

Nanna B. Hartmann, DTU Sustain  
ATV Vintermøde 2026

# Plast: fra gavn til gru





Image: The Royal Ontario  
Museum/Veronica Di Cecco

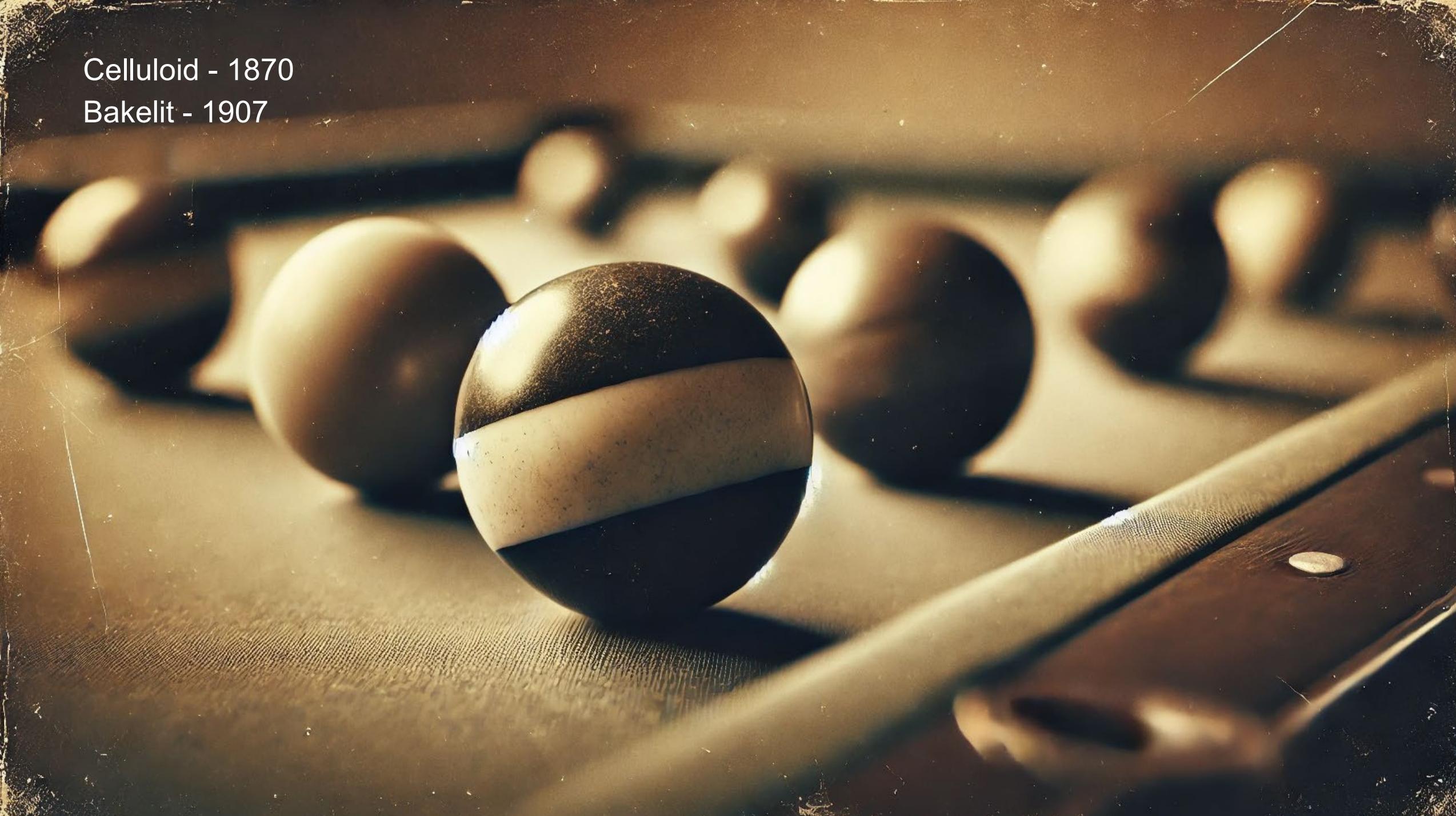






Celluloid - 1870

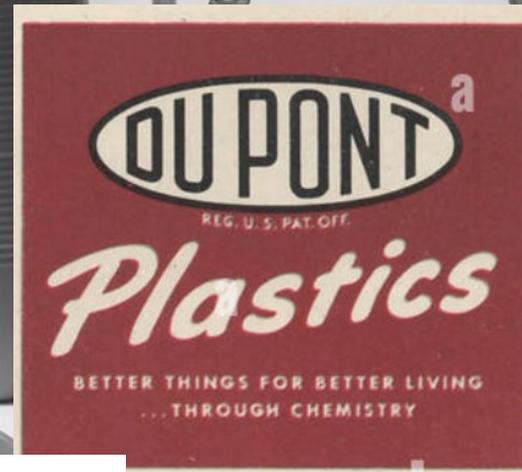
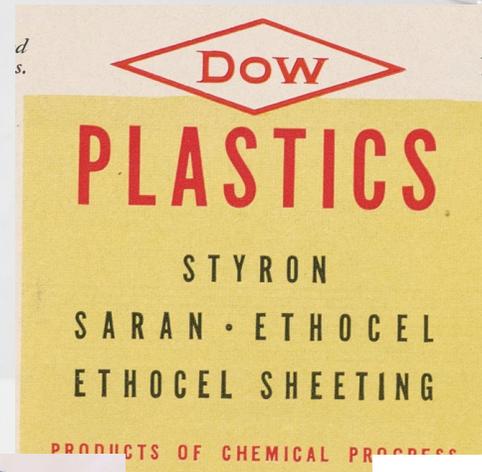
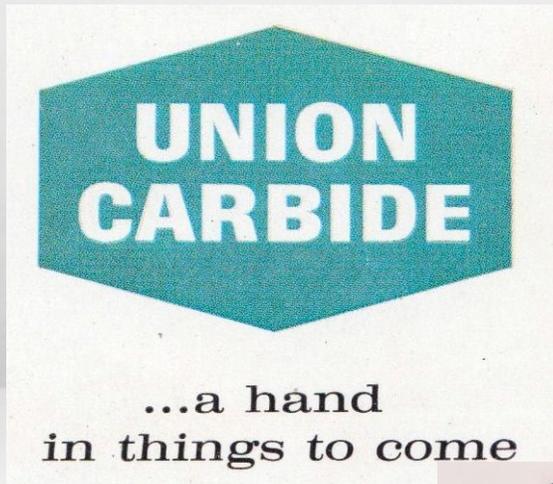
Bakelit - 1907



1950'erne:

Nylon, polyethylen og polystyren var fuldt udviklede. Innovation drevet af militære formål og nødvendig substitution.

Den kemiske industri muliggjorde masseproduktion af plast, som fik status som "fremtidens materiale".



# Den eksklusive plast – demokratiseret luksus

PUNCH, OF THE LONDON CHRYSTAL—DECEMBER 7, 1931

*Be Unique*

GIVE 'BEAUTYWARE'  
THIS CHRISTMAS

**B**EAUTIFUL. In highly polished Bakelite. Gracefully shaped jug. Smart modern tray. Exquisite crystal tumblers.

**C**OLOURFUL. In rosewood, walnut, blue and red, black and green, red flecked dark red, orange flecked dark orange, green flecked dark green.

**S**ERVICEABLE. Jug lined with patent almost-unbreakable "Thermos" lining. "Always-ready" hot or cold drinks . . . in dining-room, library, card-room, billiard-room or bedroom. EVERY room needs a "Thermos" Bakelite Service Set.

**R**EASONABLE. Complete Sets. Pint size, 45/-. Quart size, 55/-.

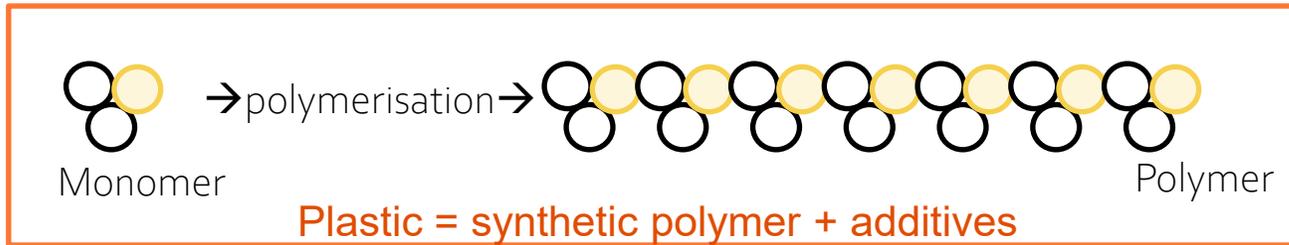
**THERMOS**  
BAKELITE SERVICE SET

NEW "THERMOS" No. 17 FLASK in the same delightful colours and finish as the "Thermos" Bakelite Service Set above. Pint size, 8/6. Quart size, 14/6. This flask carries the usual "Thermos" guarantee—hot for 24 hours, ice cold for three days.

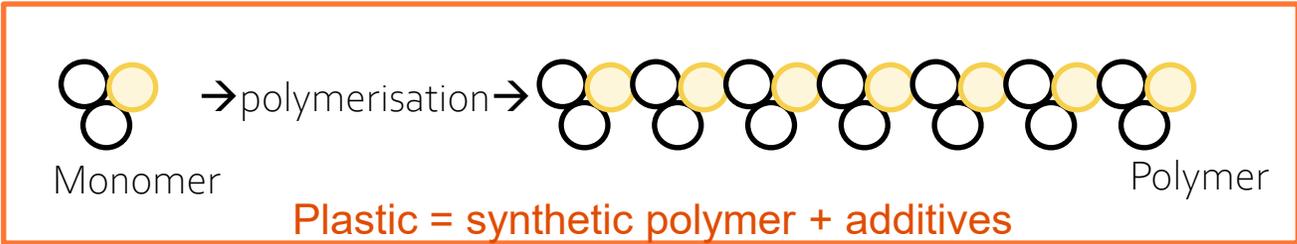
Obtainable from all the leading London Stores or from the best shop in your Town.  
THERMOS (1925) LTD., 45, ALDERMANBURY, LONDON, E.C.2



# Plastic fantastic – hvordan det hele begyndte...



# Plastic fantastic – hvordan det hele begyndte...



## Throwaway Living

### DISPOSABLE ITEMS CUT DOWN HOUSEHOLD CHORES

The objects flying through the air in this picture would take 40 hours to clean—except that no housewife need bother. They are all meant to be thrown away after use. Many are new; others, such as paper plates and towels, have been around a long time but are now being made more attractive.

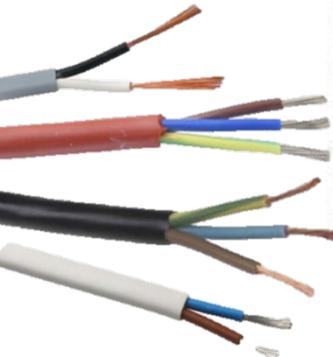
At the bottom of the picture, to the left of a New York City Department of Sanitation trash can, are some throwaway vases and flowers, popcorn that pops in its own pan. Moving clockwise around the photograph come assorted frozen food containers,

a checkered paper napkin, a disposable diaper (seriously suggested as one reason for a rise in the U.S. birth rate) and, behind it, a baby's bib. At top are throwaway water wings, foil pans, paper tablecloth, guest towels and a sectional plate. At right is an all-purpose bucket and, scattered throughout the picture, paper cups for beer and highballs. In the basket are throwaway draperies, ash trays, garbage bags, hot pads, mats and a feeding dish for dogs. At the base of the basket are two items for hunters to throw away: disposable goose and duck decoys.

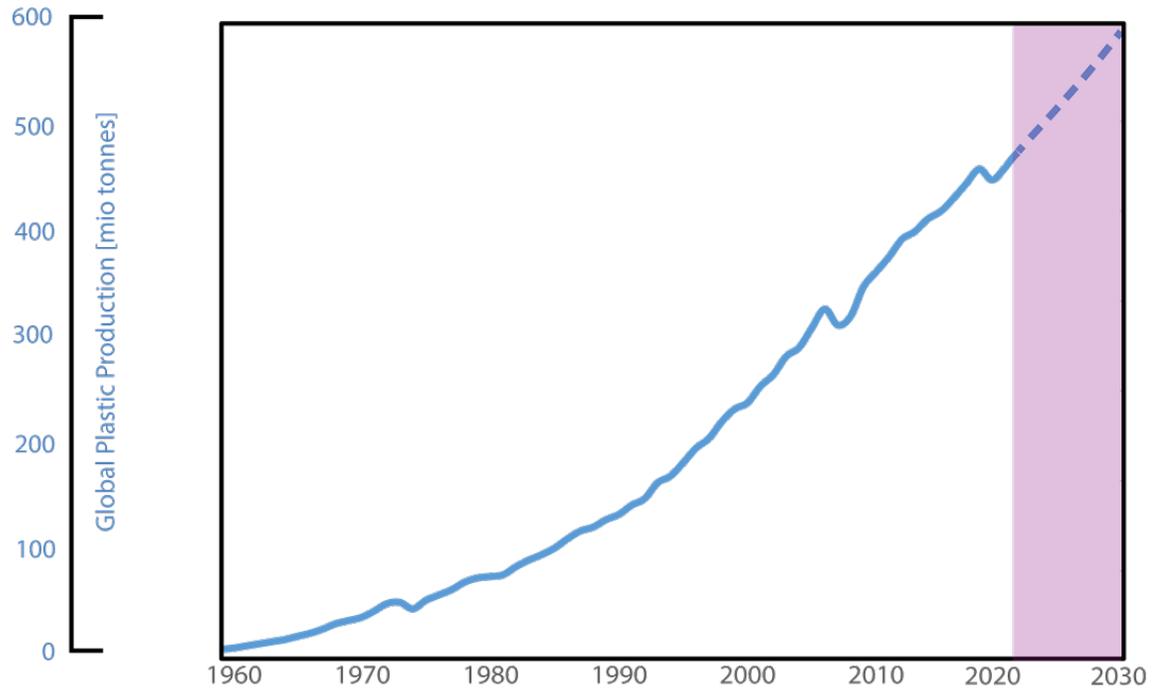
CONTINUED



Life Magazine 1955



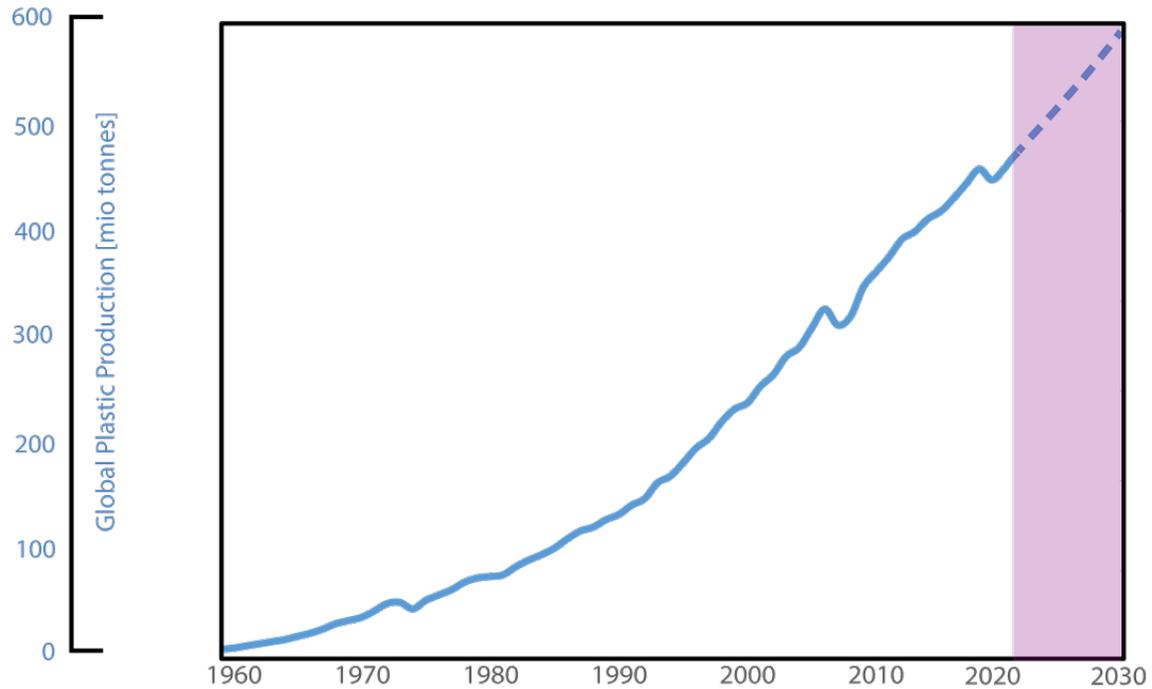
# “Plastocænen”



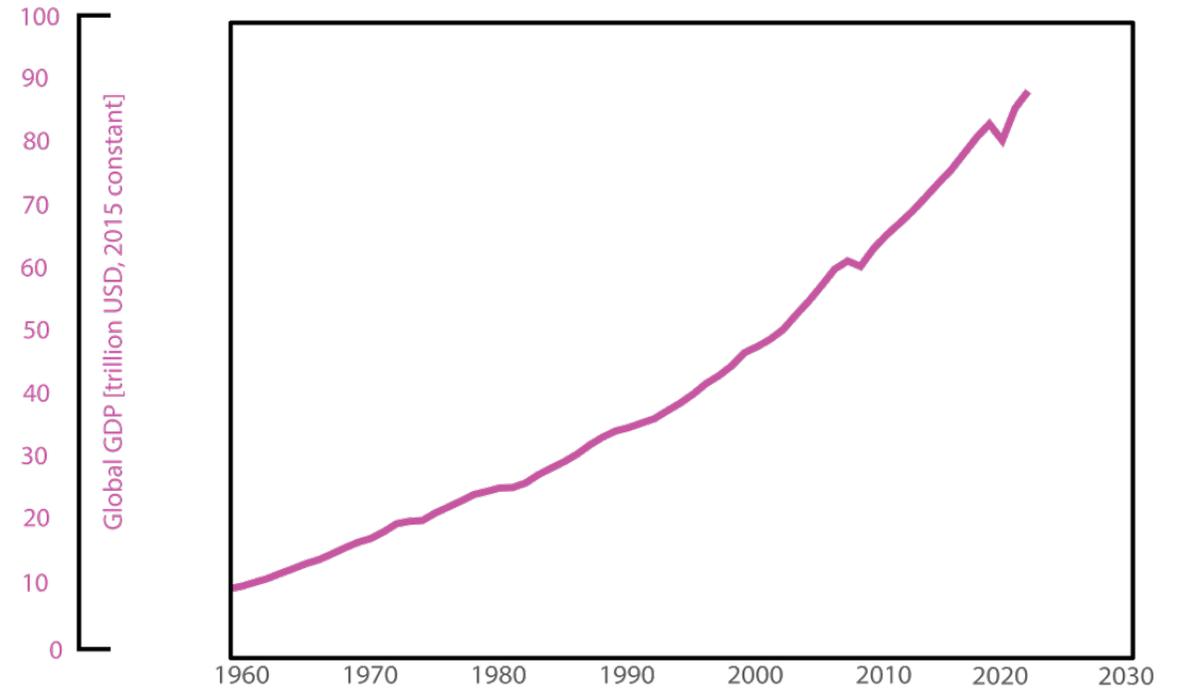
**Global plastic production**

Hartmann et. al, Plastics in a Context of the Triple Planetary Crisis, manuscript in prep

# “Plastocænen”



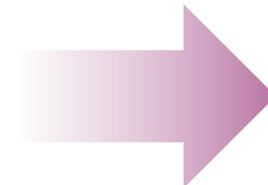
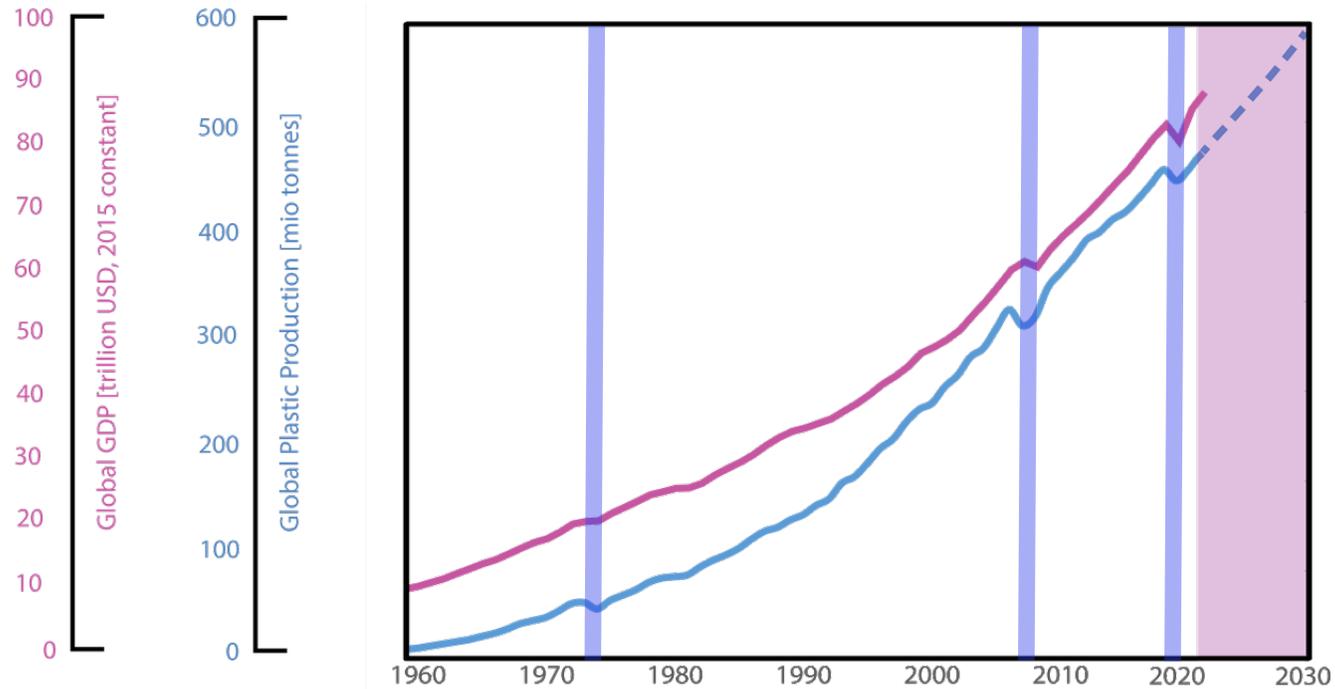
**Global plastic production**



**Global Economic Growth  
(measured as Gross Domestic Product, GDP)**

Hartmann et. al, Plastics in a Context of the Triple Planetary Crisis, manuscript in prep

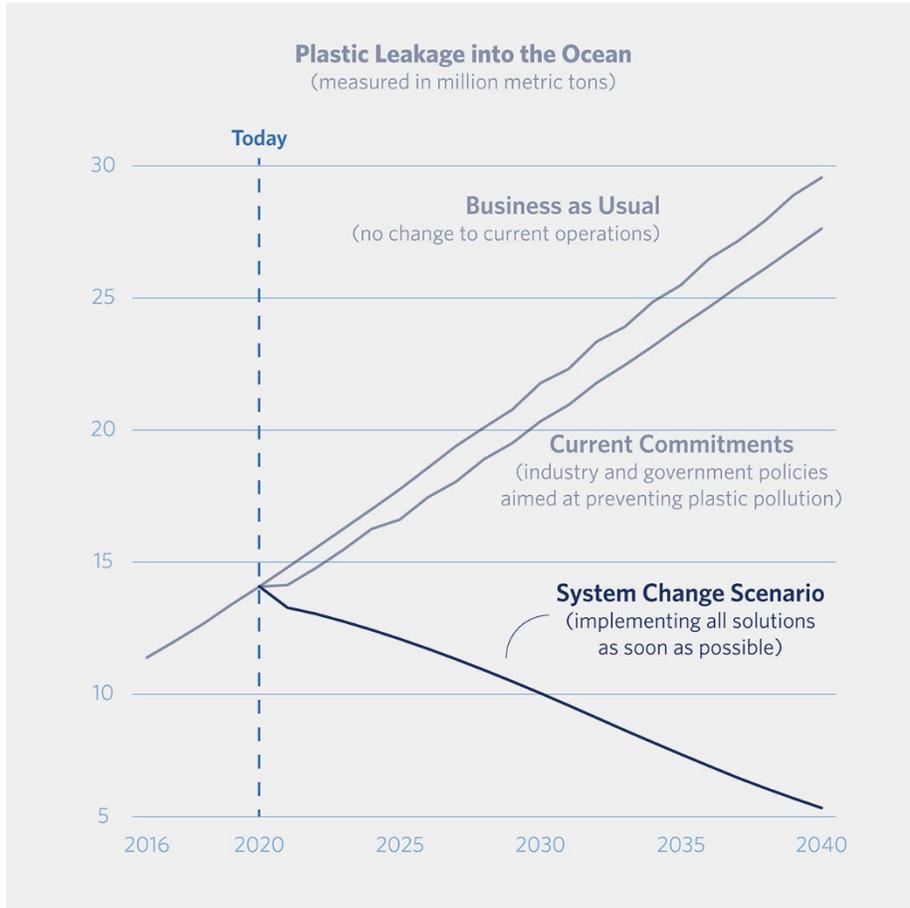
# “Plastocænen”



Hartmann et. al, Plastics in a Context of the Triple Planetary Crisis, manuscript in prep

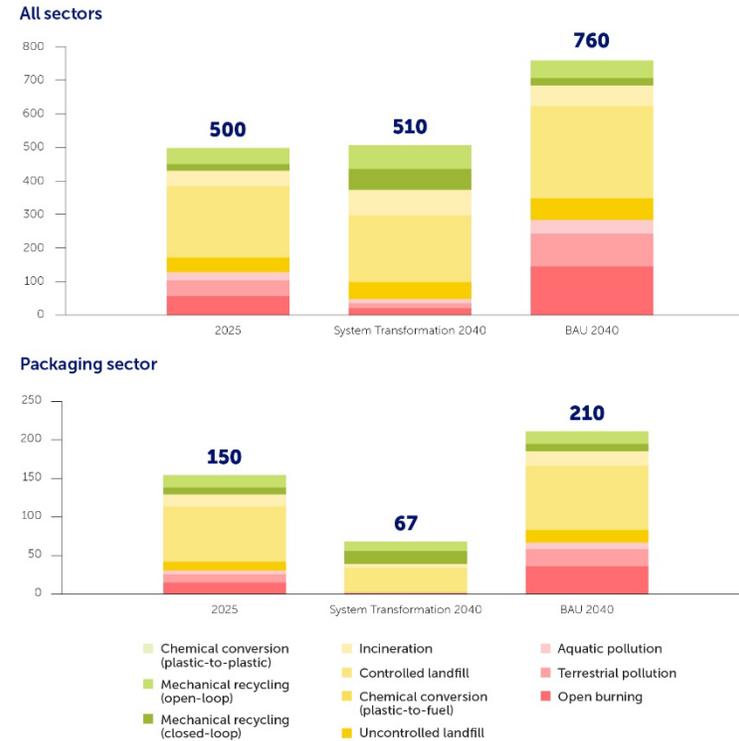


# Systemproblem kræver system transformation



Breaking the Plastic Wave 2020

**Figure 2: Existing Strategies, Implemented at Scale, Can Substantially Reduce Plastic Pollution**  
System Transformation outcomes for all economic sectors and for packaging only in Mt per year, 2025 and by scenario 2040



© 2025 The Pew Charitable Trusts

Breaking the Plastic Wave 2025



# System transformation

## Produktion

- ↓ Fossil råstof & primær plast
- Udfasning af subsidier til olie og petrokemi
- Kemikalietransparens & polymer-standardisering

## Marked & Design

- Design for genbrug/genanvendelse
- Mindre emballage & refill
- Producentansvar & nye forretningsmodeller

## Forbrug & Affald

- Global infrastruktur
- ↑ Indsamling & høj kvalitet genanvendelse
- ↓ Miljølækage

Plastproblemet er strukturelt – ikke kun teknisk

Kræver systemisk omstilling af hele værdikæden – ikke kun affaldshåndtering

Ændringer er nødvendige både opstrøms og nedstrøms



MAKE LESS

Reuse

Recycle

Replace

Recover

MAKE BETTER



📷 Rediger coverbillede



# Modern Society

520 venner

+ Tilføj i story

✎ Rediger profil



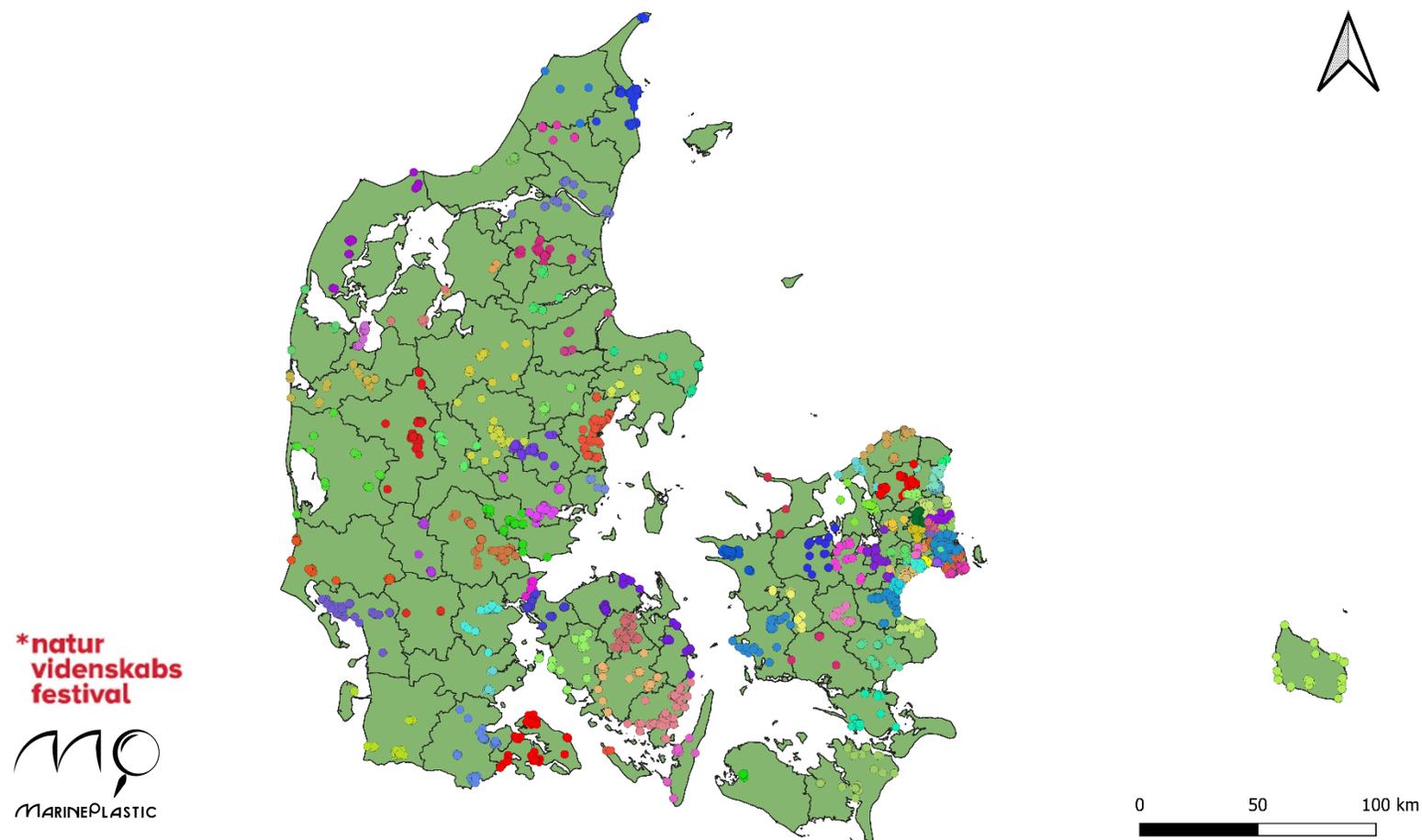
## Basic Information

### Relationship Status

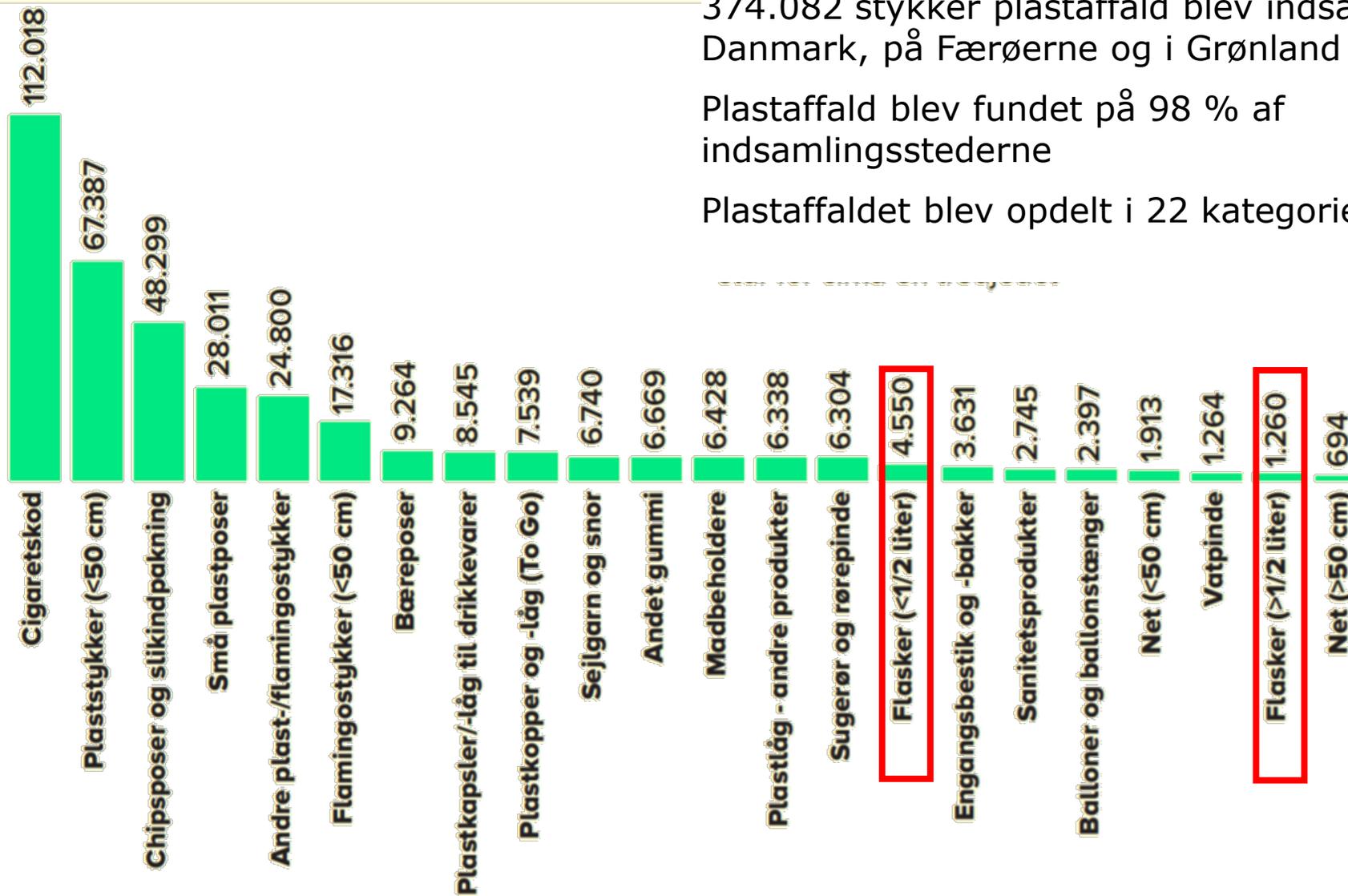
- Single
- In a Relationship
- Engaged
- Married
- It's Complicated
- In an Open Relationship
- Widowed
- Separated
- Divorced
- In a Civil Union
- In a Domestic Partnership



# Masseeksperimentet 2019



Syberg, K., Palmqvist, A., Khan, F.R., Strand, J., Vollertsen, J., Clausen, L.P.W., Feld, L., Hartmann, N.B., Oturai, N., Møller, S. and Nielsen, T.G., 2020. A nationwide assessment of plastic pollution in the Danish realm using citizen science. *Scientific reports*, 10(1), p.17773.

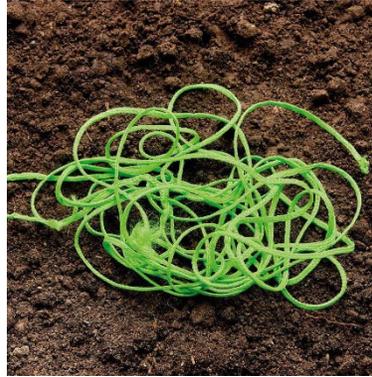


374.082 stykker plastaffald blev indsamlet i Danmark, på Færøerne og i Grønland

Plastaffald blev fundet på 98 % af indsamlingsstederne

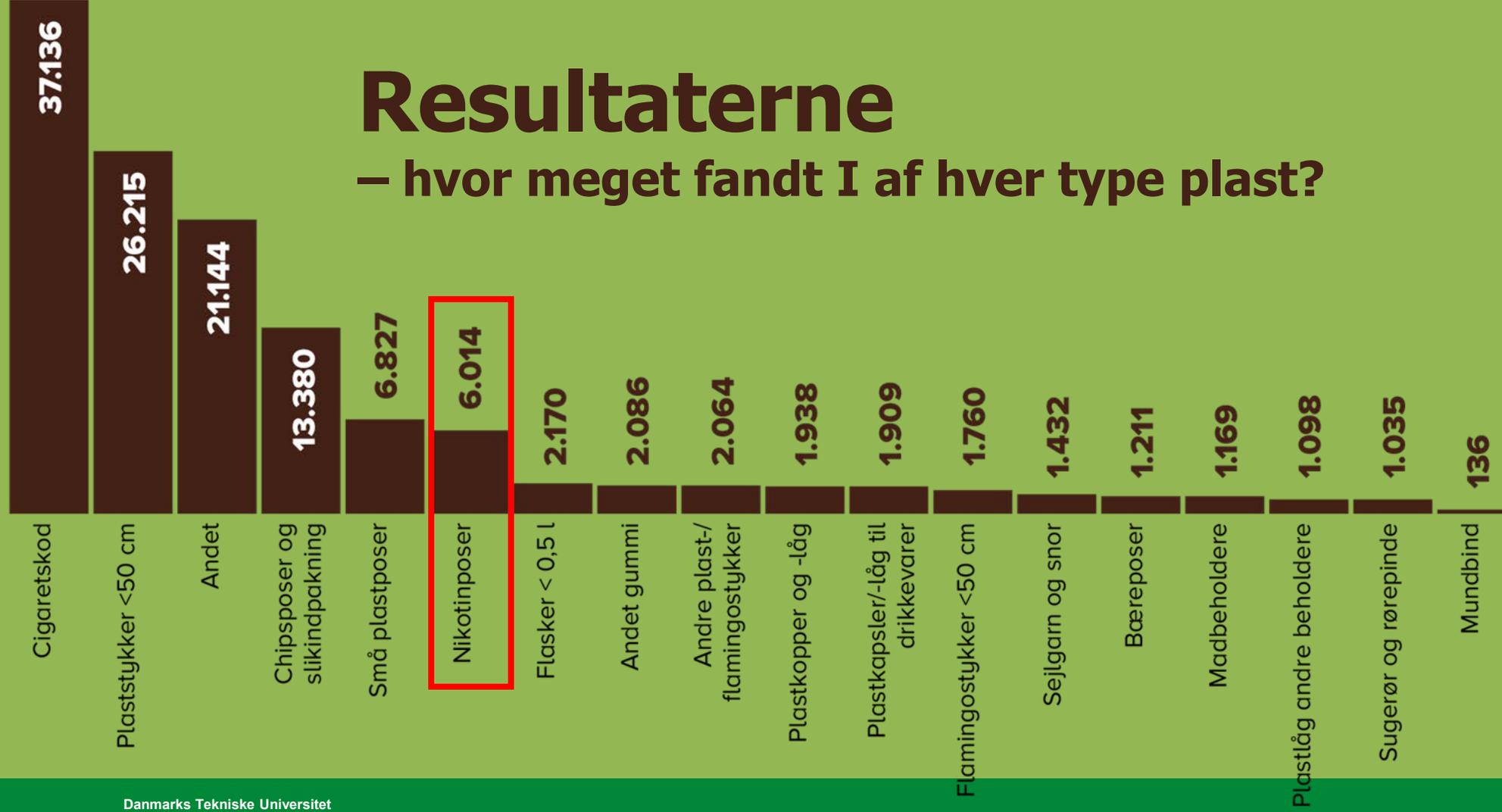
Plastaffaldet blev opdelt i 22 kategorier:





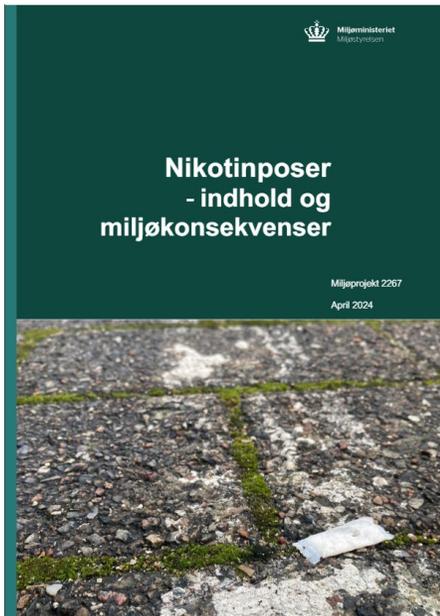
# Resultaterne

– hvor meget fandt I af hver type plast?



# Nikotikposer i naturen – hvad er omfanget?

Estimat: 5.3 mio poser ender i den danske natur hvert år...



Kaskelot – Biologiforbundet – næste nummer...

## Nikotinposer: det nye cigaretskod

Snus, snulle, daus, madpakke, træstamme, et stykke til overkøjen... kært barn har mange navne! Nikotinposer, og andre røgfrie nikotinprodukter, bliver stadig mere populære. Desværre ses de også oftere som henkastet affald i byer og i naturen. Dette er ikke kun et æstetisk gene, men kan også skade miljøet.

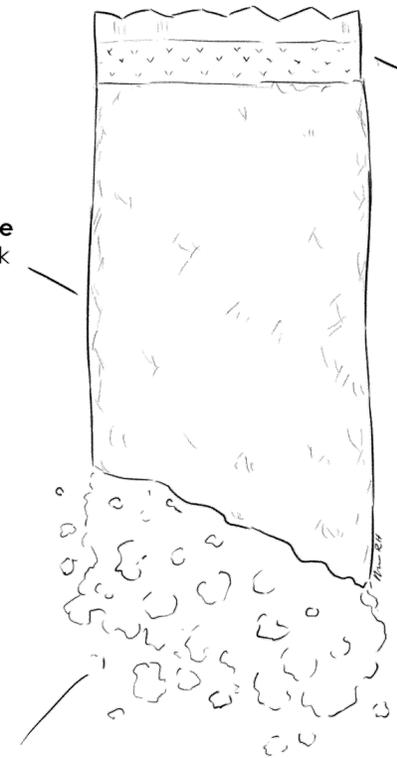
Tekst af Nanna Bloch Hartmann  
Illustrationer af Marie Rubæk Holm

Illustration: Marie Rubæk-Holm //Kaskelot

# Posematerialet



**Posemateriale**  
Semi-syntetisk  
cellulose

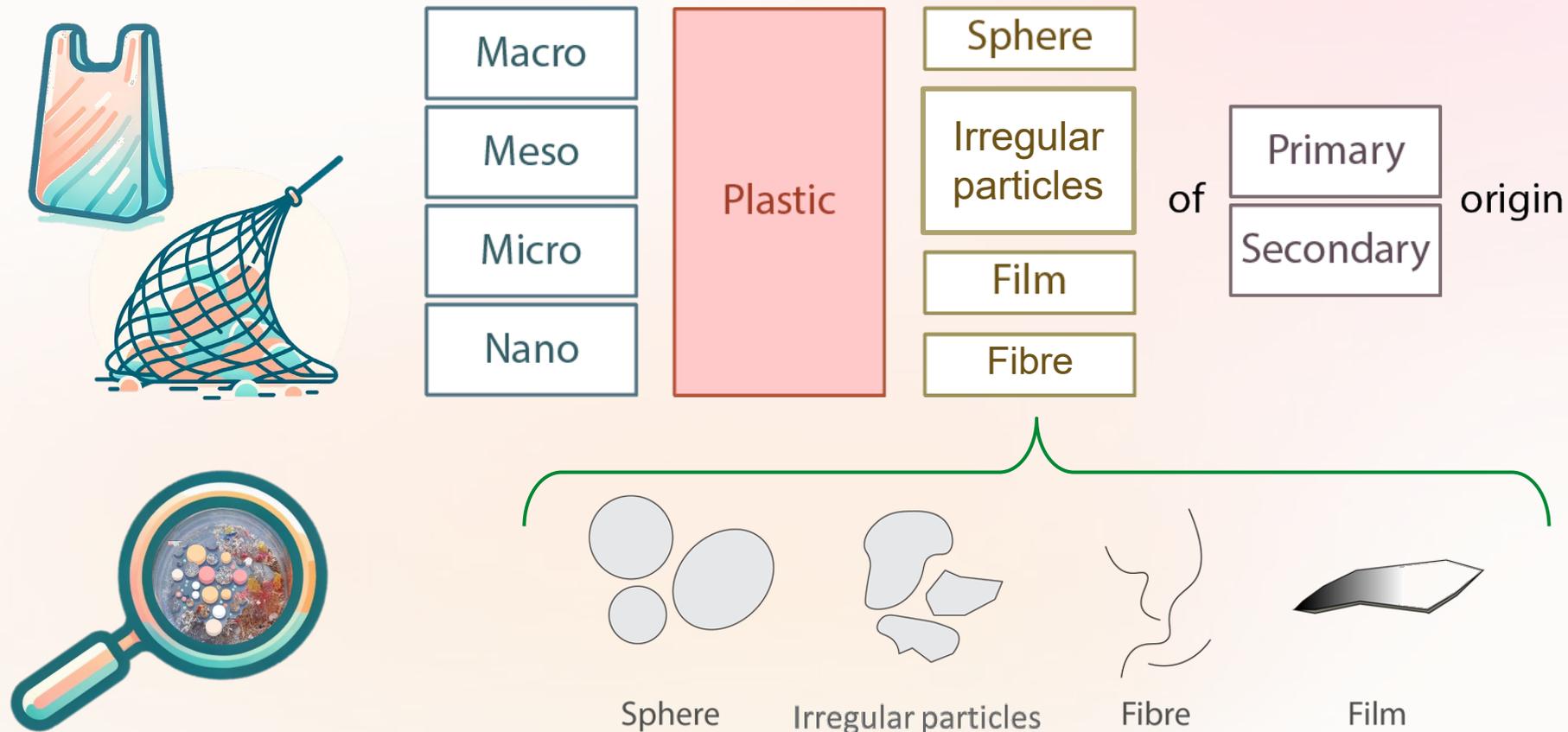


**Bindemiddel**  
polymer, som  
smelter ved  
opvarmning og  
forsegler posens  
kanter

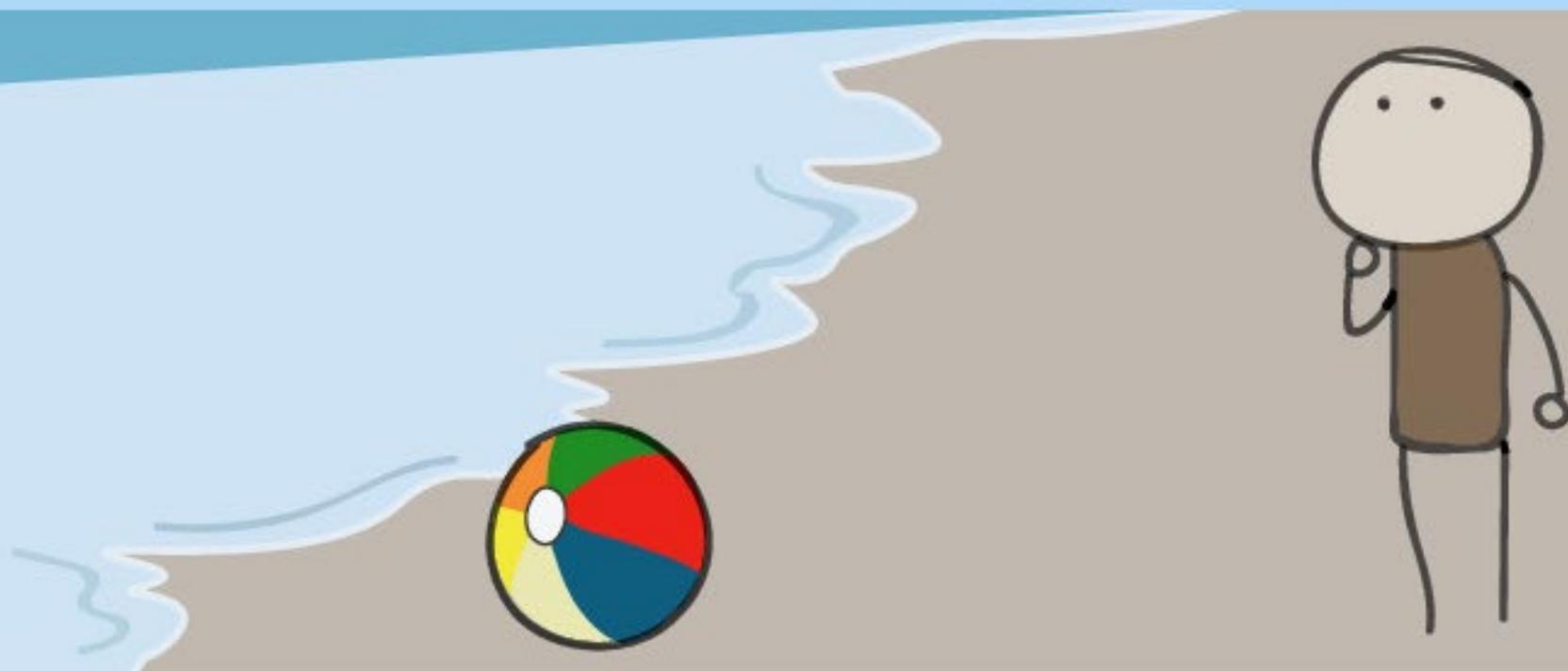
**Fyld**  
Fyldmateriale af cellulose hvortil  
nikotin binder sig.  
Derudover er der smagsstoffer,  
antioksidanter, sødestoffer,  
konserveringsmidler m.m.

Illustration: Marie Rubæk-Holm //Kaskelot

# Definitioner og typer af plastaffald



# Spherical macroplastic?





It is suggested that the wax fingers represent the preserved record of a conduction path which became molten during the atmospheric phenomenon usually referred to as brush discharge. To test that hypothesis, pine needle specimens were mounted on one of a pair of electrodes in a closed system and subjected to various electrical gradients in the laboratory. In each case carbon-coated disks were attached to the opposite electrodes, and the collected particulates were replicated and examined with an electron microscope. Particles collected when the pine needle was raised to a potential of 20 kv with respect to a flat plate 20 cm away are shown in the electron micrograph (Fig.

The plastics were collected with a neuston net (3), 1 m in diameter with 0.33-mm meshes, towed at 2 knots (1 knot = 1.85 km/hour) on cruise 62 of the *Atlantis II* (27 September to 18 October 1971). The particles of plastic were manually sorted from the contents of the neuston tows; they were counted and their weights were determined on shore with a Mettler H 15 balance. Plastics were present in all 11 neuston tows (Table 1). Their occurrence was widespread, since the distance from the southernmost to the northernmost tow was 1300 km.

There were, on the average, about 3500 plastic particles per square kilometer (the range was from 50 to 12,000). This density gives a mean of one particle per 280 m<sup>2</sup> and a maximum of one particle per 80 m<sup>2</sup>. The weight per square kilometer was from 1 to 1800 g and averaged about 290 g. The lowest concentrations were observed at stations 10 and 11, as we began to enter the Gulf Stream.

Most of the pieces were hard, white cylindrical pellets, about 0.25 to 0.5 cm in diameter, with rounded ends (Fig. 1). Chemical weathering and wave action may have produced the pellet shape. Many pieces were brittle, which suggests that the plasticizers had been lost by weathering. Some had sharp edges, which indicates either recent introduction into the sea or the recent breaking up of larger pieces. A few particles (6 percent by number) were colored green, blue, or red, and there were also a small

### Plastics on the Sargasso Sea Surface

**Abstract.** *Plastic particles, in concentrations averaging 3500 pieces and 290 grams per square kilometer, are widespread in the western Sargasso Sea. Pieces are brittle, apparently due to the weathering of the plasticizers, and many are in a pellet shape about 0.25 to 0.5 centimeters in diameter. The particles are surfaces for the attachment of diatoms and hydroids. Increasing production of plastics, combined with present waste-disposal practices, will undoubtedly lead to increases in the concentration of these particles. Plastics could be a source of some of the polychlorinated biphenyls recently observed in oceanic organisms.*

While sampling the pelagic *Sargassum* community in the western Sargasso Sea, we encountered plastic particles in our neuston (surface) nets. The occurrence of these particles on the sea surface has not yet been noted in the literature [we also collected petroleum lumps, which have received attention (1, 2)].

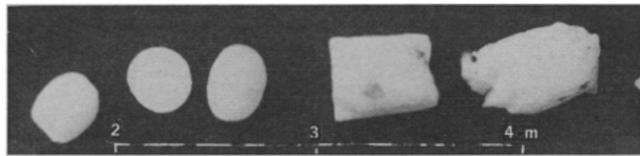


Fig. 1. Typical plastic particles from tow 2. White pellets are on the left.

Table 1. Neuston tow data.

Tow number	Date (October 1971)	Towing time (hours)	Location at start	Number collected	Weight collected (g)	Concentration	
						Number/km <sup>2</sup>	g/km <sup>2</sup>
1	12	2.25	30° 10.5'N 60° 02.5'W	5	0.31	601	37.7
2	12	2.66	30° 19.4'N 60° 00.9'W	48	2.48	4,877	251.9
3	12	4.08	30° 55.6'N 59° 57.1'W	22	1.06	1,457	70.2
4	13	1.00	31° 51.7'N 60° 37.8'W	4	0.22	1,081	60.0
5	13	0.50	32° 25.2'N 61° 14.6'W	8	0.73	4,324	395.1
6	14	6.50	33° 32.5'N 62° 30.9'W	62	2.48	2,579	103.3
7	14	0.85	34° 21.8'N 62° 53.0'W	38	5.57	12,080	1,770.7
8	15	1.00	35° 15.4'N 63° 46.3'W	17	0.96	4,595	258.9
9	15	0.85	35° 37.4'N 64° 20.8'W	22	0.64	6,994	201.9
10	16	1.00	37° 02.0'N 65° 41.0'W	1	0.22	270	4.9
11	16	5.75	37° 00.5'N 65° 34.8'W	1	0.08	47	0.6
Mean						3,537	286.8

### Plastics on the Sargasso Sea Surface

Author(s): Edward J. Carpenter and K. L. Smith, Jr.

Source: *Science*, Mar. 17, 1972, New Series, Vol. 175, No. 4027 (Mar. 17, 1972), pp. 1240-1241

Published by: American Association for the Advancement of Science

Små plastkugler dukker op i plankton net

chance, we must suspect that the key to their evolution is a dissipative mechanism not present in the solar system today. It might have involved a viscous medium in the early solar nebula or the influence of a passing star. A study of evolutionary models with such alternate mechanisms might provide useful clues about conditions in the young solar system.

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C. C. COUNSELMAN, III  
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### Polystyrene Spherules in Coastal Waters

**Abstract.** *Polystyrene spherules averaging 0.5 millimeter in diameter (range 0.1 to 2 millimeters) are abundant in the coastal waters of southern New England. Two types are present, a crystalline (clear) form and a white, opaque form with pigmentation resulting from a diene rubber. The spherules have bacteria on their surfaces and contain polychlorinated biphenyls, apparently absorbed from ambient seawater, in a concentration of 5 parts per million. White, opaque spherules are selectively consumed by 8 species of fish out of 14 species examined, and a chaetognath. Ingestion of the plastic may lead to intestinal blockage in smaller fish.*

Polystyrene spherules are widespread in the coastal waters of southern New England. We first observed spherical plastic particles in plankton tows in January 1971 while sampling to determine the effects of a nuclear power station on the ecology of Niantic Bay (northeastern Long Island Sound). The particles, although usually present in zooplankton samples throughout the year, were not investigated in detail until February 1972. The spherules are markedly different in size, shape, distribution, and chemical composition from the plastics on the Sargasso Sea surface (1).

Infrared spectrophotometry of the particles indicated that they were polystyrene plastic. Two types are present in seawater, in approximately equal proportions. One is a clear or crystalline polystyrene, and the other is a white, opaque form with pigmentation due to the presence of a diene rubber compound in the plastic, as indicated by infrared spectrophotometry and confirmed by a representative of the plastics industry (2). Both forms are virtually perfect spheres and average about 0.5 mm in diameter, ranging from 0.1 to 2 mm. They contain various sizes and numbers of gaseous voids. Thus, they are found at the sea surface, in the water column, and presumably in the

### References and Notes

- See, for example, P. Goldreich, *Mon. Notic. Roy. Astron. Soc.* 130, 159 (1965).
- A complete discussion is given by R. J. Greenberg, thesis, Massachusetts Institute of Technology (September 1972).
- D. Browner and G. Clemence, *Methods of Celestial Mechanics* (Academic Press, New York, 1951), p. 492.
- This qualitative aspect of the stability for relatively high values of  $e_2$  was described by Goldreich (1) and by C. J. Cohen and E. C. Hubbard [*Astron. J.* 70, 10 (1965)].
- The time scale for the evolution of the Titan-Hyperion resonance presents certain problems; these are discussed in (2).
- R. R. Allan, in *Symposia Matematica* (Istituto Nazionale di Alta Matematica, Città Universitaria, Rome, 1970), vol. 3, p. 75. Here the conjunction longitude librates about the average longitude of the satellites' ascending nodes on Saturn's equatorial plane, so the resonance involves the inclinations of both satellites.

30 June 1972

range was not delimited. All samples were collected with oblique plankton tows by using the National Academy of Sciences (NAS) reference net (0.5 m in diameter at the mouth; mesh size 333  $\mu$ m) equipped with a flowmeter (3). The highest concentrations observed were in the Niantic Bay area with an average of about 1 spherule per cubic meter for 72 samples taken on six dates between February and May 1972. Concentrations up to 14  $m^{-3}$  were observed in this area. At other stations sampled in February to March 1972 the average concentrations were as follows: Long Island Sound (stations 22 to 27), 0.07  $m^{-3}$ ; east of Block Island (stations 13 to 18), 0.03  $m^{-3}$ ; Great Salt Pond on Block Island and west to Long Island Sound (stations 19 to 21), 0.02  $m^{-3}$ .

Bacteria and polychlorinated biphenyls (PCB's) are present on surfaces of the plastic particles. Freshly collected spherules from Niantic Bay were transferred through four washings of sterile seawater and plated onto A-C seawater medium (4), where rod-shaped gram-negative bacteria were observed after incubation. An extraction of the surface of the spherules from Niantic Bay with hexane showed that they contained PCB's (Aroclor 1254) in a concentration of 5 parts per million. Since PCB's are not added in the manufacture of polystyrene (2), it is probable that the source was ambient seawater.

Table 1. Sample location, date, volume filtered, and concentration of plastic spherules in coastal water. Stations 1 to 12 were in an area of about 10 km<sup>2</sup>; the averages and ranges of the spherule concentrations at these 12 stations are presented.

Station	Location	Date (1972)	Volume filtered (m <sup>3</sup> )	Spherules per cubic meter	
				Avg.	Range
<i>Niantic Bay</i>					
1-12	41°18'N, 72°10'W	1 February	475	0.75	0.39-1.94
1-12	41°18'N, 72°10'W	17 February	140	2.58	0.62-14.1
1-12	41°18'N, 72°10'W	16 March	513	0.79	0.00-2.52
1-12	41°18'N, 72°10'W	7 April	603	0.13	0.00-0.51
1-12	41°18'N, 72°10'W	25 May	387	0.61	0.03-2.44
<i>Buzzards Bay</i>					
13	41°34'N, 70°43'W	9 March	59	0.03	
14	41°34'N, 70°43'W	9 March	50	0.02	
<i>Vineyard Sound</i>					
15	41°30'N, 70°39'W	10 March	48	0.02	
16	41°30'N, 70°39'W	10 March	31	0.00	
<i>Rhode Island Sound</i>					
17	41°20'N, 71°03'W	24 March	108	0.10	
18	41°13.5'N, 71°18'W	25 March	76	0.00	
<i>Great Salt Pond</i>					
19	41°09'N, 71°33'W	25 March	94	0.04	
<i>Block Island Sound</i>					
20	41°12'N, 71°44'W	25 March	191	0.01	
21	41°12'N, 72°00'W	25 March	104	0.01	
<i>Long Island Sound</i>					
22	41°10'N, 72°20'W	25 March	280	0.10	
23	41°09'N, 72°36'W	25 March	122	0.05	
24	41°08'N, 72°52'W	25 March	48	0.10	
25	41°16'N, 72°01'W	23 March	109	0.05	
26	41°17'N, 72°03'W	23 March	125	0.07	
27	41°17'N, 71°59'W	23 March	151	0.04	

### Polystyrene Spherules in Coastal Waters

Author(s): Edward J. Carpenter, Susan J. Anderson, George R. Harvey, Helen P. Miklas and Bradford B. Peck

Source: *Science*, Nov. 17, 1972, New Series, Vol. 178, No. 4062 (Nov. 17, 1972), pp. 749-750

Plast pellets indeholder PBC'er, som menes at stamme fra miljøet

Fisk spiser de små plastkugler

Effekter er ukendte, men blokering af fødekanal på små fisk er muligt

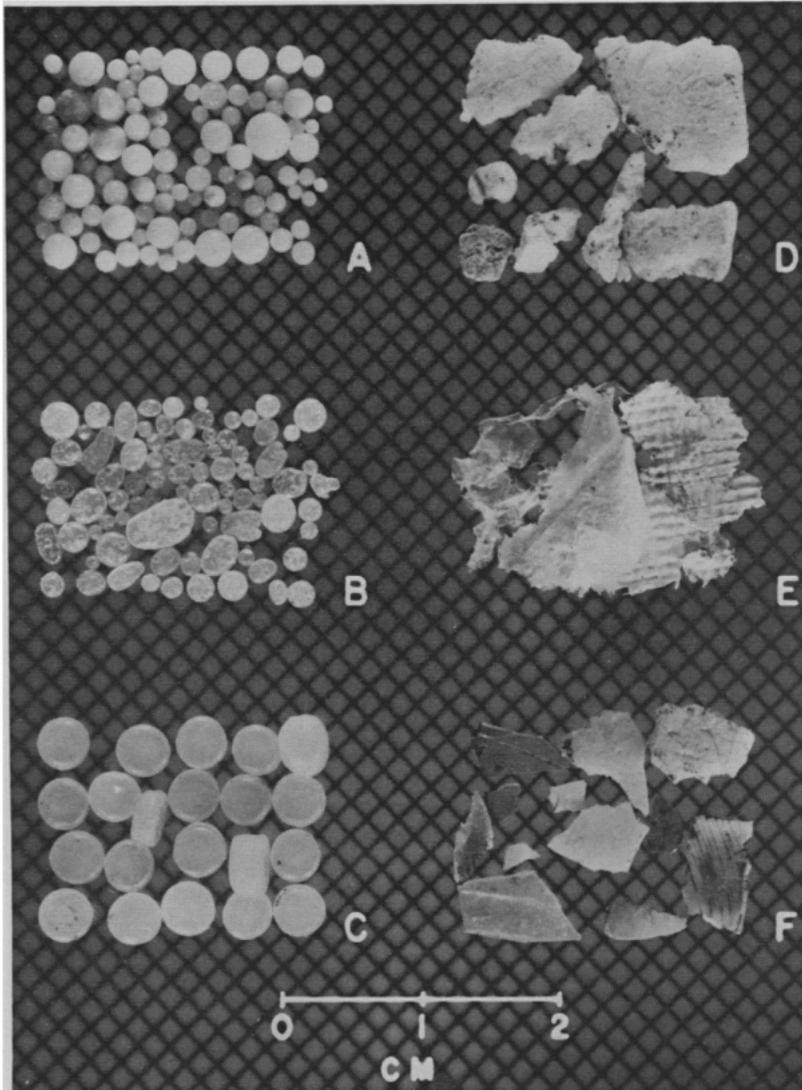


Fig. 2. Typical plastic particles: (A) opaque polystyrene spherules, (B) clear and translucent polystyrene spherules, (C) opaque and translucent polyethylene cylinders, (D) Styrofoam, (E) plastic sheets, and (F) plastic pieces.

Science  
AAAS

## Plastic Particles in Surface Waters of the Northwestern Atlantic

The abundance, distribution, source, and significance of various types of plastics are discussed.

John B. Colton, Jr., Frederick D. Knapp, Bruce R. Burns

### Fremhæver bl.a.:

Plast er persistent og akkumulerer i havet  
Stigende produktion vil øge koncentrationer

### Påpeger behov for:

- nedbrydelige polymerer til nogle anvendelser
- udvikling af effektive affalds- og forbrændingssystemer
- Markant styrket plastgenanvendelse – inkl. ændret industriadfærd

# "microplastics"

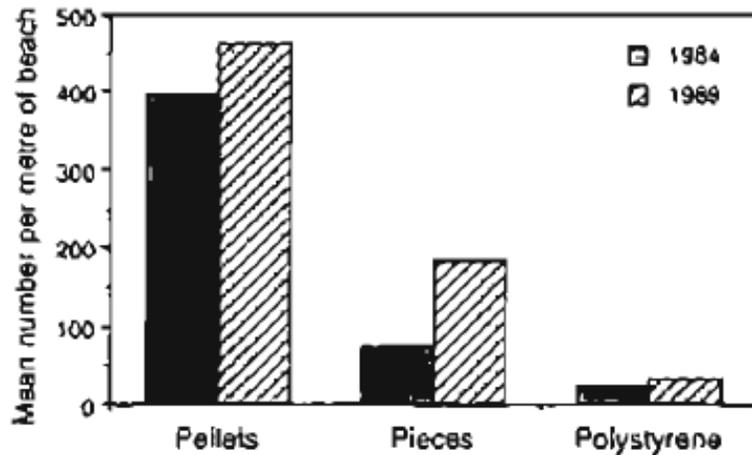


Fig. 2. Changes in the mean abundance of three categories of micro-plastic particles on South African beaches between 1984 and 1989.

## Plastic and other artefacts on South African beaches: temporal trends in abundance and composition

*Suid-Afrikaanse Tydskrif vir Wetenskap* Vol. 86 Julie – Oktober 1990

P.G. RYAN and C.L. MOLONEY

*FitzPatrick Institute and Marine Biology  
Research Institute, University of Cape Town,  
Rondebosch, 7700 South Africa.*

Sampling was performed at two levels: **micro-artefacts (< 20 mm diameter)** were collected from a 0.5-m-wide transect running up the beach by sieving the top 50 mm of sand through a 2-mm mesh sieve ( $n = 51$  beaches); and macro-artefacts ( $> 20$  mm) were collected from 50-m stretches of beach ( $n = 51$ ) and were identified as far as possible to determine their origin. In addition, pumice was collected along with micro-artefacts in 1984.

**Micro-plastics were grouped into three categories:** virgin industrial pellets that form the feedstock for the plastics industry, expanded polystyrene, and fragments of plastic articles (e.g. pieces of bottles and bags, rope fibres, etc.). Macro-plastics were grouped into four categories: packaging and other disposable items (e.g. bags, bottles, straps, etc.), fishing equipment (nets, line, floats, etc.), non-disposable user objects (shoes, gloves, etc.), and unidentified pieces.

1990



1997





PERGAMON

Marine Pollution Bulletin 44 (2002) 1035–1038

MARINE  
POLLUTION  
BULLETIN[www.elsevier.com/locate/marpolbul](http://www.elsevier.com/locate/marpolbul)

## A comparison of neustonic plastic and zooplankton abundance in southern California's coastal waters

C.J. Moore <sup>a,\*</sup>, S.L. Moore <sup>b</sup>, S.B. Weisberg <sup>b</sup>, G.L. Lattin <sup>a</sup>, A.F. Zellers <sup>a</sup>

<sup>a</sup> *Algalita Marine Research Foundation, 345 Bay Shore Avenue, Long Beach, CA 90803-1956, USA*

<sup>b</sup> *Southern California Coastal Water Research Project, 7171 Fenwick Lane, Westminster, CA 92683, USA*

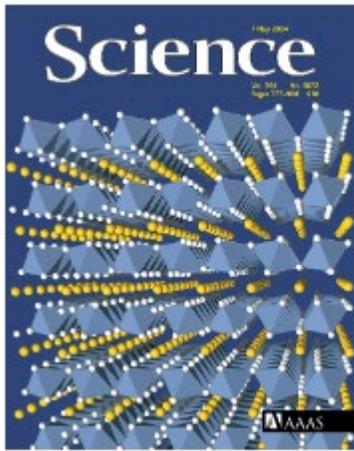
2002

### Abstract

The density of neustonic plastic particles was compared to that of zooplankton in the coastal ocean near Long Beach, California. Two trawl surveys were conducted, one after an extended dry period when there was little land-based runoff, the second shortly after a storm when runoff was extensive. On each survey, neuston samples were collected at five sites along a transect parallel to shore using a manta trawl lined with 333  $\mu$  mesh. Average plastic density during the study was 8 pieces per cubic meter, though density after the storm was seven times that prior to the storm. The mass of plastics was also higher after the storm, though the storm effect on mass was less than it was for density, reflecting a smaller average size of plastic particles after the storm. The average mass of plastic was two and a half times greater than that of plankton, and even greater after the storm. The spatial pattern of the ratio also differed before and after a storm. Before the storm, greatest plastic to plankton ratios were observed at two stations closest to shore, whereas after the storm these had the lowest ratios.

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*Keywords:* Southern California; Neuston; Plastics; Zooplankton; Debris; Pollution monitoring



## BREVIA

## Lost at Sea: Where Is All the Plastic?

Richard C. Thompson,<sup>1\*</sup> Ylva Olsen,<sup>1</sup> Richard P. Mitchell,<sup>1</sup>  
Anthony Davis,<sup>1</sup> Steven J. Rowland,<sup>1</sup> Anthony W. G. John,<sup>2</sup>  
Daniel McGonigle,<sup>3</sup> Andrea E. Russell<sup>3</sup>

Millions of metric tons of plastic are produced annually. Countless large items of plastic debris are accumulating in marine habitats worldwide and may persist for centuries (1–4). Here we show that microscopic plastic fragments and fibers (Fig. 1A) are also widespread in the oceans and have accumulated in the pelagic zone and sedimentary habitats. The fragments appear to have resulted from degradation of larger items. Plastics of this size are ingested by marine organisms, but the environmental consequences of this contamination are still unknown.

Over the past 40 years, large items of plastic debris have frequently been recorded in habitats from the poles to the equator (1–4). Smaller fragments, probably also plastic, have been reported (5) but have received far less attention. Most plastics are resistant to biodegradation, but will break down gradually through mechanical action (6). Many “biodegradable” plastics are composites with materials such as starch that biodegrade, leaving behind numerous, nondegradable, plastic fragments (6). Some cleaning agents also contain abrasive plastic fragments (2).

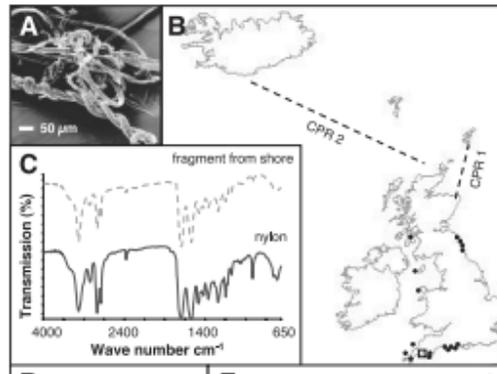
ing, and rope, suggesting that the fragments resulted from the breakdown of larger items.

To assess the extent of contamination, a further 17 beaches were examined (Fig. 1B). Similar fibers were found, demonstrating that microscopic plastics are common in sedimentary habitats. To assess long-term trends in abundance, we examined plankton samples collected regularly since the 1960s along routes between Aberdeen and the Shetlands (315 km) and from Sule Skerry to Ice-

land (850 km) (7) (Fig. 1B). We found plastic archived among the plankton in samples back to the 1960s, but with a significant increase in abundance over time (Fig. 1E). We found similar types of polymer in the water column as in sediments, suggesting that polymer density was not a major factor influencing distribution.

It was only possible to quantify fragments that differed in appearance from sediment grains or plankton. Some fragments were granular, but most were fibrous, ~20  $\mu\text{m}$  in diameter, and brightly colored. We believe that these probably represent only a small proportion of the microscopic plastic in the environment, and methods are now needed to quantify the full spectrum of material present. The consequences of this contamination are yet to be established. Large plastic items can cause suffocation and entanglement and disrupt digestion in birds, fish, and mammals (3). To determine the potential for microscopic plastics to be ingested, we kept amphipods (detritivores), lugworms (deposit feeders), and barnacles (filter feeders) in aquaria with small quantities of microscopic plastics. All three species ingested plastics within a few days (7) (fig. S1).

Our findings demonstrate the broad spatial extent and accumulation of this type of contamination. Given the rapid increase in plastic production (Fig. 1E), the longevity of plastic, and the disposable nature of plastic items (2, 3), this contamination is likely to increase. There is the potential for plastics to adsorb, release, and transport chemicals (3, 4). However, it remains to be shown whether toxic substances can pass from plastics to the food chain. More work is needed to establish whether there are any environmental consequences of this debris.



2004



VELUX FONDEN



MARINE PLASTIC

MARINE PLASTIC II

RUC

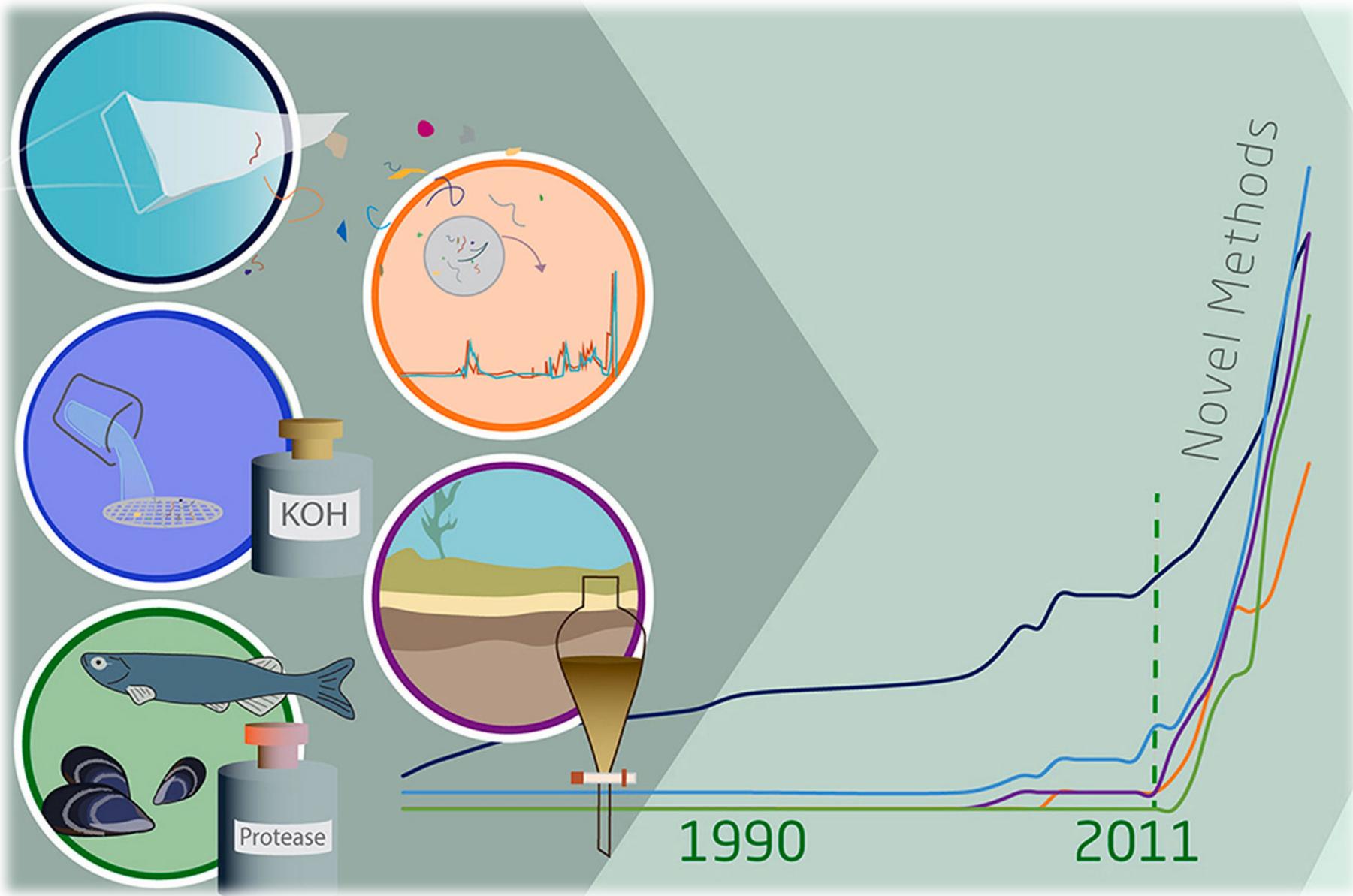


DTU





2011



Rist, S, Hartmann, NB & Welden, N 2021, 'How fast, how far: Diversification and adoption of novel methods in aquatic microplastic monitoring', *Environmental Pollution*, vol. 291, 118174. <https://doi.org/10.1016/j.envpol.2021.118174>

# Mikroplast ender ikke blot i havene – det blæser rundt i luften omkring os

17. apr. 2019, 21:59



TV2.dk

## Overraskede forskere: Det regner med plastic i Rocky Mountains

Ingeniøren, 14. aug 2019

UDLAND

## Mikroplast falder fra himlen i Arktis - Danmark går ikke fri

15. aug. 2019, 09:28



TV2.dk

Det regner med mikroplastik i  
London

Videnskab.dk, 2. jan 2020

# Forskere finder mikroplast i menneskelort 8 steder i verden

Videnskab.dk 23. okt 2018



## You eat thousands of bits of plastic every year

Though abundant in water, air, and common foods, it's unclear how it might affect our health.

*National Geographic, June 5th 2019*





© 1995 American Plastics Council

You could think of them as the sixth basic food group. Oh, you certainly wouldn't eat them, but plastic packaging does help pro-

help keep air out. While others let air in to help the food we eat stay fresher longer. Plastics also let you see what you're buying,

## Plastics. An Important Part Of Your Healthy Diet.

tect our food in many ways. • To help lock in freshness, plastic wrap clings tightly to surfaces. To help lock out moisture, resealable containers provide a strong seal. And plastic wrap helps extend the shelf life of perishable produce, poultry, fish and meats. • To prevent spoilage and contamination, some varieties of plastics

taking the mystery out of shopping. All of which makes them versatile, durable, lightweight and shatter-resistant. • To learn more, call the American Plastics Council at 1.800.777.9500 for a free booklet. Plastics. One part of your diet you may never break.



American Plastics Council

PLASTICS MAKE IT POSSIBLE.™

Visit us at <http://www.plasticsresource.com>

*Plast. En vigtig del af en sund kost.*

*"Du kan tænke på dem som den sjette basisfødevarergruppe.*

*Ej, du ville selvfølgelig ikke spise dem, men plastemballage kan hjælpe med at holde luft ude. Andre typer kan lade luften komme ind og hjælper med at holde maden frisk længere.*

*(...)*

*Plast. En del af din kost som du aldrig kan nedbryde"*



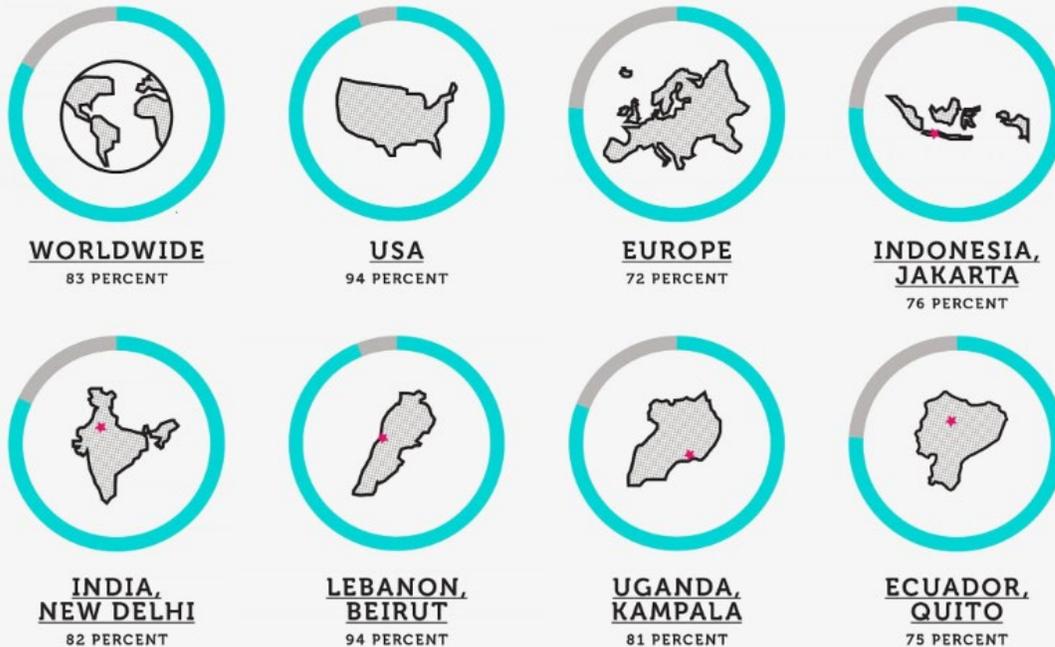


# PLASTIC FIBERS IN TAP WATER, 2017



orb. one world. one story.

PREVALENCE OF MICROSCOPIC PLASTIC FIBERS BY SAMPLE SOURCE LOCATION.



[The Invisibles — Orb Media](#)

- Prøver indsamlet af samarbejdsinstitutioner, Orb medarbejdere og frivillige.
- 500 mL opsamlet i HDPE flasker
- Sendt til University of Minnesota for analyse
- Vandprøver filtreret på cellulosefilter med 2.5 um porestørrelse
- Mikroplast partikler identificeret ved visuel analyse under mikroskop
- Analyser af laboratorie-blanks for at kontrollere for kontaminering.

## Mikroplast i drikkevand: Nu kaldes minister i samråd

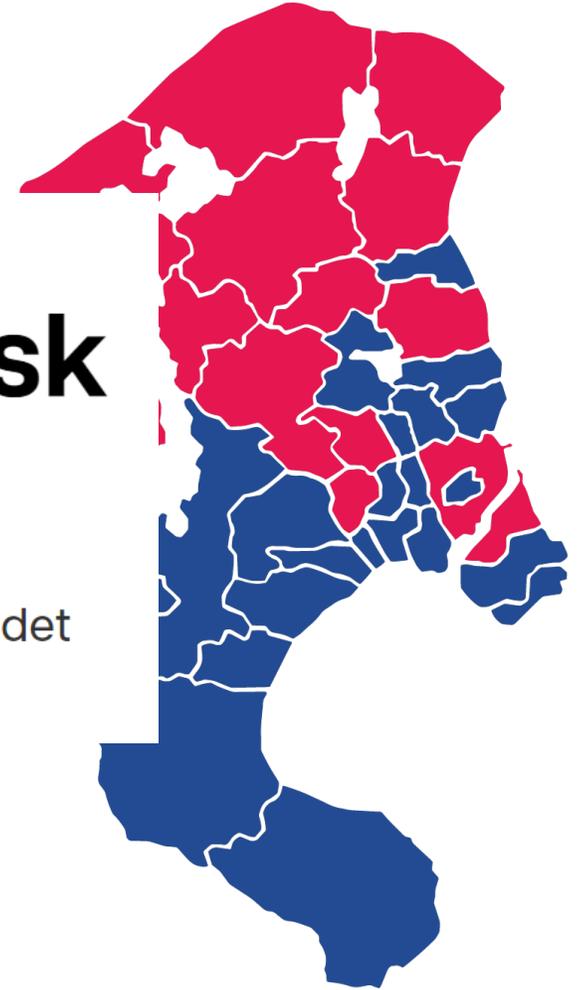
Forskere har fundet mikroplast i drikkevandet i 12 kommuner. Radikale Venstre og Konservative mener, at vi skal være forsigtige over for stoffet.



MILJØ

# Mikroplast fundet i dansk drikkevand

Politikere vil have undersøgt, hvor meget mikroplast der er i det danske drikkevand.



Det er "ærgeligt" og "bekymrende", mener Ida Auken, Rad. Ven., og Mette Abildgaard, Kons.  
Foto: Ida Guldbæk Arentsen & Simon Skipper - Scanpix

TV 2 Kosmopol, 20. sep. 2017

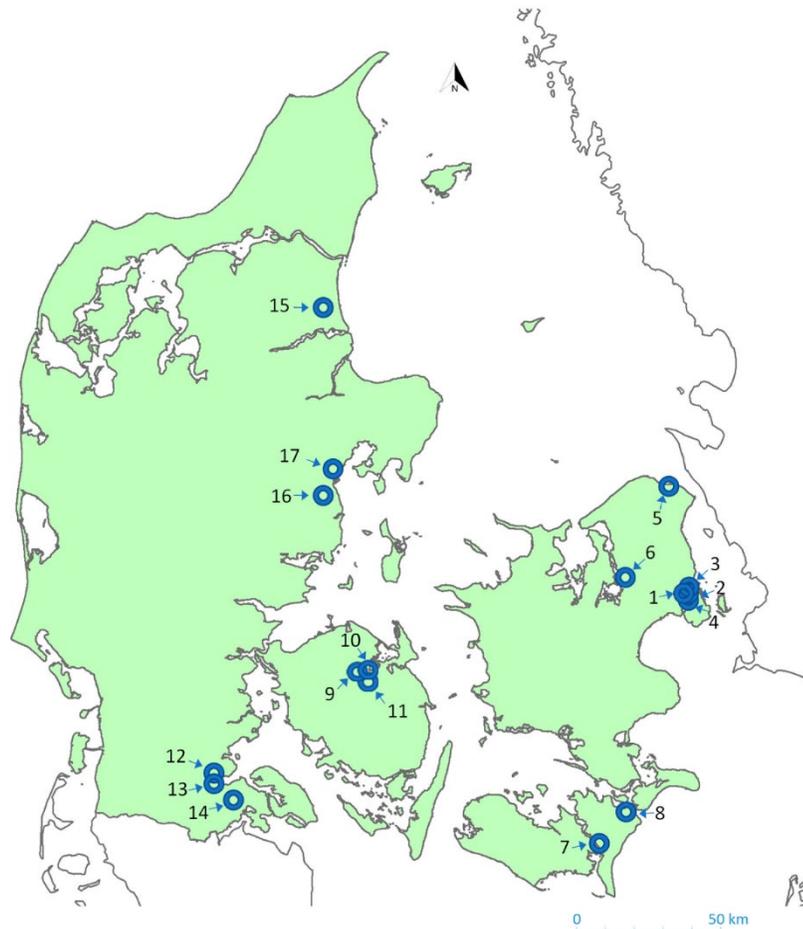
## Mikroplast i det danske grundvand?

- Undersøgelse af 6 grundvandsboringer (10–100 L prøver).
  - Mortenstrup (Hørsholm) Assermølle (Lejre) Solhøj (Hedehusene) Rødekro Nord Farversmølle (Aabenraa)
  - Filtreret på stålfiltre med porestørrelse på 10 µm og Analyseret med u-FTIR
- Få påviste partikler — vurderes primært som **kontaminering** fra prøveudtagning.
- Litteraturen peger på **meget lav risiko** for mikroplast i dansk grundvand. Transport af små partikler (<1 µm) kan ikke udelukkes, men jordlag fungerer typisk som effektivt filter.

*Mackevica, A., & Hartmann, N. B. (2018). Mikroplast i grundvand – En vurdering af potentialet for forekomst af mikroplast i dansk grundvand. Danmarks Tekniske Universitet (DTU) (findes på [orbit.dtu.dk](http://orbit.dtu.dk))*



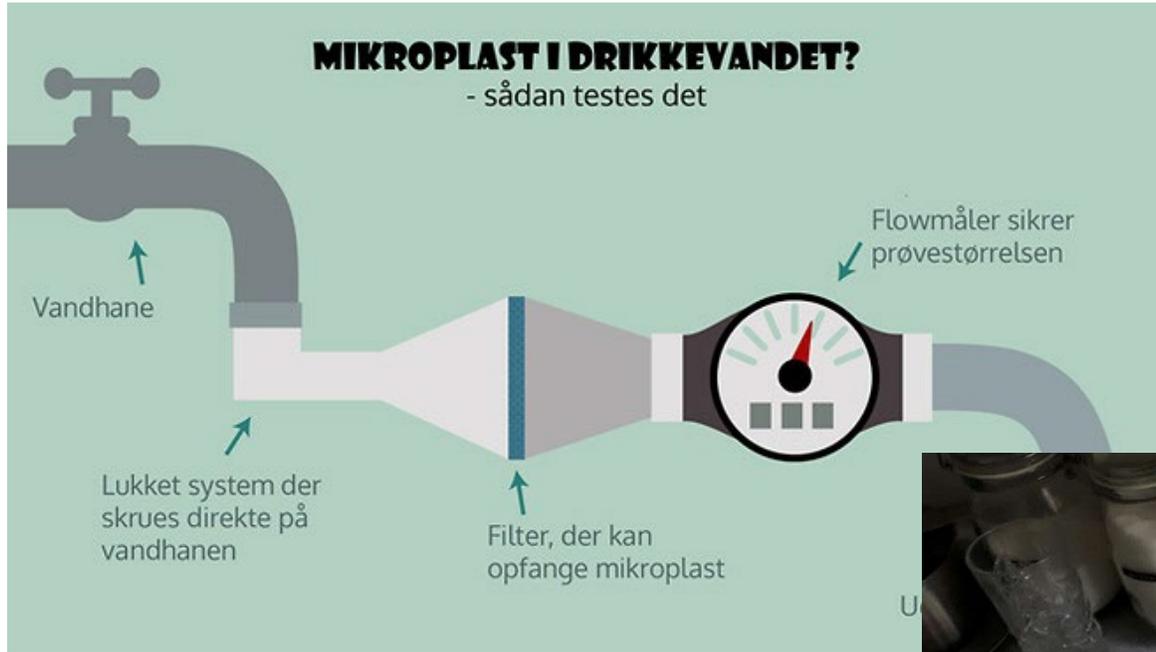
# Mikroplast i det danske drikkevand?



- Vandprøver tappet fra vandhaner på 17 lokaliteter fordelt i hele landet (forår 2018)
- 50L blev tappet direkte fra vandhanerne og stammer både fra private boliger, private arbejdspladser samt private og offentlige institutioner.

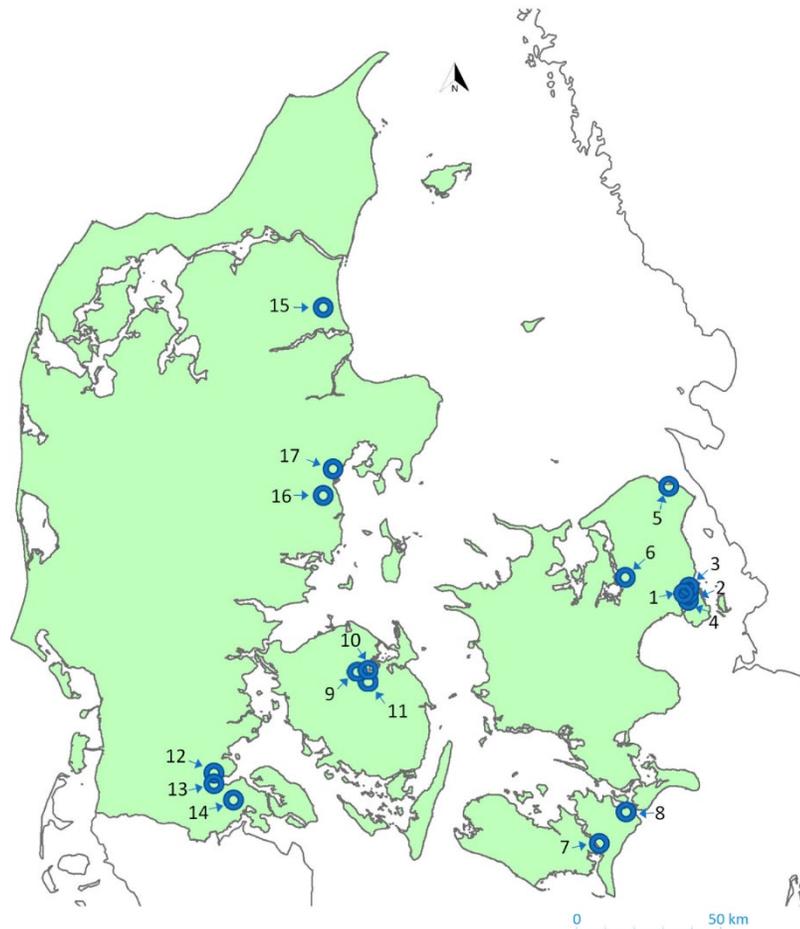
*Strand, J., Feld, L., Murphy, F., Mackevica, A., & Hartmann, N. B. (2018). Analysis of microplastic particles in Danish drinking water. Aarhus University. Scientific Report from DCE – Danish Centre for Environment and Energy No. 291*

*Feld, L, da Silva, VH, Murphy, F, Hartmann, NB & Strand, J 2021, 'A Study of Microplastic Particles in Danish Tap Water', Water, vol. 13, no. 15, 2097. <https://doi.org/10.3390/w13152097>*



*Strand, J., Feld, L., Murphy, F., Mackevica, A., & Hartmann, N. B. (2018). Analysis of microplastic particles in Danish drinking water. Aarhus University. Scientific Report from DCE – Danish Centre for Environment and Energy No. 291*

# Mikroplast i det danske drikkevand?



- Vandprøver tappet fra vandhaner på 17 lokaliteter fordelt i hele landet
- 50L blev tappet direkte fra vandhanerne og stammer både fra private boliger, private arbejdspladser samt private og offentlige institutioner.

- Indholdet af mikroplastik var under detektionsgrænsen i alle 17 drikkevandsvandprøver

- **NB! Begrænset datasæt!**  
**...og kun partikler >10 um**

## Undersøgelse rensr drikkevand for mistanke om mikroplast

Du skal ikke frygte vandet fra din vandhane, hvis du er bange for mikroplast. Sådan lyder konklusionen i en ny rapport.

TV 2 Kosmopol, 8. okt. 2018

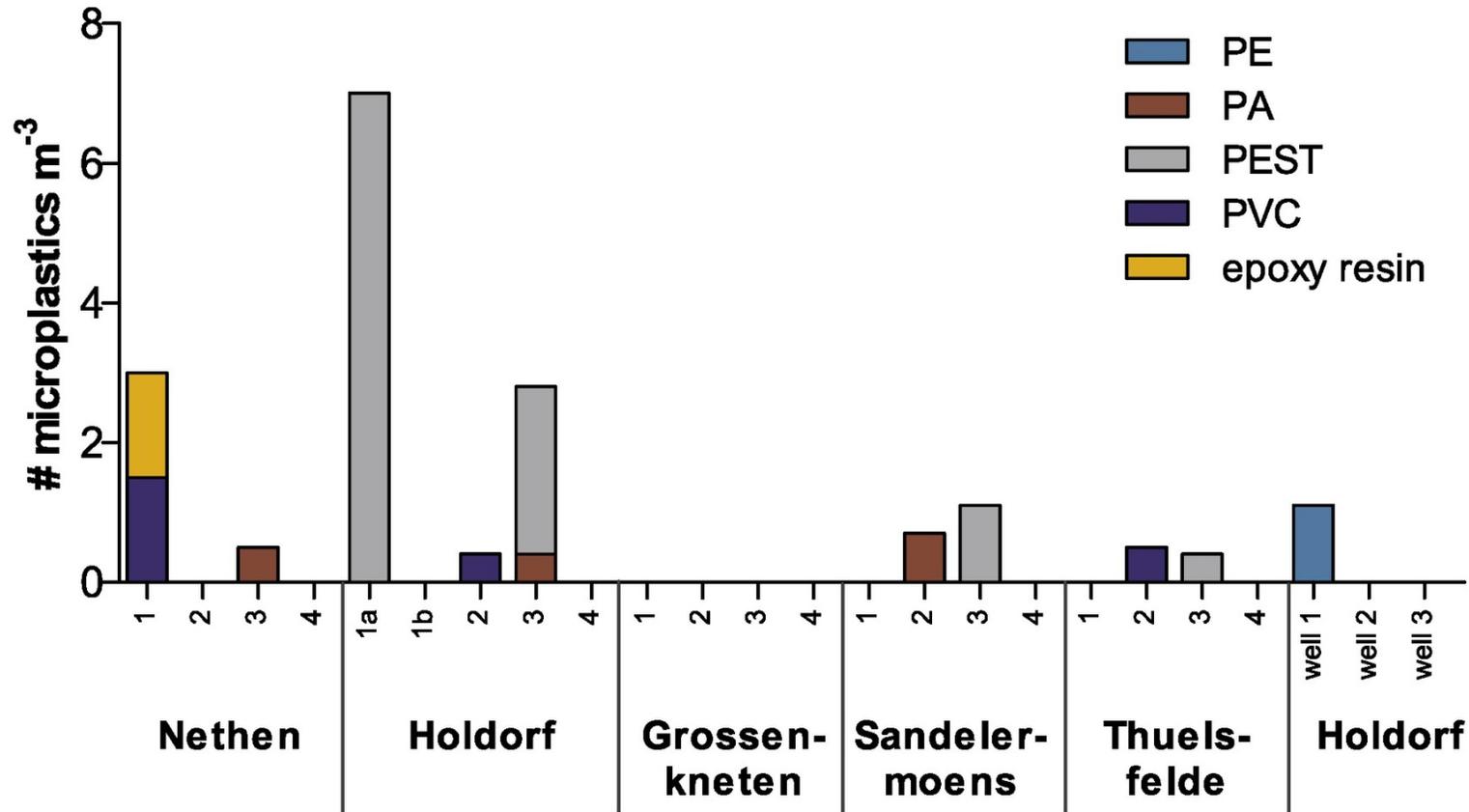


Hjem ~ Nyheder ~ Dansk drikkevand frikendt for mikroplast

# Dansk drikkevand frikendt for mikroplast

En undersøgelse lavet af Aarhus Universitet og Danmarks Tekniske Universitet tyder på, at mikroplast ikke er et problem i det danske drikkevand.

# Lave koncentrationer af mikroplast i grundvand og drikkevand - Tyskland

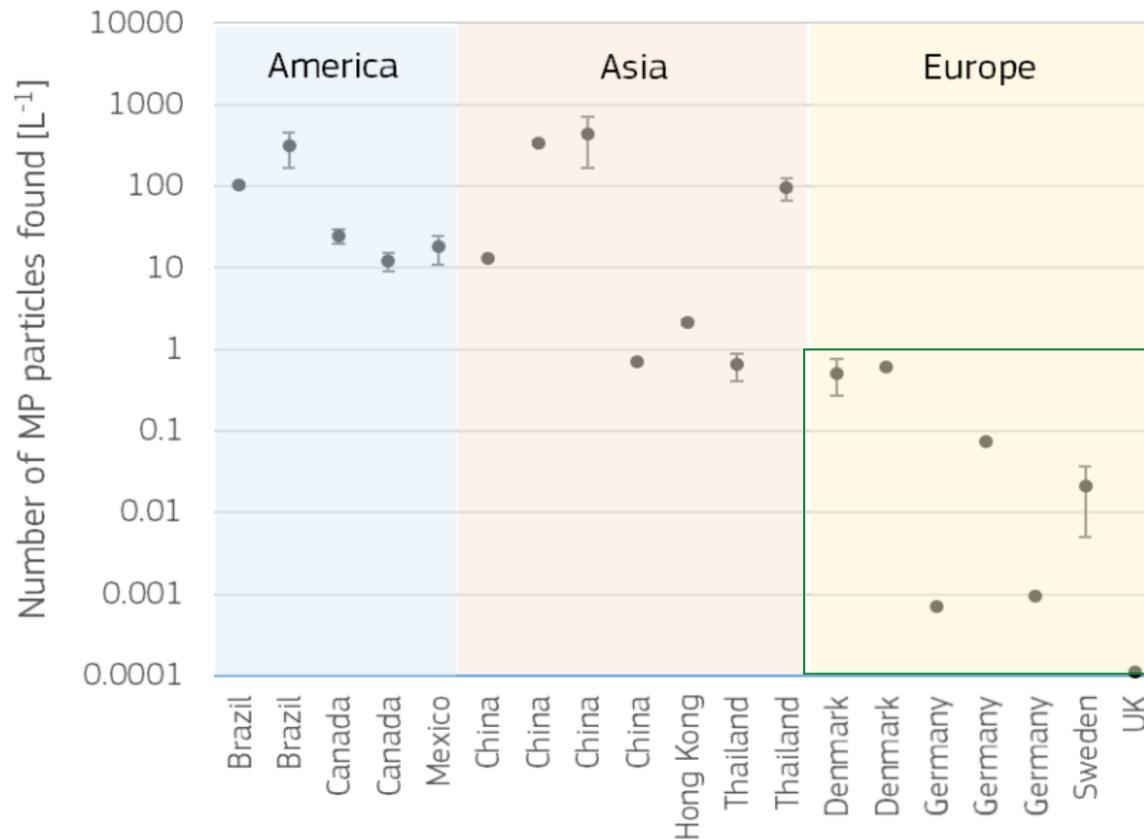


Mintenig, S. M., Löder, M. G., Primpke, S., & Gerdt, G. (2019). Low numbers of microplastics detected in drinking water from ground water sources. *Science of the total environment*, 648, 631-635.



# Internationale undersøgelser

Figure 6. Measured microplastic (MP on vertical axis) number concentration (including error bars) by country and region as reported by the studies focussing on one country. Due to the wide variety of size ranges applied, vertical axis is logarithmic.



**Baseret på studier frem til 2021:**  
 Koncentrationen af mikroplast i europæisk drikkevand er under 1 partikel pr. liter, og størstedelen lå markant under 0,1 partikel pr. liter.

*Belz, S., Cella, C., Geiss, O., Gilliland, D., La Spina, R., Méhn, D. and Sokull-Kluettgen, B., 2024. Analytical methods to measure microplastics in drinking water. Publications Office of the European Union: Luxembourg.*  
<https://data.europa.eu/doi/10.2760/109944>

# Det Europæiske Drikkevandsdirektiv

Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption

- *For at imødekomme den voksende offentlige bekymring over virkningerne af nye stoffer, såsom (...) mikroplast, på menneskers sundhed gennem brug af vand beregnet til menneskelig konsum (...) bør dette direktiv indføre en watch-list-mekanisme. Watch-list-mekanismen vil gøre det muligt at reagere på voksende bekymringer på en dynamisk og fleksibel måde.”*
- Direktivet fastlægger *monitorering* og *metodekrav* (som beskrevet i *JRC rapport*), men **ingen bindende kvalitetskrav eller grænseværdier**
- Overvågning vil gøre det muligt at sætte realistiske og sundhedsbeskyttende mål, hvis nødvendigt



# Det Europæiske Drikkevandsdirektiv - supplement



Official Journal  
of the European Union

EN  
L series

2024/1441

21.5.2024

COMMISSION DELEGATED DECISION (EU) 2024/1441

of 11 March 2024

supplementing Directive (EU) 2020/2184 of the European Parliament and of the Council by laying down a methodology to measure microplastics in water intended for human consumption

(notified under document C(2024) 1459)

(Text with EEA relevance)

“En filterkaskade skal bruges til at opsamle partikler og fibre fra vand, der er beregnet til menneskelig konsum. Billeder fra optisk mikroskopi eller kemisk kortlægning bruges derefter til at bestemme individuelle partikelstørrelser og -form, mens vibrationsmikrospektroskopi bruges til at identificere partikelsammensætninger.”

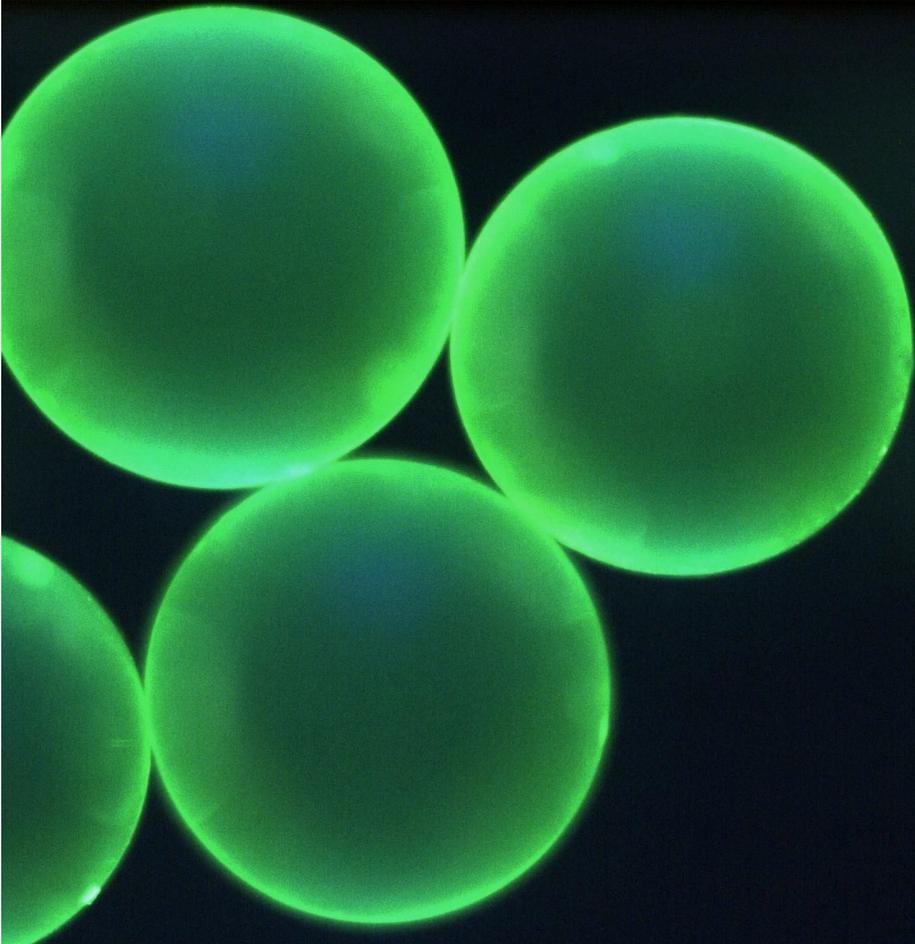
“Et minimumsvolumen på 1.000 liter vand skal udtages som prøve.”

[Link: Delegated decision - EU - 2024/1441 - EN - EUR-Lex](#)

# Info om fastsættelse af grænseværdier – Californien vs EU

- **SB 1422 (2018)** pålægger *State Water Resources Control Board* at udvikle og implementere et reguleringsprogram for mikroplast i drikkevand.
- Trin 1: Definition af mikroplast (2020)
- Trin 2: standardiserede metoder (2021-2022)
- Trin 3: 4-årigt monitoreringsprogram (Fase 1: 2023-2025, Fase 2: 2026-2028)
  
- Baseret på (**mangelfuld**) data for effekter på mennesker:
  - En ikke-regulatorisk screeningsværdi på  $0,3 \mu\text{g L}^{-1}$  eller  $5,7 \times 10^5$  partikler  $\text{L}^{-1}$  (for  $0,5 \mu\text{m}$  polystyrenkugler, for hvilke der fandtes toksicitetsdata).
  
- Kan bruges til bl.a. at fastsætte prøvetagningsvolumen ud fra analyse-mæssige detektionsgrænser
  
- ***Et underliggende problem: mikroplast er ikke bare mikroplast...***

# Mikroplast er ikke bare mikroplast...



# Plast er ikke bare plast...

+ mere end 16.000 kemikalier, der potentielt anvendes til - eller findes i -plastmaterialer og produkter

...hvoraf mere end 4200 er identificeret som 'kemikalier af potentiel bekymring

...og der mangler faredata for mere end 10.000 kemikalier.

LDPE

HDPE

PP

PET

PVC

PA6 (nylon)

PS

m.fl. ....

ABS

PC

∞ kombinationsmuligheder



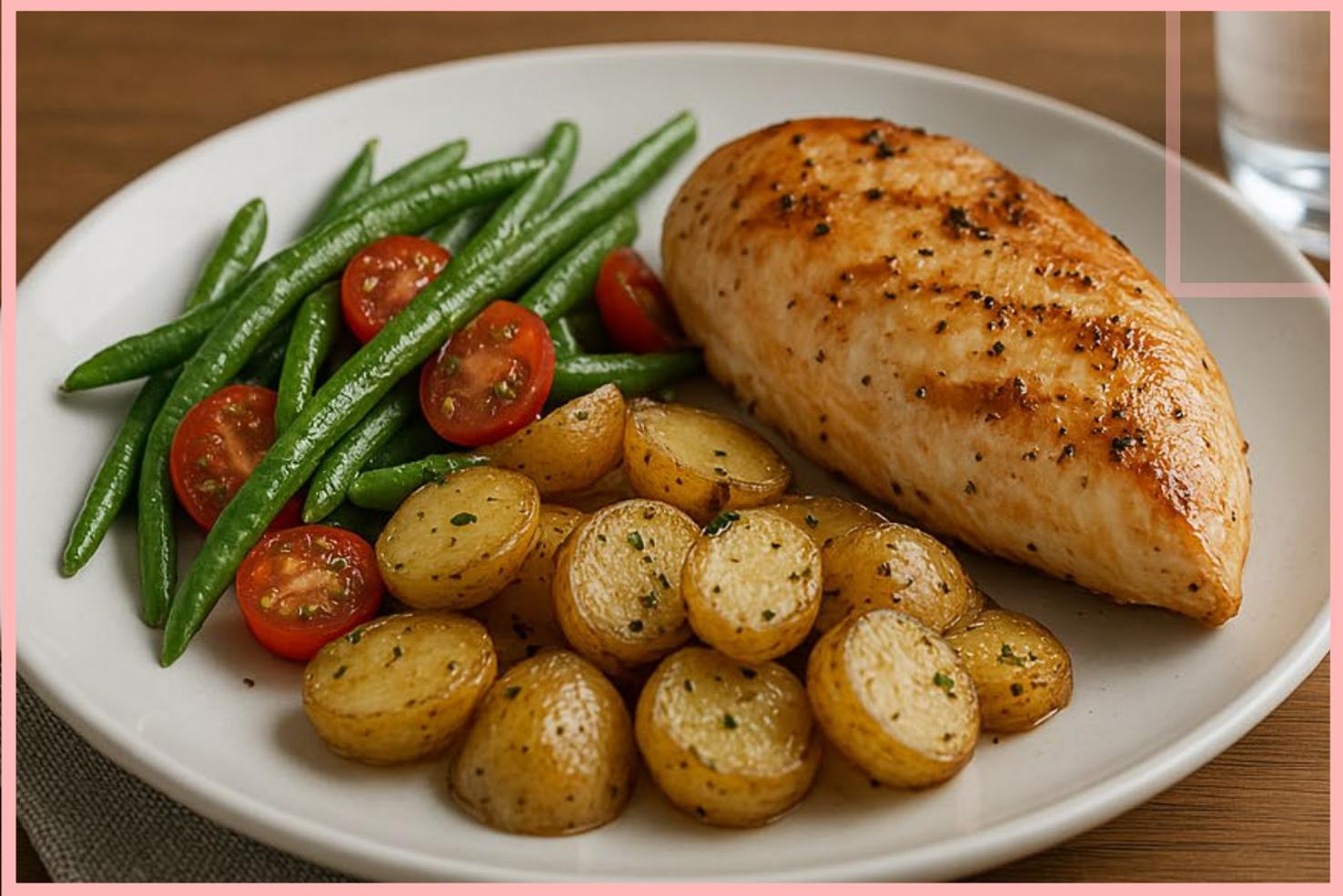


# Mikroplast....

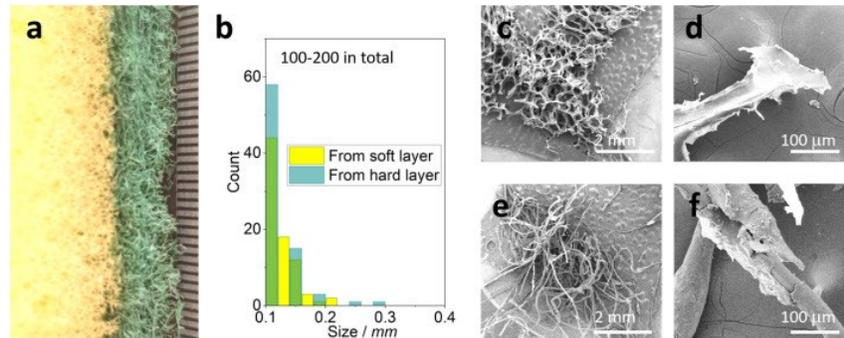
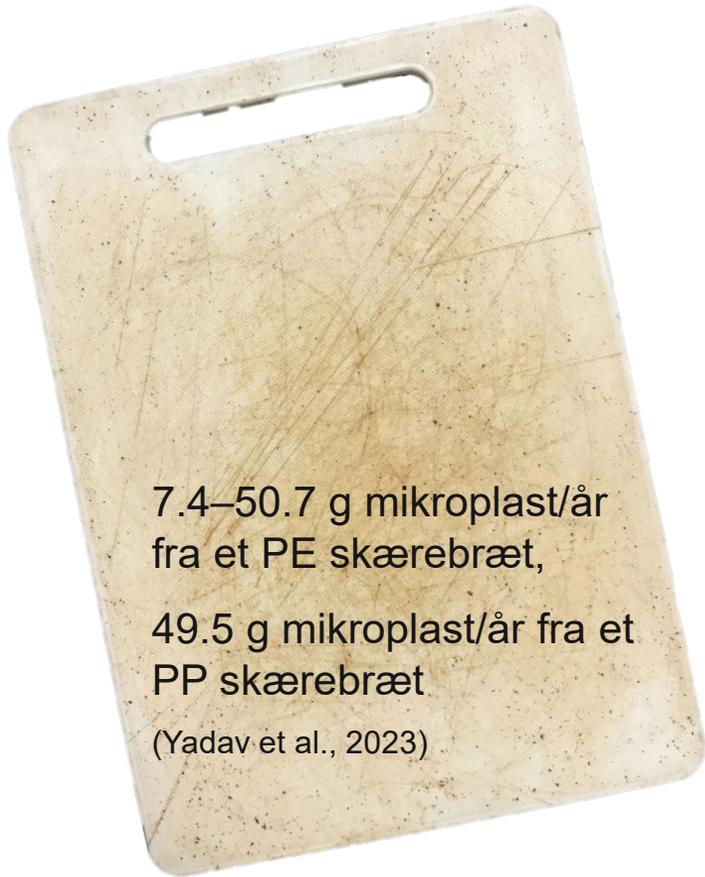
- 1  $\mu\text{m}$

1000  $\mu\text{m}$





# I køkkenet



Kilde: Luo et al., 2022



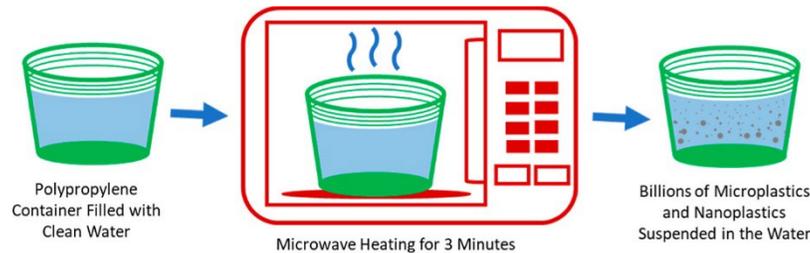
Reference-salt:  $423 \pm 161$   
mikroplast partikler per 0.1 g

Polyoxymethylene (POM) kværn:  
 $7628 \pm 2655$  mikroplast partikler  
per 0.1 g

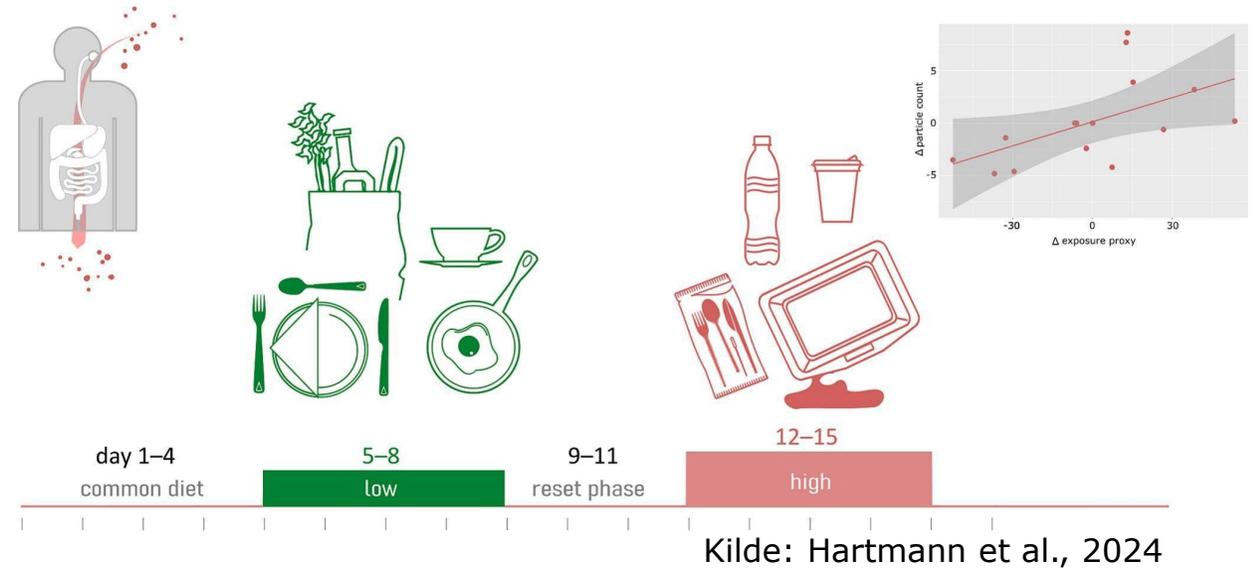
(Schymanski et al., 2020)

# Emballage & tilberedning

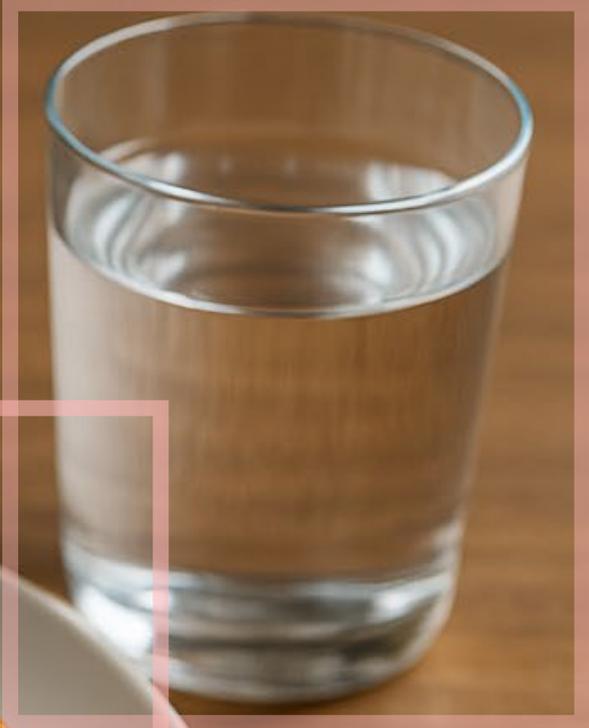
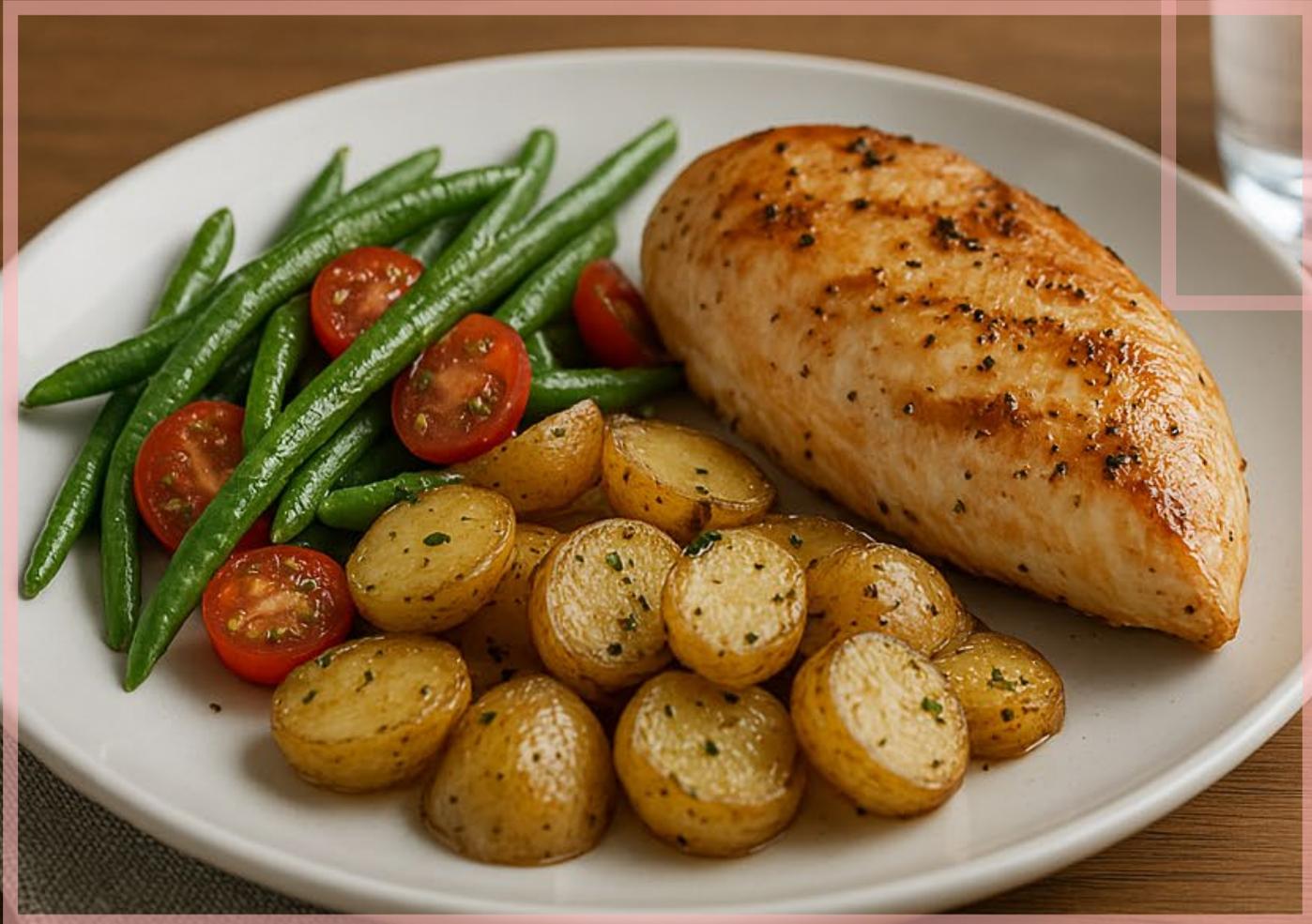
- Brugen af plast til emballering og tilberedning af mad samt indtagelsen af stærkt forarbejdede fødevarer er statistisk signifikant forbundet med indhold af mikroplast i afføringen (Hartmann et al., 2024)



Kilde: Hussain et al., 2023



- Opvarmning i mikroovn forårsager frigivelse af millioner af partikler (Hussain et al., 2023)  
→ micro- og nanoplast?





7 mikroplast partikler på 20 minutter



# Mikroplast i jord og afgrøder

Jord (herunder landbrugsjord) fungerer som en 'sink' for mikroplast.

Mikroplast tilføres jorden via flere kilder, bl.a. slam, kompost, dækningsplast og atmosfærisk nedfald.

Viden om effekter på jordorganismer, jordstruktur og næringsstofkredsløb er stadig begrænset.

*Men: realistiske scenarier for spredning af slam viser risiko for kroniske effekter på jordorganismer* (Boisseaux et al, 2025)

Optag af nanoplast er påvist i planter via rødder og blade

EU direktiv om jordbundsovervågning: "...dette direktiv gør det muligt at medtage mikroplast og nanoplast i overvågningen af jordforurenende stoffer" ([Europa-Parlamentets og Rådets direktiv \(EU\) 2025/2360 af 12. november 2025](#))

# Opsummering

- Plastens succes i det 20. århundrede har skabt et **systemproblem** i det 21.
- **Plastforurening er allestedsnærværende og persistent**
- Plast og mikroplast hænger uløseligt sammen
- **Næsten umuligt at fjerne**, når det først er i miljøet.
- **Dokumenterede effekter på mennesker og miljø**, selv om væsentlige videnskuller består.

*Kan plastforurening betragtes som en **global generationsforurening**?*

# Effekter gennem plastens livscyklus



Ekstraktion af fossile brændsler



Plastik produktion



Produkt fremstilling



Anvendelse hos forbruger



Genbrug og genanvendelse



Affald

→ At ændre et systemproblem kræver system transformation

# FNs Plasttraktat forhandlinger



**Resolution adopted by the United Nations Environment Assembly on 2 March 2022**

**5/14. End plastic pollution: towards an international legally binding instrument**

**Ambition:** Et udkast til en global, juridisk bindende aftale inden udgangen af 2024.

## **Møder i den Mellestatslige Forhandlingskomité (INC):**

Nairobi, marts 2022  
Vedtagelse af resolution

- INC-1 – Uruguay – 2022
- INC-2 – Frankrig – 2023
- INC-3 – Kenya – 2023
- INC-4 – Canada – 2024
- INC-5 – Korea – 2024
- INC-5.2 – Schweiz – 2025
- ..... →

# Plast: fra gru til gavn?

Plast er plastisk, smidigt, villigt,  
verdens venligste produkt.

Smuk teknik skal bruges smukt.

Når man gør det groft og billigt,  
er det mennesket, der svigter.

Plast kan alt, men: Plast forpligter!

*Gruk skrevet af Pirt Hein til Plastindustrien i Danmark i anledning af deres 40-års  
jubilæum, 1987, gengivet i Ingeniøren "Plast er verdens venligste produkt" (27. maj  
1994).*

# Tak for jeres opmærksomhed!



VELUX FONDEN



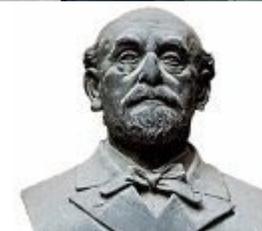
MarinePlastic II

SCARPA

UPLIFT

Innovation Fund Denmark

SusBrarane, Grand Solutions  
programme



Reinholdt W. Jorck & Hustrus Fond



PLAST TUR/RETUR  
PLAST TUR/RETUR

DTU MED VÆRT  
NANNA HARTMANN

NANNA HARTMANN  
DTU MED VÆRT

E-mail: [nibh@dtu.dk](mailto:nibh@dtu.dk)

Tlf: 93 51 08 55

DTU



# Referencer

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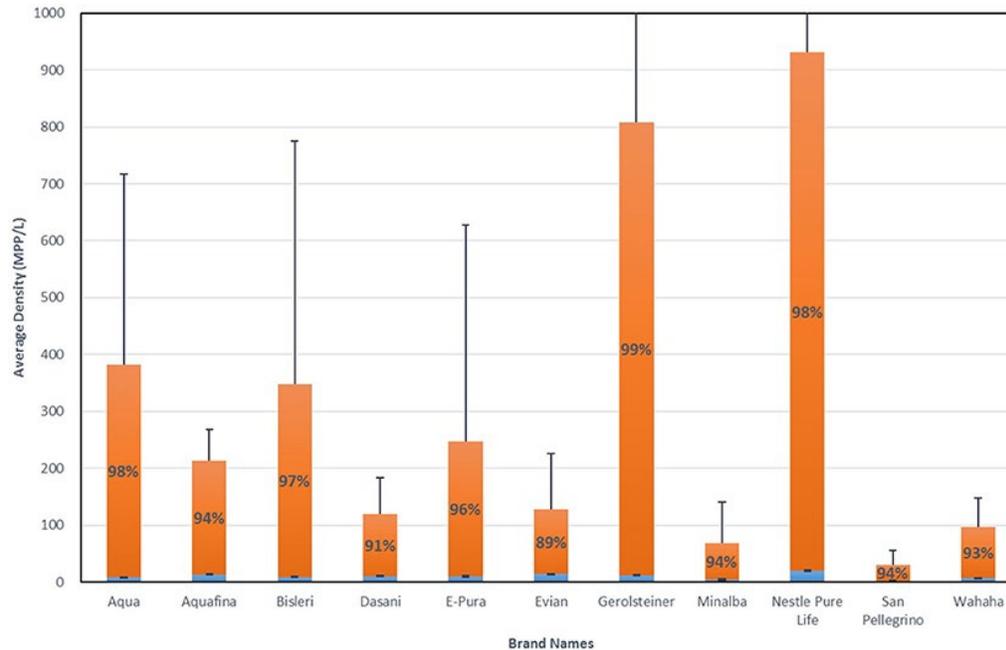
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# Vand på flaske



- 96 Mikroplast partikler/L (Gennemsnit, Nizamali et al 2023)
- 325 Mikroplast partikler/L (Gennemsnit, Mason et a., 2018)
- Meget stor variation mellem mærker (Mason et al, 2018. Winkler et al., 2019)

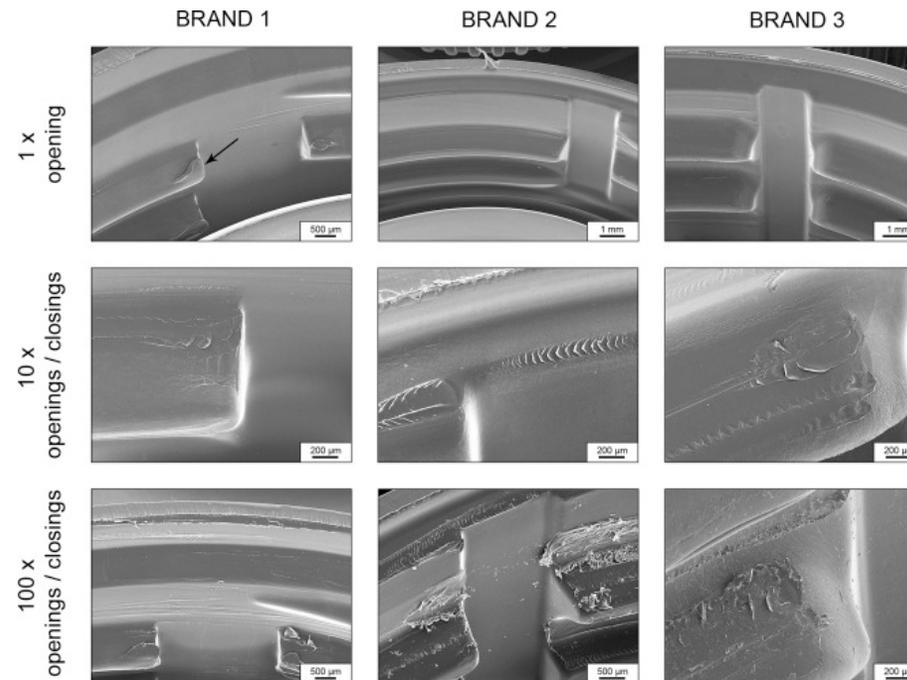


Kilde: Mason et al., 2018

# Vand på flaske



- 96 Mikroplast partikler/L (Gennemsnit, Nizamali et al 2023)
- 325 Mikroplast partikler/L (Gennemsnit, Mason et a., 2018)
- Meget stor variation mellem mærker (Mason et al, 2018. Winkler et al., 2019)
- Mekaniske påvirkninger er årsag
- til frigivelse af mikroplast



Kilde: Winkler et al., 2019