obesity, diabetes mellitus, reproduction, thyroid, cancers, and neuroendocrine and neurodevelopmental functions” (Gore et al, 2015).

24 Precautionary principle by virtue of which where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

2.5. Potential impacts on food safety and security with raising levels of marine plastics.

Without immediate action, the environmental impacts and the economic costs is due to become much worse in the short term: as mentioned in point 2.1, more than a hundred million tonnes of plastics are estimated to have been dumped already to the oceans, and projections in plastic production and consumption indicate that plastic inputs in the sea may have an exponential increase if no urgent actions are taken (Jambeck *et al.*, 2015). On average, plastic consumption reached 100 kg per person per year in Western Europe and North America, and 20 Kg in Asia (Gourmelon, 2015), and these figures are expected to grow rapidly as urban population increases globally (especially in populated developing countries) and urban dwellers must purchase all of their (plastic packaged) food and beverage.

It is estimated that fish provides more than 3,1 billion people with almost 20 percent of their average per capita intake of animal protein (FAO, 2016). As stated before, EDCs can affect marine biodiversity, especially fish populations, raising concerns about food safety and security in a near future. This can have a serious economic impact at global level, especially in countries/islands where fish is a staple food, by exacerbating poverty (Nerland *et al.*, 2014; Mckinley *et al.*, 2010; Johnston & Roberts, 2009) in a context of climate change and growing competition for natural resources.

2.6. Urgent measures needed.

Having a fully fledged efficient and sound environmental waste collection, management and recycling waste systems at global level that would guarantee an almost zero plastic leaking could be a financially challenging enterprise and decades-long process. Moreover, while such infrastructure could be economically feasible in developed countries, it may not be feasible or cost-effective for developing nations (Gabrys J (ed), 2013). In addition, the exponential increasing global tendency of plastic production and consumption, in a context of global financial crisis, makes extremely uncertain the ability to achieve already established objectives of reduction of marine litter[25] at global, regional, sub-regional or national levels.

Therefore, urgent and strong actions with relatively low public investment are needed at global level, i.e. policy reforms including extended producer responsibility (EPR) and fiscal and economic instruments. A prevention and 'Best Available Techniques and Practices' approach, built on a holistic life cycle basis, could allow scarce resources and effort to be focused on measures that are very likely to reduce the problem by directly attacking the source, similar to the way in which industrial toxic emissions were effectively curbed in some developed countries at the end of the last century, instead of relying on 'end-of-pipe' solutions (e.g. focusing only on cleaning measures like 'fishing for (macro)plastic', which are not efficient and economically viable in an oceanic scale and which do not stop the continuous inputs of plastic and the already existing microplastic pollution), or by only assessing and monitoring how much worse the problem it is getting (EUNOMIA, 2016).

Although there is still need to carry out focused scientific research to fill the knowledge gaps about the impacts of plastic litter in the marine environment, the food chain and human health, the already existing scientific evidence and reasonable concerns should be enough to support actions by the scientific, industry, policy and civil society communities to curb the leaking of plastics into the marine environment in the short term. To think in terms of "business as usual" and "adaptation measures" to cope with plastic pollution in the oceans instead of prevention and mitigation measures would lead to another predictable environmental crisis for future generations to cope with. The dangers of working in isolation are already apparent from industry-centred responses such as the development of 'oxo-degradable' plastic products, which merely take out of sight plastics by fragmenting them at the end of their lifetime into numerous small but essentially non-degradable pieces (Gabrys J (ed), 2013).

25 The Honolulu Strategy, the global framework to prevent marine litter, does not prescribe specific marine debris reduction targets but expects "substantial progress" by 2030. The UN's Sustainable Development Goal number 14 (Sustainable Oceans) aims to "prevent and significantly reduce" marine litter in 2025. In the European Union, a 30% reduction for beach litter by 2025, compared with 2015 levels, has been proposed for all its regional seas.

Strong Policy actions in order to curb unnecessary plastic packaging on the demand side on the short term, like the ban on free single-us plastic bags, or to substantially increase the collection rate of plastic waste, like the deposit-refund schemes for plastic beverage bottles[26] which have a demonstrated high rate of success in many countries[27], and the ban on plastic microbeads in cosmetics and personal care products, are strongly needed at regional, sub-regional or national level as part of their strategies for waste management. Initiatives to promote measurement of the types and quantities of plastic used by companies or communities, like the 'Plastic Disclosure Project'[28], could facilitate accountability and the implementation of measures to reduce avoidable plastic use by the private and public sectors. Other measures to consider in developing countries or remote rural communities of Africa, America or Pacific SIDS, with no or few environmentally sound disposal facilities, would be for example the take-back or repatriation schemes of plastic waste under extended producer responsibility (EPR) schemes, or the use of alternatives to persistent plastics which can be reused or recycled in the country with local jobs creation, e.g. glass.

Campaigns to make plastic litter socially unacceptable and educate consumers across the supply chain would be necessary elements of any policy of awareness on waste. Designing for recycling would allow to divert important volumes of plastic waste from the waste management systems. It is necessary to work with companies and research institutes, especially in the food sector, to optimize food packaging and materials in order to avoid unnecessary use of persistent plastics and toxic chemicals. Strong policy actions, as well as more research, development and innovation in green chemistry are needed for the substitution of POPs, EDC and other toxic substances in plastics as well as for the development of more benign alternatives to persistent polymers in the marine environment.

It is important to highlight that compostable bioplastics or plastics labelled as 'biodegradable in the environment' are not degraded in marine conditions, where parameters like temperature, oxygen, salinity, etc. are very different that those expected in a composting process, and so they have equivalent properties in the marine environment in this regard as persistent plastics.[29] Other innovative materials, like marine biodegradable polymers, especially for food packaging, could have an important role to play in reducing the environmental damage of plastics leaking to the marine environment, but the biodegradability in marine environment of such alternative plastics (like the polyhydroxyalkanoates, PHAs) would require further study and validation under a range of conditions in seawater, and internationally accepted certification seals. Further avenues of research on these biomaterials would be to study their complete lifecycle (e.g. to ensure that they do not compete with food production, best options to recycle), potential harms by ingestion to marine biota, and its rate of adsorption of HOC in seawater before its degradation compared with other adsorbing media in the marine environment, including persistent plastics.

Implementing or improving environmentally sound waste collection and management systems of urban waste represents a basic necessary step to reducing plastic inputs, especially in developing economies. Special attention should be paid to avoid creating further environmental and health impacts, for example by promoting non-BAT waste incineration of plastics without tight environmental controls, which may be an important identified source of POPs, such as dioxins and furans. Effective mandatory or voluntary measures are urgently needed to curb the consumption of single-use plastics, as well as banning micro-plastics in cosmetics and personal care products.

26 Plastic beverage bottles represent around 20% of all plastic packaging waste in the EU.

27 i.e. compared with the relatively low and stagnate rates of curbside separate collection of plastic packaging waste, with the added benefit of delivering a high-quality product ready for recycling (PWC, 2011).

28 Plasticdisclosure.org

29 Biodegradation according to EN13432 is considered to be complete if at least 90% of the material has been converted into carbon dioxide (the remainder is due to the fact that besides carbon dioxide, water and biomass are produced during biodegradation).When all the organic carbon in the polymer is converted, it is referred as complete mineralisation.

The actual levels of POPs in marine plastics collected from the sea should be taken into consideration when deciding on management options for marine waste, including recycling.

The implementation of action plans to reduce the input of marine plastic around the world needs to involve all stakeholders from the local and national authorities to international bodies, the scientific community, plastic manufacturers, tourism and fishing industries, NGOs, etc., in order to effectively address socio-economic and environmental issues related to plastic pollution from a sustainable and global point of view (Thevenon *et al*., 2014).

3.- RECOMMENDATIONS TO THE PARTIES OF THE STOCKHOLM AND BASEL CONVENTIONS TO ADDRESS THE ISSUE.

STOCKHOLM CONVENTION

To acknowledge plastic marine litter as an issue of global environmental and health concern, due to its persistence, wide geographical distribution and long range transport capacity of toxic chemicals in the marine environment.

Due to the toxic chemicals exposure of marine biota through marine plastic litter and the related bioaccumulation and widespread distribution in all marine compartments of persistent micro and nanoplastics with chemicals of concern acting as persistent organic pollutants in the marine environment, and given the potential human affection, to consider:

1- To take into account the risks of additives in plastics with endocrine disruptor properties that may become marine litter when selecting and assessing substances for the listing of new POPs in the Stockholm Convention. These substances, which might not pass some of the POPs screening criteria like persistence in standard laboratory conditions, are expected to have longer half-lifes in the plastic due to the protection (or molecular encapsulation) within the polymer matrix and may have even longer half-lifes in the marine environment, due to its physical and chemical properties like lower temperatures, lower oxygen levels, salinity, pH, and lower levels of light in water column and sea floor and sediments, i.e. theoretically "non-persistent" chemical additives in plastics (like alkylphenols, phthalates, BPA) have been detected in high concentrations in floating polyethylene and polypropylene plastic (the most widely used in packaging) in open oceans (Takada H; Hirai *et al*., 2011). In addition, apart from their mobility and fluxes through all the compartments of the marine environment (GESAMP, 2016), the new inputs of 'fresh' plastic into the marine environment is so continuous and widespread through all the oceans that would be equivalent to the continental or oceanic long-range transport property of highly persistent POPs. Their exposure to marine biota is relevant due to:

    1) the very low doses of EDCs required to affect the endocrine systems in marine biota and humans, compared to those required in toxicological tests to prove carcinogenicity in candidate POPs, especially during the embryo and developing stages.
    2) the uptake of microplastics containing those chemicals by marine biota, which may affect biodiversity, food security, food availability and potentially human health, especially if the persistent plastic consumption and production follows the expected growing trends in the coming decades, without the necessary environmentally sound waste management and collection facilities being in place globally in order to avoid plastic leaking into the oceans.

2- The introduction of measures to reduce marine plastic litter in National Implementation Plans for the Stockholm Convention on Persistent Organic Pollutants, such as:

- Promoting BATs to reduce plastic leakage to oceans and improving information on input loads, sources and originating sectors.
- Supporting research on environmental and health impacts of marine plastics, microplastics and nanoplastics and related fate of EDCs and POPs.
- Encouraging plastic waste prevention and supporting development and implementation of safer or more benign alternatives to persistent plastics in the marine environment.
- Encouraging the improvement and efficiency of collection and sound environmental management of waste.
- Encouraging changes in consumption and littering behaviour.
- Encouraging plastic waste recycling when feasible.

BASEL CONVENTION:

To acknowledge plastic marine litter as an issue of global environmental and health concern, due to its persistence, wide geographical distribution and long range transport capacity of toxic chemicals in the marine environment.

To consider

- The consideration in the Strategic Framework for the implementation of the Basel Convention of measures to avoid or reduce marine plastic litter.

- To revise Annex I and III of the Convention in order to ensure the listing of all chemicals with endocrine disruptor substances (EDCs) in plastics that may end up as microplastic waste in the marine environment.

- The adoption of new guidelines on Environmental Sound Management of plastic and plastic containing wastes, with a view to minimize the possibility of plastic leaks into the oceans coming from waste management.

- Reviewing policies related to the export of plastic containing waste to countries where no environmentally sound recycling, recovery or final disposal of the plastic materials contained in the waste are guaranteed — i.e. uncontrolled recycling of plastics with toxic chemicals, waste disposal in non-BAT open dumps, or incinerated in cement furnaces with no environmental controls, or non-BAT incinerators without tight environmental controls like dioxin catalyzers and continuous outflow monitoring and sound environmental landfilling of its ashes.

- To ensure best available techniques and best environment practice is recommended in Basel Convention waste guidelines and manuals to ensure avoidance of disposal methods that might re-release toxic chemicals into the air, water or soils in order to safeguard the health of neighboring communities.

- To develop efficient strategies for achieving the prevention and minimization of the generation of marine plastic litter.

4. POSSIBLE FUTURE ACTIVITIES TO ADDRESS THE ISSUE.

The Working Group identified a number of possible future activities to address the issue by the Basel and Stockholm Conventions Regional activity centres in coordination with existing platforms, or by any other UN Environment institutions, IGOs, governments, ONGs, etc., such as:

- Dissemination, information and training activities to improve awareness and knowledge on the risks posed by plastic marine litter and on measures to reduce it.

- Technical assistance and capacity-building activities to support parties and other stakeholders in implementing waste management and efficient waste collection measures to reduce plastic marine litter.

- Develop recommendations to review regional and national regulatory frameworks concerning plastic and plastic containing wastes and inclusion of measures to prevent plastic waste, like measures to reduce plastic bags consumption and establishment of Deposit and Return schemes for beverage packaging.

- To promote innovation and technology transfer to avoid persistent plastics and sound chemical substitution of toxic components in plastic packaging and other plastics.

- To assist developing countries, economies in transition and Small Island Developing States with efficient collection and environmentally sound management of plastic waste and plastic packaging, which they are unable to dispose of or recycle in an environmentally sound manner but continue to receive nonetheless, including through take-back or repatriation policies under extended producer responsibility (EPR) schemes.

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