Public Safety Notice

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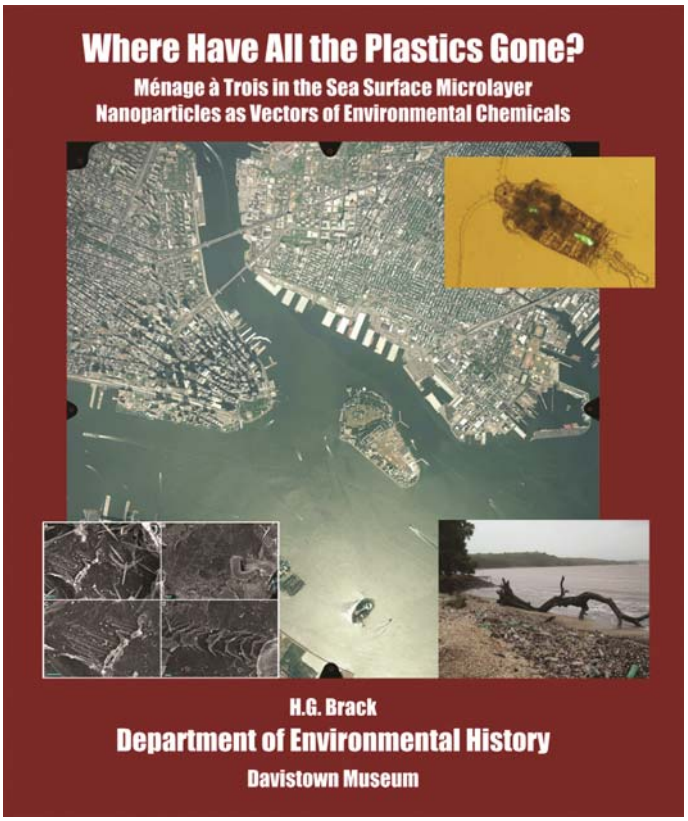
Hazardous Material Alert

Plastic nanoparticles (±50nm to 200nm) as vectors of **environmental chemicals** (e.g. persistent organic pollutants [POPs])

A detailed review of the literature pertaining to nanoparticles is published in *Where Have All the Plastics Gone? Ménage à Trois in the Sea Surface Microlayer: Nanoparticles as Vectors of Environmental Chemicals.*

Plastic nanoparticles (PNP) are derived from plastic wastes, including the well-known microbeads released by cosmetics, and become a hazardous material due to diminishing surface area and increasing surface to mass ratio, which results in the rapid increase of the sorption (absorption and/or adsorption) of environmental chemicals. Ecotoxic PNP are then ingested by heterotrophic grazing microbes and are biomagnified in marine and other food webs. Plastic nanoparticles are an additional invisible vector for the movement of environmental chemicals throughout the biosphere, and raise public safety issues of compelling contemporary interest to all concerned citizens.



- The Age of Plastic (after 1950) has resulted in the production of in excess of 3 billion tons of plastics used in the production of consumer and industrial products of every description.
- At least 200 million tons of plastic debris has been deposited in the marine environment since 1950, of which 10% or less can now be documented in oceanic gyres such as the great Pacific garbage patch.
- Plastic nanoparticles rapidly sorb environmental chemicals such as organochlorines, organophosphates, methylmercury, and other lipophilic (fat-loving) hydrophobic (water-hating) anthropogenic (manmade) ecotoxins.
- The Centers for Disease Control has documented the presence of these environmental chemicals in human cord blood, serum, and urine.
- PNP are an additional invisible pathway for the transport of environmental chemicals through all trophic levels of the biosphere. Marine and freshwater fisheries are especially susceptible to contamination by invisible plastic nanoparticles, which are difficult to measure, and whose chemical content and movement within the hemispheric water cycle cannot be mitigated by legislation, concerned citizen meetings, or Paris climate conferences.

This publication is available from Amazon.com

Comments and corrections, as well as 501 (c)(3) donations to support this publication are welcomed
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The unfortunate consequence of the evolution of PNPs from plastic debris

Among the many useful functions of synthetic nanoparticles is the application of highly sorbent nanosized iron particles for environmental cleanup procedures (Tratnyek 2006, 44). Many other synthetic nanoparticles have numerous useful biomedical, consumer product, electronic, cosmetic, clothing, paint, and food packaging applications. Unfortunately, end of life synthetic nanoparticles have the same harmful characteristics as plastic nanoparticles: they also sorb environmental chemicals at increasing rates as their surface to mass ratio increases. The bad news: nanosized iron is applied to specific contaminated areas; ecotoxic plastic nanoparticles are now moving throughout all microbiomes and trophic levels of the biosphere.

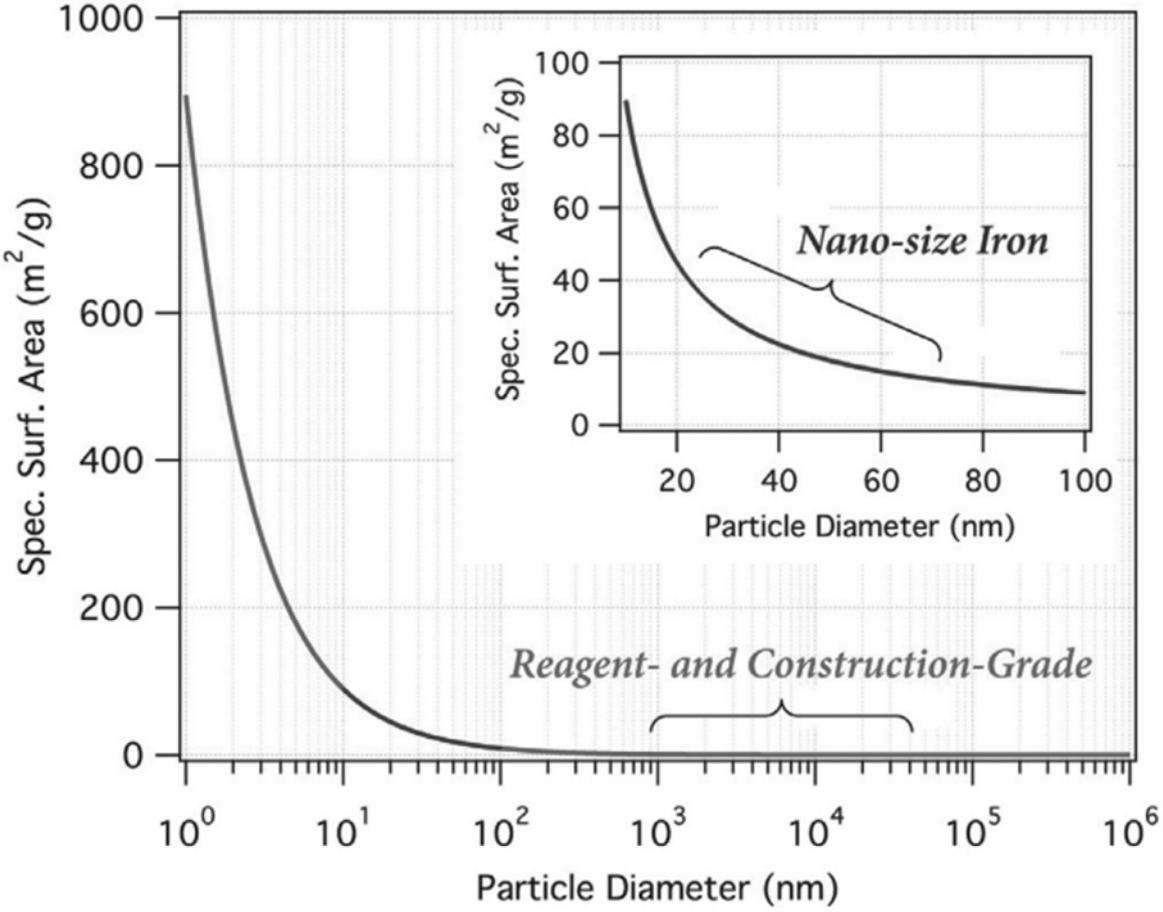

Fig. 2 Particle surface area calculated from diameter assuming spherical geometry and density 6.7 g/cm³ (based on the average of densities for pure Fe^0 and Fe_3O_4).

Reprinted from *Nanotoday*, 1(2), Tratnyek, P. and Johnson, R. Nanotechnologies for environmental cleanup, pg. 46, Copyright 2006, with permission from Elsevier.

“Nanoparticles in the environment could constitute a completely new class of non-biodegradable pollutants… [They are] highly reactive nanoparticles which, because of their small size, can have a total surface area measuring up to 1,000 square meters per gram.” (Annabelle Hett, 2004, *Nanotechnology: Small matter, many unknowns*. Swiss Reinsurance Company. Zurich, Switzerland)

Hazardous Material Alert Update
Microbeads vs. plastic nanoparticles (PNP)

On December 23rd, 2015, the U.S. Congress enacted the **Microbead-Free Waters Act of 2015**, including a ban on microbead manufacturing after July 1st, 2017 and delivery after July 1st, 2018. This ban applies to microbeads used for "rinse-off cosmetics" and to "exfoliate or cleanse the human body," including toothpaste. Microbeads are defined as "any solid plastic particles…less than 5 mm in size" (5 mm = 5,000 µm = 5,000,000 nm). Most plastic microbeads used in commercial applications have a size range of 10 µm to 1,000 µm, and are commonly 100 um (1 µm = 1 micron = microns = 1/1,000,000th of a meter as measured by a micrometer).

Microbeads are considered a hazardous plastic substance because once released to the environment they sorb and transport environmental chemicals. Plastic microbeads are one of thousands of types of sorbent microplastic debris now present in all aquatic and terrestrial environments. Microplastic wastes are transformed into plastic nanoparticles (PNP) by abrasion and photodegradation; their proportionate sorption of environmental chemicals increases as their size becomes smaller. Degredation time may be ±10 years.

Please be advised there are **±4,000 microbeads** in a bottle of "rinse-off cosmetics." A typical microbead is 100 µm (a 100 µm microbead = 100,000 nm).
Question: How many 100 nm plastic nanoparticles will theoretically fit into a 100 µm microbead? **Answer: 1,000,000,045 (over 1 billion).**
Question: How many 100 nm plastic nanoparticles can be theoretically contained in the 4,000 microbeads in your jar of cosmetics? **Answer: 4,000,000,180,000 (4 trillion+).**

Problems:

- **Evaluation of environmental chemicals sorbed by plastic nanoparticles is extremely difficult due to small particle (PNP) size, e.g. ± 100 nm.**
- **The large number of environmental chemicals (± 100,000) now moving throughout the biosphere**
- **The difficulty and cost of measuring tiny amounts of environmental chemicals in PNP or other media**

Most environmental chemicals in food web nanoparticles will be well below any MCL (Maximum Contaminant Level) for EPA listed chemicals of concern. As noted in the New York Times (January 10th, 2016), most environmental (e.g. industrial) chemicals remain unevaluated for their toxicity (Legislation re: Toxic Substances Control Act pending in Congress may or may not address this issue).

Conclusion:

There are a lot more hazardous plastic nanoparticles (PNP) (size range 20 nm – 200 nm) moving throughout our hemispheric water cycle, including all food webs, than have been reported in most scientific journals and all media (eg., Nature, Science, NY Times, CNN, Huffington Post, etc.). The words "plastic nanoparticle" have yet to appear in the printed version of the New York Times.

Please see our commentary on plastic nanoparticles, including those on 20 nm PNP polymer spaghetti loops (see illustration below) in *Where Have All the Plastics Gone?*

Theoretical form of an end of life plastic polymer which is still able to sorb and transport environmental chemicals. This spaghetti shape may also characterize plastic polymers in any plastic nanoparticles. Note: Unlike PNP fragments in the environment, this illustration is actually made up of a ball of electrical wires.

What you can do:

- Purchase a copy of **Where Have All the Plastics Gone?** and read it. It can be purchased on Amazon.com. Please ask your concerned friends to inform others of the huge numbers of plastic nanoparticles now moving through all food chains.

- Make a tax deductible donation to the **Davistown Museum** to support the work of the **environmental history department**, care of davistownmuseum.org. Don't forget to visit our site online and enjoy a photo tour of the museum collections.

- Call the New York Times and ask them to provide more accurate media coverage on the increasing but invisible presence of ecotoxin-laden **plastic nanoparticles** in our food and water, including fisheries. This term has not yet appeared in the printed version of the New York Times.

For more information, comments and corrections, contact H.G. "Skip" Brack, department of environmental history, at curator@davistownmuseum.org