

Plastic, Synthetics; Environment and Health

- 240 million tons of plastic are produced every year - with conspicuous effect: Life in the oceans impends to be suffocated by plastic litter while more and more people have to suffer from cancer, infertility and other "civilization" diseases as a result of poisonous ingredients of synthetics.

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In summer 1997 skipper Charles J. Moore decided to return home from a sailing regatta and was returning on his way from Los Angeles to Hawaii after his crew had recovered from the exertions of the regatta. They decided to go home through an area that was usually avoided by sailors because of its doldrums yielding little wind: the horse latitudes. In spite of the wind absence exasperating from time and time again they could go in peace. There they made an incredible and unsettling discovery:

"As I was looking from board on what should be the surface of a pristine, untouched ocean I could only spot plastic litter as far as my eyes could see. It seemed to be unbelievable but I could not find a free spot anywhere." describes Skipper Charles J. Moore later in his report for the "Natural History Magazine".

However this was yet not all to be witnessed. The crew was followed by plastic litter for more than a week: „No matter at what time of the day I had gone to have a look from the deck there was plastic litter floating all over on top of the sea surface: bottles, plastic covers, wrappings, fragments."

Some scientists were not surprised by the discoveries of skipper Moore. To them it was just the fulfillment of their own forecasts and apprehension. The NOAA had already stated a litter vortex in the northern Pacific in 1988.

Oceanographers estimate the size of the Great Pacific Garbage Patch in the east of Hawaii with its million tons of plastic by the time as four times the size of Germany (700.000 - 15 Mio km²). At that time in the center of the litter vortex every kilo of plankton was outnumbered by six kilos of plastic litter. In the meantime the relation

amounts to incredible 1:46 parts of litter per plankton.

The reason why the problem exacerbates so rapidly is not only due to rising production. The litter circulates about 16 years in the plastic vortex before if it is released. The worst thing about it is however that plastic is hardly biodegradable. Released once into the environment it can pollute the environment for a long time at least until it gets sedimented.

But the Great Pacific Garbage Patch is not the only litter vortex. There is also one in the Sargasso Sea in the Atlantic which is revolved by the current of the Kanarens, the Northern Atlantic and the Gulf Stream. Its size and composition does resemble the Great Pacific Garbage Patch strikingly.

The reason why such great litter swirls can appear can be found in the fact that the sea current is considerably low in these areas. Litter can be brought to these areas by currents from other locations but can not be brought away from there because there is no sufficient sea current on the surface.

Scientists from the University of Manoa have found more similar areas by analysis of sea currents: one area near the Bermudas, one in the west of Central Chile in the Pacific, another one from Argentina far across the Atlantic almost up to South Africa.

Whenever plastic litter arrives in areas close to the continent it covers whole shores. Werner Boote shows in his film Plastic World how volunteers in Japan clean a beach covered entirely with plastic every year just so that it gets covered by plastic litter little time afterwards. Plastic arrives on every beach of the worlds oceans. Even the sand on our beaches contains plastic up to a certain degree.

Even waters like the Mediterranean Sea or the Northern Sea have a litter problem even though litter does not collect in big vortexes there.

The litter washed ashore and caught in huge vortexes is just the top of an iceberg. The larger part, more than 70 percent sinks down and covers the seafloor like a suffocating, air tight shroud.

Before the litter sinks down it already causes full devastation. Seals, turtles and birds tangle up in plastic strings and rings without any chance to rescue. Many animals like whales, dolphins and sea birds eat plastic parts and die of hunger by a stomach filled with plastic if they do not die of a stomach

closing first. The protected and endangered sea turtle *Caretta Caretta* confounds translucent plastic bags with its favorite food jellyfish. According to the Union of Conservation of Nature and Natural Resources (IUCN) one Million of sea birds and about 100.000 sea mammals per year become victims of plastic litter.

These numbers are dramatic but not the only danger to marine ecosystems. Another problem are fishing nets which have gone off deck deliberately or unintentionally. By the time more and more sea animals get caught up in these nets. Once the fishing nets get too heavy they sink down; just to rise up again at a later time when all the sea animals have decomposed - and the destruction begins again.

In conjunction with other anthropogenic influences like massive overfishing, oil spills and the discharge of noxious substances a whole ecosystem could collapse. This would mean that the oceans could no more serve as a source of food for humankind.

More often inferior animals like jellyfish start to dominate so that fishing nets are full of jellyfish but without a singleton fish. This is not only owed to the exhaustion of fishing grounds but also to the increasing spill of fertilizers out of agricultural use. The acidification of our oceans by the massive increase of CO₂ air content will be bad for marine organisms based on bones and limestone skeletons like corals. A symptom of human made global warming induced by sharply rising CO₂ levels (greenhouse effect). Even marine food chains such as between plankton and plankton eating animals like fish are at risk because some animals are accustomed to the blooming period of their food source which changes by global warming.

In addition to restrictive international fishing quotas the resolution of the plastic litter problem will be essential in order to rescue our oceans from passing out in the future.

Simple ex-post resolution attempts like collecting out the plastic garbage are futile due to the sheer amounts. Other attempts like stopping the litter at river mouths are impossible due to shipping routes.

Increased recycling of synthetics could be part of a solution.

If shipping companies got paid for disposing of their plastic litter instead of

having to pay in order to get rid of it they would not simply throw it away over-deck shredded together with organic waste. International shipping authorities would have to allocate money for this purpose which could be taken in before by litter fees. A mere prohibition may be useless because it can not be checked sufficiently without controlling that the litter is returned in the harbour.

Unfortunately, in contrast to efforts to increase the recycling level for beverage packings the recycling portion has fallen in Austria from 60% (1997) to 40% (2007), for bottled water even from 96% (1994) to 24,3% (2007).

Comprehensive plastic recycling could reduce the rapidly growing problems to some extent; however, one cannot think of it as a solution to the plastic litter problem. 80% of all spilt plastic litter whether thrown away deliberately or unwittingly left or blown by wind out of hand makes its way over the rivers into the ocean.

The plastic recycling proportion has strikingly fallen in the last years instead of achieving a rise.

The only viable way to cope with the plastic litter problem would be a stringent regulation by the means of law that all commodities must be made of 100% degradable plastic.

Biodegradable plastics do already exist for a long time. The industry just does not have any interest in deploying these synthetics - in the lack of appropriate regulations. Biodegradable does not mean that plastic synthetics need to be produced of biological base materials. Biodegradable synthetics could also be cheaply produced out of crude oil.

Non biodegradable materials would need to be reserved for special technical purposes ; everywhere where special material properties are required or a product as a whole can not be created biodegradably.

If the majority of synthetics would need to be biodegradable then it would solve problems like the abandoned fishing nets.

In order to rescue the worlds oceans an international treaty would be necessary. Nonetheless the EU or other countries could try to go a step ahead in abolishing non-degradable materials in certain areas which would also require blocking imports on non-conformant goods. If a joint action of nations

going ahead in this area could make major exporters to change their products then a worldwide enforcement is just a few steps ahead.

1.2. Environmental Effects of Degradation

Sun, wind and water reduce bigger plastic parts to smaller pieces until only small suspended articles are left over. The main part of plastic litter consists of these particles circulating not far under the surface. They become ingested by maritime organisms together with plankton.

When ingested by animals these microparticles turn out to be traps for persistent toxins. As the plastic parts get smaller and smaller their surface size shrinks to the square while their volume shrinks to the third potency, effectively the surface becomes much bigger in relation because the volume shrinks much faster. We do also remember that many plastics have the well known property to take up smells. Consequently the concentration of toxins being easily assimilated through the bigger surface can outnumber the concentration in the ambient sea water for Millions of times.

That way in the small plastic particles concentrate persistent toxins such as DDT, which had been abolished in the 40ies, or PCBs (Polychlorinated Biphenyls) which have been used in color, sealing and plastic (also in electrical components) as softeners until the 80ies. Both substances are carcinogenic and endocrine disruptors deranging the human hormone system.

However, not only persistent toxins which have already been forbidden for long but also poisonous substances still being in use get trapped in the small suspended plastic particles. Just to mention bisphenol A which is an endocrine disruptor and can trigger genetic mutations or the carcinogenic Polystyrol widely used. Polystyrene or styrofoam exhibits its toxic potential when being chopped into small pieces like this.

First scientific studies have shown the following: As soon as maritime organisms eat this toxic litter the toxins will be released in their stomach during digestion so that the poison can be ingested into the organism. As maritime organisms accumulate these poisons they concentrate in the food chain; - and at the end of the food chain stands the human being.

2. Effects on Human Health

The human being is not only exposed to toxins due to the consumption of maritime organisms. The usage of poisonous base materials for commodity production is not uncommon. We can absorb these toxic materials through the air we breath (smell of new commodities), by abrasion or simply by touching certain products (gluey plastic grips).

In this context hormonally effective substances are of interest, so called endocrine disruptors because they can cause significant harm in very small doses. Hormones have control tasks in our body thus a very small dose can provoke an intense reaction causing significant damage to our health.

Even worse, poisonous materials are used for packing food. Almost all we buy in the supermarket is shrink- or bloat-wrapped into plastic. It is striking that there are exact regulations for food ingredients but only insufficient regulations for the packing of food.

It is not hard to verify that many substances like phthalates, bisphenol A or Acetaldehydes migrate from the wrapping into the food. Would these substances be added directly as ingredients they would have to be declared on the packing. But the consumer notices nothing this way.

Phthalates are plasticizers which are added to synthetics in order to make them more soft. They are, however, not ligated with the plastic polymers but rather freely floating additives which get dispensed into the environment throughout the whole lifetime of the plastics.

Especially Soft-PVC contains high doses of up to 70% of health-damaging plasticizers. If at some time all of the softener has evaporated into the environment the lifetime of the plastics is exhausted and it will fall into pieces. 90% of phthalate production goes into Soft-PVC; only 10% into other types of plastics. That way phthalates can be found in different products like floor coatings, pipes, carpets, artificial leather, nail lacquer, colors, adhesives, cosmetics and even food packings.

Bisphenol A (BPA) is the worlds most used industry chemical. Its application rises in the European Union for about 8% per year.

Bisphenol A stabilizes the plastic package and is furthermore the base material for a special class of plastics, the polycarbonates. Polycarbonates are firm, quasi unbreakable and feature a high temperature resistance of up to 145° Celsius and resistance against acids and oils (use in one way and microwave plates, hard plastics, food packages, translucent household commodities like keys, baby flasks, CD covers, car armatures).

BPA is also used to produce epoxied-resin, adhesives and in small amounts for the flame resistant tetrabrombisphenol A. Beverage cans and can preserved food usually carry an epoxied-resin coating on the inner side. BPA is also in tetra packs, nail polish, thermopaper, in flask caps and even in tooth inlays.

Phthalate as well as bisphenol A can be detected in body fluids and the blood of humans. A study of the Federal Environmental Agency (Dr. Marike Kolossa-Gehring) between 2003 and 2006 has shown that at least 80% of all children ingest more of the five most common phthalates DnBP, DEHP, DiBP, BzBP and DiNP than tolerable for health. Other xenoestrogens that can sum or even exponentiate up the effects with phthalates are not included into this study. Industry chemicals of plastics production were even found in the blood of Amazon-Indians.

Both substance classes, phthalates and bisphenol A can be considered carcinogenic¹, can promote diabetes and obesity and can act as xenoestrogens; this means that they have a similar effect on the body as the hormone estrogen. The already banned persistent pollutants like DDT, PCB and nonylphenol are carcinogenic and xenoestrogens (Nonylphenol was still imported by plasticized cloth printings in 2012).

The consequences are alarming. As the University Clinic of Copenhagen had to ascertain already more than a half of all men have too little or too small spermatozoa to have children without artificial fertilization (means that 50% of all men ca not have children in a natural way.). The number of cancer diseases and malformations is on the constant rise. Dr. Niels Jørgensen, Andrologist of the University Clinic at Copenhagen: "Some of these phthalates and other plasticizers are ingested by pregnant women. They concentrate in the body of the mother

and do thereby also get into the body of the fetus. These substances do consequently take effect on the unborn child especially on the development of the testicles. The consequence: The testicles can not develop properly. We have found out: If this happens in an early stage of fetal development the cells get deranged that badly that the testicles produce only too little spermatozoa later on."

Xenoestrogens like the phthalates do however not only harm the male body. It has for long been observed that girls reach sexual maturity earlier and earlier. Breast cancer and proliferation of uterus (endometrium) is on the rise, not to forget the higher rate of malformations.

2.1. Phthalates

Up to now politics has only reacted with partial thrusts against phthalates which could ameliorate the situation to some extent but which are completely inadequate to tackle the full extent of the problem (basically the situation is still worsening due to increased production amounts).

In 2005 the EU banned DEHP, DBP and BBP from baby articles and child toys which does, however, not apply for imported toys (~80% of all toys).

Why dangerous softeners are forbidden in EU-made toys but still admitted in packings needs to stay an enigma especially as unborn child can suffer from unrecoverable harm by these chemicals.

Even though the standard exposition levels for phthalates in food have been lowered this is not doing good as long as there is no complete ban. For example even award-winning bio-cheese is allowed to be packed and sold in poisonous PVC-packages (always containing high amounts of plasticizers) which can only be spotted by the recycling code at the bottom of the package (products with the Hundertwasser product-certification note are not allowed to contain phthalates.).

DEHP, the most dangerous phthalate should have been eliminated completely from the market in October 2012. Egregiously it has only remained a voluntary self-commitment so that after all industry does use other phthalates to a large extent now.

Now all other phthalates which are also and first of all toxic in a combination or which

¹ f.i. Bisphenol A and Phthalate Enhanced the Growth of Prostate Cancer. - Lee HR, Hyun SH, Jeung EB Choi, KC.

can concentrate in the soil like DINP and DIDP because of their long lifetime are still used.

Since 2007 DEHP, BBP and DBP are on the list of especially dangerous chemicals of the EU-directive REACH which resulted in the obligation to declare these chemicals from 0,1% up.

As the most important softener on the asian market DEHP has arrived at the European consumer because packaging is imported due to the lower provisions for work and environment up to a large extent from China. It helps little if the chemical industry ascertains not to produce DEHP in Europe any more. According to the market research institute Ceresana DEHP still holds an outstanding 54% of the world market.

A relation between obesity, diabetes and the ingestion of certain phthalates has also been proven. According to a current Swedish study certain phthalates promote the development of diabetes melitus type 2. A Mexican study with less participants had preceded. MMP, MiBP and MEP bind to special receptors which control the blood fat and sugar levels. Some of them inhibit the creation of insuline, others seem to promote an insuline resistency as shown by an investigation of the British environment organization ChemTrust in spring 2012.

One of the possibly most dangerous phthalates may be DPHP which damages the thyroid gland and the hypophysis.

2.2. BPA

Besides the well known impact of phthalates another toxine needs to make us alarmed: Bisphenol A, the worlds most used industry chemical.

Bisphenol A harms the development of the brain. That was proven in more than 40 surveys on rodents and in lower concentrations than measured in humans. Newest studies on monkeys have shown that concentrations which were assessed to be save up to now can already influence memory, learning and behavior.

Bisphenol A can derange the immune system. Dr. Eric Haudeau, cell-researcher at the INRA Toxalim Center: Within our organs reside cells that take care that pathogens can not reach our cells. BPA prevents these cells to develop in the embryo. They can no more differentiate between good and bad germs. The whole warning system breaks

down and our body is invaded by pathogens.

The derangement of the immune system could be an explanation for the significant rise in auto-immune diseases, allergies and asthma which can be noted in the developed world.

Exaggerated hygienics is often stated as a reason because children of farmers who grow up in a less germ free environment suffer far less often from allergies and asthma.

However this approach cannot serve as a comprehensive explanation. This can only be part of the reason as children from farmers eat more food out of their own production. The dispensing of poisonous substances from the packaging could therefore be less.

Dr. Eric Haudeau: „The lifetime of an animal simply does not suffice in order to see the full catastrophic impact of BPA on the human organism. We as humans are surrounded by these chemicals for our whole lifetime. The animals are just exposed for a few weeks.”

Furthermore epidemiological studies show a significant correlation between measured BPA concentrations and metabolic diseases like between hart and blood circulation, diabetes and obesity even though the main reasons for these diseases can be found in an unhealthy lifestyle and unhealthy food (too much sugar, too much and especially unhealthy kinds of fat, trans fat, too much salt). Experiments on human fat tissue show that BPA suppresses the hormone Adiponectin.

The fact that the exposition of the population with BPA lies far above the limits deemed as harmless is made clear by a study on female monkeys: In a survey of the University of Missouri-Columbia scientists have fed BPA doses of 400µg/kg body weight which lies eight times above the dose deemed as harmless. In spite of this the BPA content in the blood of the animals was still below the BPA blood content of humans in industry nations 24h after feeding. This points to the fact that BPA can either be resorbed less, degraded faster by monkeys or that humans are exposed to much higher doses. This has to be taken especially into account when considering other studies conducted with monkeys showing risks which could thereby turn out to be more engraving than initially assessed like f.i. the study on learning and behaviour cited above.

Bisphenol A is carcinogenic. The effects can extend up to genetic mutations. BPA is a xenoestrogen like the phthalate DEHP which is also dangerous. Investigations have shown that the chemical is especially harmful in the phases before and after birth and can even have effects on successive generations. At the same time the highest concentrations were measured in children. Many baby flasks were made translucent and hardened by BPA. Children like to put things into their mouth and even many processed products like nut-nougat cremes or jelly babies contain phthalates.

Children react most sensible on chemicals like BPA or phthalates and the harm caused from these chemicals is considerable.

2.3. Invitation to Act

Even though the effects of different phthalates is by various means different phthalates do have the effect of endocrine disruptors in common. DEHP makes infertile, DPHP takes effect on the thyroid gland and on the hypophysis, MMP, MiBP und MEP promote metabolic diseases.

Whatever may be the effects of a specific phthalate they all have their effect as endocrine disruptor in common. Phthalates are a dangerous class of chemicals that should be banned from products of daily use.

Due to the epidemiological dimension, the extent of the problem and the fact that many substances like DEHP, BPA and some pesticides can act as xenoestrogens an instantaneous and comprehensive ban of all xenoestrogens would be direly required.

An instantaneous prohibition would also make sense for DPHP (effects on the thyroid gland and the hypophysis). In the future the chemical industry will have to avoid the use of these substances f.i. using softeners made of plant oil.

The use of bisphenol A needs to be banned in goods of daily use because of its high poisonousness. Much of the harmfulness of BPA is due to the fact that it can be assimilated through the human skin and that packings dispense this substance which is especially harmful in the case of food storage. The usage of bisphenol A needs to be bounded strictly due to its overflowing amount.

Instead of chemicals made of BPA many

traditional materials like glass, ceramic, stoneware and wood would have to be reused.

The same applies to PVC which can only be made usable by a high share of plasticizers for many application purposes. PVC poses a problem at waste disposal because it can not be recycled. When being burnt dioxin emerges because of the high content of chlorine. Salts remaining in the filter need to be disposed as special hazardous waste.

An imperative claim is also the obligation to declare all substances, at least those used in the packaging of food. It is well known that fat-dissolving additives do migrate into food. The only thing the consumer can find out about the packaging at the moment is the recycling code at the bottom which is usually directly impressed into the plastic. It gives a coarse information about the kind of plastic being used but nothing about possible additives like the softeners discussed (plastic foil does f.i. also use release agent).

The claim for an obligatory declaration of all additives is not only important because additives can migrate and be released into the environment but more than this because additives are often used unnecessarily. It is possible to influence the properties of the resulting material by control of pressure and temperature during polymerization up to a very large extent completely without the usage of additives. By use of the correct pressing technique polystyrene can be substituted by nontoxic polyethylene and polypropylene up to a large extent. This way the consumer could contribute in banning toxic materials without a law which is always hard to realize.

In order to reduce the effect of synthetics on the environment the use of biodegradable plastics would be necessary.

Politics have not reacted appropriately on the threat to humans and their environment by industrial chemicals.

Joe Hennon, speaker of the European environmental commission: „We do work with priority on violations of the EU environment rules especially against violations against the EU chemistry regulation REACH. At the moment we are very unsatisfied with the number of chemicals that are listed and tested accordingly. This is a serious problem.“

More than this the enforcement through

27 EU member states, the parliament and the commission is difficult and long lasting.

“ ... there are many different international administrations, rules and cultures; and there is the industry lobby.”

The EU does have difficulties with prohibitions because of the trade rules of the WTO. Those are mercilessly undercutting global standards for work, health and environment.

The EU is not able to stop the import of poisonous goods because this can be deemed a violation of trade rules of the WTO. The only possibility is to repeatedly ask the trade partners to ban poisonous products of their products whereby it is not possible to test each product. Fortunately the EU could use its dominant position in foreign trade to ameliorate the situation.

Regarding the actual legal situation the protection of the consumer still remains unsatisfied. Not even the implementation of current regulations like REACH is guaranteed.

Since July 1st, 2007 the regulatory framework REACH is in power. It should have protected us comprehensively from dangerous chemicals for the future.

By the fact that REACH is also valid for products imported into the EU REACH was watered down under massive pressure of the USA and Japan.

There is no more mandatory substitution (i.e. abolishment) of carcinogenic, generatively harmful (among other things harming fecundity) and for chemicals being dangerous for other reasons like the phthalates or bisphenol A which were discussed in this article (this has been dropped due to pressure from the USA and Japan).

Only long-living, bio-accumulating substances need to be substituted obligatory. Instead something called “adequate control” has come into force. However this effort remains illusive because now these materials can already be found in places where they should not be like in mother-milk, in blood, in food and drinking water.

The no more precisely defined “adequate control” opens the flood gate to the demands of the industry (more precise definition has been watered down by industry pressure).

The obligation to give information is not good in practice in its current form because it is not applied in shops and there is no need

to print the information on the packaging. Information about ingredients or used substances need to be retrieved from the producer and not before the article has been purchased. It is furthermore only applied to 1.500 chemicals of high risk.

The liability of the industry has been zeroed which may especially come into effect when the industry conducts studies on its own². However, it needs to be noted that chemicals used at a higher quantity can no more be marketed untestedly.

Unfortunately there is only very little the consumer can do in order to save himself from chemicals like BPA and phthalates in packaging and other objects.

Prof. Dr. Gerd Glaeske, pharmacologist at the University of Bremen recommends: “People should consider to avoid plastic-wrapped goods. One should rather make unpacked purchases. This is most important especially when there are children in the household.”

Food with a lot of grease (fat) like cheese are especially affected. Fats and oils dissolve plasticizers (softeners) or other additives out of the packaging and accumulate them. Whenever possible one should also refrain from tins and canned food because at the customary high temperature filling process high amounts of BPA out of the inner coating made of synthetic resin can be dissolved.

Even many milk and juice packages are coated with plastic on the inner side that can dissolve high amounts of additives especially in fatty milk or sour juice. For this reason many orange juice producers have switched in the last years from plastic to aluminium coating (though somewhat more expensive).

More than pesticides which can be washed off are packagings contaminating our food.

The voluntary self commitment of the industry has already failed in the 1950ies. Some phone calls of worried consumers are appeased in a minute. What is needed are rigorous legal provisions, the full political work assignment and the full power of the EU, its member states and as many other

2 Frederick vom Saal (University of Missouri, USA) to the surveys about BPA: „the result of a survey seems to depend on who has financed the studies.“ - 138 of 152 public surveys found out about the harmfulness of BPA in the zone of low doses but none of 11 studies conducted by the industry which politicians like to point to.

countries as possible. The industry lobby does not sleep. It always tries to scoop out new regulations by “adaptions” or to fully circumvent new regulations whenever control is cumbersome or lacking.

Citizens and consumers must show that they do care about these facts. They must draw consequences and ask politicians to



Do not buy products made of poisonous PVC (see for the recycling code at the bottom of your package). Try to shun PC (Polycarbonate).

act. The fact that politicians have failed to reduce the pollution with phthalates and BPA is evident when the industry assumes a “drastic increase in the demand” for these substances and wants to increase the production solely of phthalates until 2018 up to 7,6 megatons per year.

If we reason that we are surrounded by plastics and other synthetics for a whole life we do also need to think about currently known and possible effective consequences. Our health and our environment are the highest goods available to humanity.

Sources/Reference: online documents to the film „Plastic World“, scinexx.de: Müllkippe Meer, various film and video contributions and interviews, die Welt: Wissen am 14.August 2012, www.pubmed.org, online documentation of Greenpeace and other environmental organizations.

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