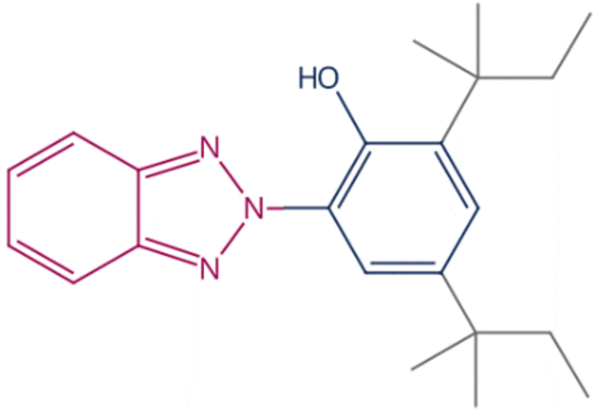
Proposal to list UV-328 in Annex A to the Stockholm Convention on Persistent Organic Pollutants

Submitted by Switzerland

Presented by Andreas Buser, Swiss Federal Office for the Environment

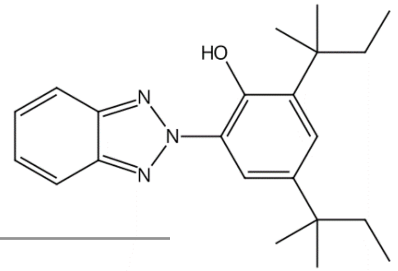
December 2, 2020

Introduction



- UV-328 is a substituted phenolic benzotriazole used as a UV absorber in a wide range of products
- Phenolic benzotriazoles absorb the full spectrum of UV light and are mostly used in transparent plastics, coatings, and personal care products. Due to their mechanism of action, their uptake of energy from UV light is reversible and non-destructive.
- UV-328 has been used worldwide in high volumes (thousands of tonnes)
- There are currently ten active registrants/suppliers in the EU under the REACH regulation and five in the United States under the Toxic Substances Control Act (TSCA)
- In 2014, the EU concluded that UV-328 is a PBT and vPvB substance and thus a substance of very high concern (SVHC)

Chemical identity



Common	**UV-328**, BDTP
IUPAC	2-(2*H*-Benzotriazol-2-yl)-4,6-bis(2-methylbutan-2-yl)phenol
CAS	Phenol, 2-(2*H*-benzotriazol-2-yl)-4,6-bis(1,1-dimethylpropyl)-
Synonyms	2-(2*H*-Benzotriazol-2-yl)-4,6-di-*tert*-pentylphenol
Commer-cial	BLS 1328, Chiguard 328, Chisorb 328, Cyasorb UV 2337, Eversorb 74, GSTAB 328, Hostavin 3310 P, Kemisorb 74, Lowilite 28, Milestab 328, Seesorb 704, Songsorb 3280, Sumisorb 350, Thasorb UV328, Tin 328, Tinuvin 328, UV 2337, UV 74, Uvinul 3028, Viosorb 591
CAS RN	25973-55-1
EC No.	247-384-8

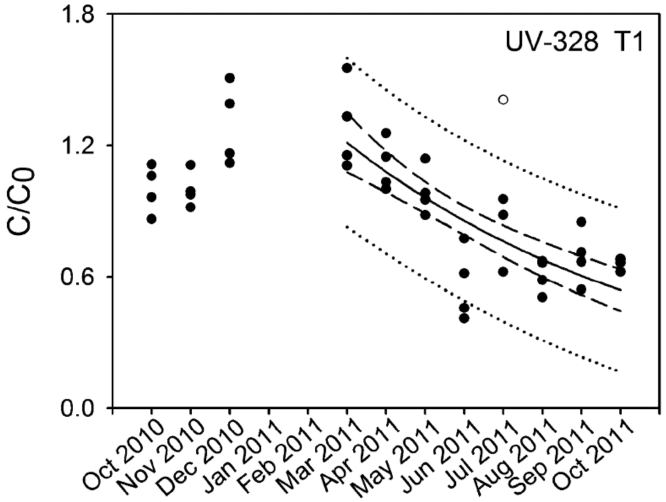
Physicochemical properties and environmental behavior

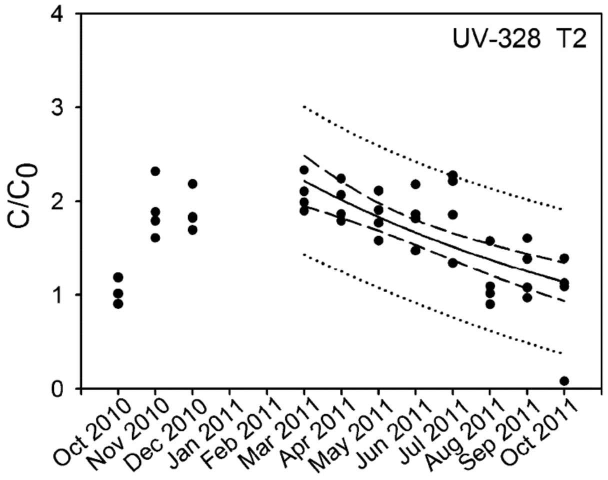
S_W : $1.3 \cdot 10^{-5}$ mg/L to 0.42 mg/L (experimental and estimated)	Low water solubility, highly hydrophobic
log K_{OW}: 6.5 – 7.3 (experimental and estimated)	Adsorbs and/or absorbs to organic material
log K_{AW}: −10.6 (estimated)	In water, UV-328 will likely partition to particles and organic matter, suspended or deposited
Vapour pressure: $3 \cdot 10^{-8}$ to $5 \cdot 10^{-6}$ Pa (experimental and estimated)	Low tendency to volatilise

Persistence

- Hydrolysis (no hydrolysable structural element, low water solubility), oxidation and photo-transformation (UV absorber characteristics) are not expected to be significant

- In a field study with sludge-amended soils, UV-328 had disappearance half-lives (DT_{50}) of 179–218 days; another similar study observed DT_{50} values of 99–223 days.





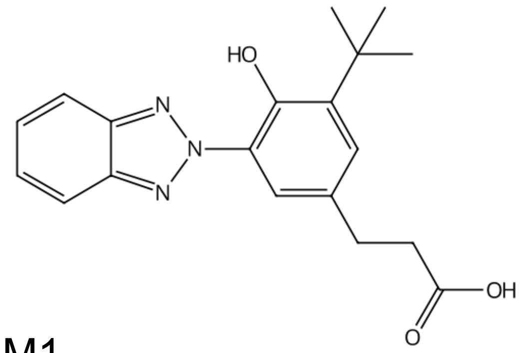
Lai et al., 2014, Environ Toxicol Chem; Lai et al., 2014, Environ Sci: Processes Impacts

Persistence

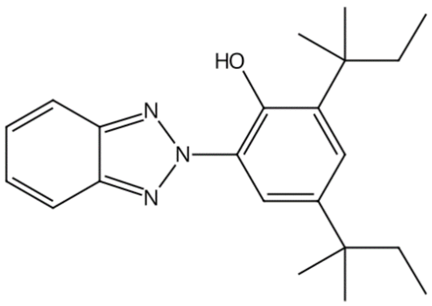
- Hydrolysis (no hydrolysable structural element, low water solubility), oxidation and photo-transformation (UV absorber characteristics) are not expected to be significant

- In a study with sludge-amended soils, UV-328 had disappearance half-lives (DT_{50}) of 179–218 days; and another similar study observed DT_{50} values of 99–223 days.

- Read across with a structurally similar substance, M1 (CAS No. 84268-36-0); calculated DT_{50} for M1 in sediment in the pond system was 238 or 248 days



M1



UV-328

Brandt et al., 2016, Environ Sci Eur

Persistence

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- Read across with a structurally similar substance, M1 (CAS No. 84268-36-0); calculated DT_{50} for M1 in sediment in the pond system was 238 or 248 days

➡ Under a weight-of-evidence approach, UV-328 fulfils the persistence criterion

Bioaccumulation

- UV-328 has a log $K_{OW} > 5$
- Bioaccumulation was tested in two different studies in 2000 and 2007.
  Test species in both studies: *Cyprinus carpio* (common carp)
- 2007 study: OECD TG 305 (flow-through fish test), exposure duration 60 days, BCFs in L/kg ww

Test concentration (µg/L)	Exposure time (days)				
	12	26	40	50	60
0.1	870	1100	990	820	1000
	570	1400	780	1000	1000
0.01	620	890	1500	1300	1000
	650	1300	1800	980	1700

Bioaccumulation

- 2000 study: OECD TG 305 C, exposure duration 8 weeks, BCFs in L/kg ww

Exposure time (weeks)		0.8 µg/L		0.08 µg/L	
2	Non-normalised	1300	1300	2300	2300
	Lipid-normalised	1500	1600	2700	2700
4	Non-normalised	1700	1100	3700	3300
	Lipid-normalised	2000	1300	4400	3900
6	Non-normalised	1700	2800	4400	5600
	Lipid-normalised	2000	3300	**5200**	**6600**
8	Non-normalised	2100	2400	4400	4800
	Lipid-normalised	2500	2800	**5200**	**5700**

- BCF values at the end of the exposure period exceed the criteria for bioaccumulation in Annex D (BCF > 5000)

- Depuration half-lives of 24 and 26 days also point towards a high bioaccumulation

Bioaccumulation

- Five finless porpoises were collected from the Yatsushiro Sea, Ariake Sea and Tachibana Bay (Japan) in 1999, 2008 and 2009, respectively
- Small fish including flathead, solefish, right-eye flounder, sandperch and sweetlips were collected from the Ariake Sea between 2004 and 2007

[ng/g ww]	Concentration in blubber	Concentration in whole body	Concentration lipid normalized (5% lipid)
Finless porpoise	29 ± 19	8.4 ± 5.5	1.9 ± 1.3
Small fish	–	0.25 ± 0.03	0.5 ± 0.2

Nakata et al., 2010, Journal of Environmental Monitoring 12(11), Nakata et al., 2009, ES&T, 43

Bioaccumulation

- The BAF of UV-328 is estimated at approx. 87,000 L/kg ww in mid-trophic level fish, indicating significant BMF in aquatic organisms when considering food intake, according to the AQUAWEB model.

- EPI Suite estimates a BCF (regression-based method) of 6000 L/kg ww

- Taken together with log $K_{OW} > 5$, the experimental BCF > 5000 L/kg ww, its detection in marine food webs, in human breast milk and in human adipose tissue …

➡ UV-328 fulfils the criteria for bioaccumulation

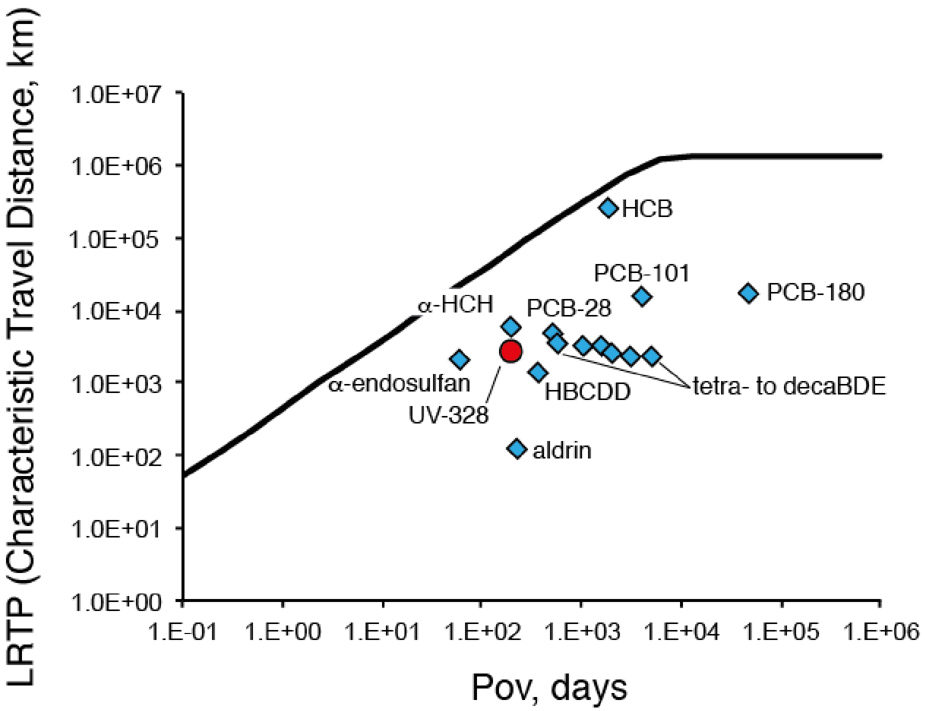
Potential for long-range transport

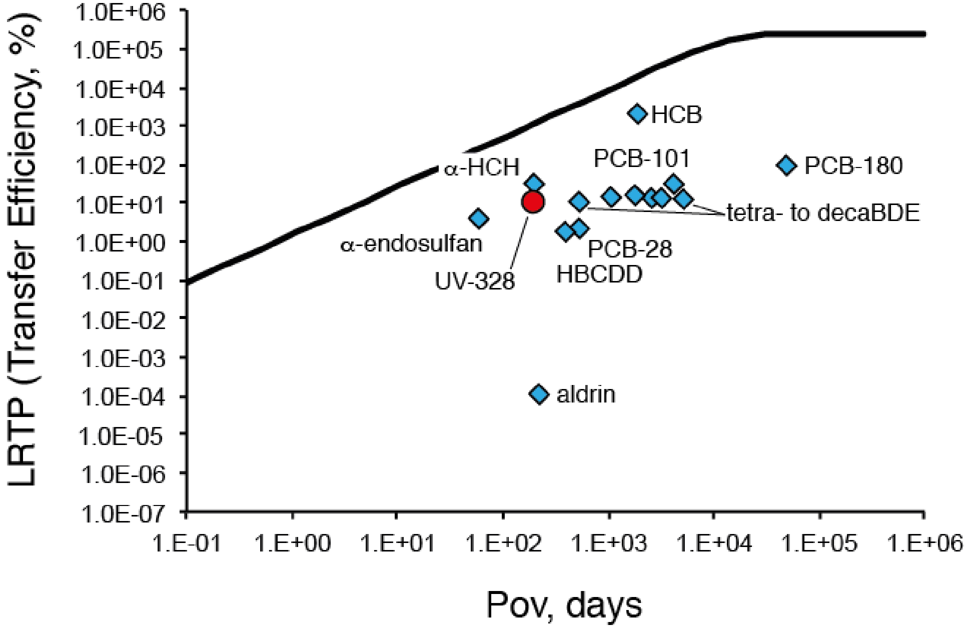
- **UV-328 is not expected to undergo atmospheric long-range transport in the gas phase** due to its low vapour pressure, low Henry's law constant and short estimated half-life in the gas phase

- The log K_{OW} and log K_{OC} values imply that UV-328 will strongly partition into organic matter, including absorption into and adsorption onto aerosol particles in air, as well as to suspended solids in water

- Once adsorbed to aerosol particles in air, **UV-328 will undergo long-range transport with the particles**

Potential for long-range transport – OECD P_{OV} LRTP Tool





Comparison of UV-328 (●) with benchmark POPs (♦)

Potential for long-range transport – Monitoring

- Around Lake Superior, UV-328 had 100% detection frequency in herring gull eggs
- On Svalbard Island, Norway, UV-328 had 60–100% detection frequency in Arctic biota (seabird eggs), except in polar bears (blood samples; not adipose tissue)
- UV-328 also detected in Pacific Ocean mussels (detection frequency 65%)
- Global monitoring in preen gland oil of seabirds ➔ *presentation by Prof. Takada*

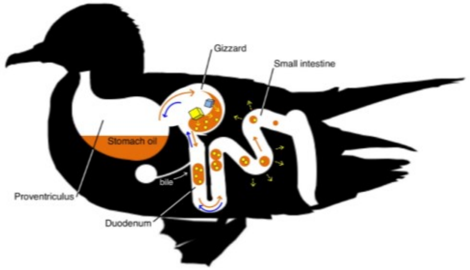
UV-328 not yet routinely monitored

Potential for long-range transport – Transport with plastics in water

1) UV-328 in plastic waste

2) Transport of plastic debris to remote regions

3) Consumption of plastic debris by seabirds



4) Uptake of UV-328 from ingested plastic debris

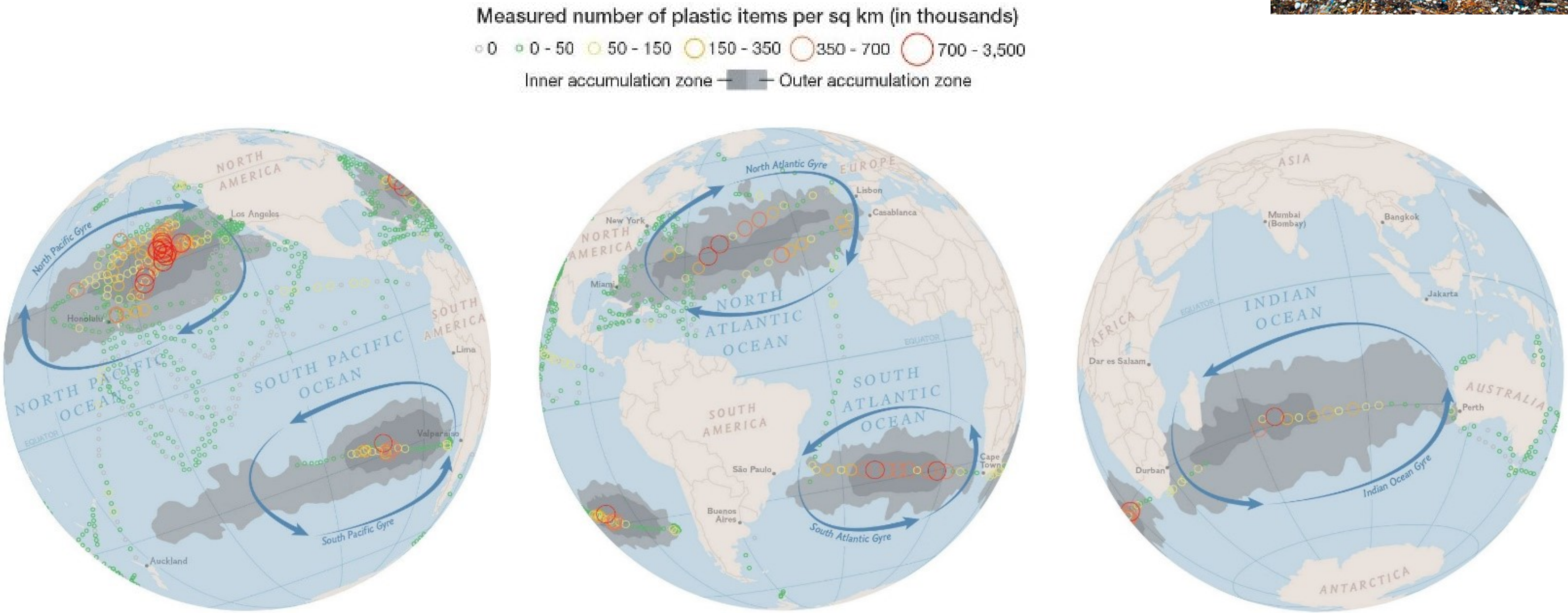
➡ **Hypothesis:**
Transport with plastics in water is a long-range transport pathway in addition to LRTP with airborne particles similar to many acknowledged POPs

Potential for long-range transport –
1) UV-328 in plastic waste

- 8300 million tonnes (Mt) of virgin plastic have been produced until 2017, 348 Mt in 2017
- 79% of plastic waste may be disposed of in landfills or in the environment
- About 8 Mt end up in the ocean every year – it persists in the marine environment for decades to centuries, part of it is transported over long distances to remote regions

- ~40% of the global production of UV-328 is used in wide range of plastic products, e.g. polyolefins

Potential for long-range transport –
2) Transport of plastic debris



National Geographic Staff, Jamie Hawk;
Cozár *et al.*, PNAS, 111(28), 2014

Potential for long-range transport –
3) Consumption of plastics by seabirds

Marine Pollution Bulletin 123 (2017) 269–278

Community-wide patterns of plastic ingestion in seabirds breeding at French Frigate Shoals, Northwestern Hawaiian Islands☆

Dan C. Rapp[a,b], Sarah M. Youngren[a,b], Paula Hartzell[c], K. David Hyrenbach[a,b,*]

[a] *Hawaii Pacific University, Marine Science Programs at Oceanic Institute, 41-202 Kalanianaole Highway, Waimanalo, HI 96795, USA*
[b] *Oikonos Ecosystem Knowledge, P.O. Box 1918, Kailua, HI 96734, USA*
[c] *U.S. Fish and Wildlife Service, 300 Ala Moana Boulevard, Honolulu, HI 96850, USA*

- Widespread plastic ingestion by seabirds, involving 11 species in 7 families and 4 orders
- Tristram's storm petrels (100%) and albatrosses (~90%) had highest plastic incidence rates. All seabirds (16 species, n = 362): 67%

Potential for long-range transport –
3) Consumption of plastic debris by seabirds

Marine Pollution Bulletin 145 (2019) 36–41

Piece-by-piece analysis of additives and manufacturing byproducts in plastics ingested by seabirds: Implication for risk of exposure to seabirds

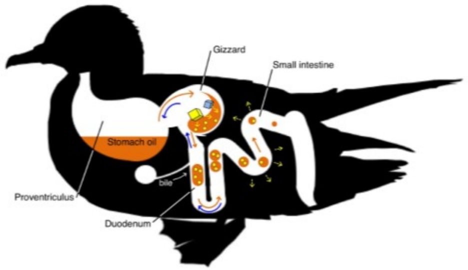
Kosuke Tanaka[a,1], Jan A. van Franeker[b], Tomohiro Deguchi[c], Hideshige Takada[a,*]

[a] Laboratory of Organic Geochemistry (LOG), Tokyo University of Agriculture and Technology, Fuchu, Tokyo 183-8509, Japan
[b] Wageningen Marine Research, Ankerpark 27, 1781 AG Den Helder, the Netherlands
[c] Division of Avian Conservation, Yamashina Institute for Ornithology, Konoyama 115, Abiko, Chiba 270-1145, Japan

Concentrations of chemicals in plastics ingested by seabirds.

Chemical	Detection % (n = 194)	Plastic type[a]	Bird species	Concentration[b] (μg/g-plastic)	Amount[b] (μg/piece)
UV-328	1.0%	PP fragment	Northern fulmar	1.1	0.026
		PP fragment	Black-footed albatross	1.4	0.016
UV-326	1.0%	PE fragment	Northern fulmar	1.8×10^2	1.2×10^1
		PE fragment	Northern fulmar	2.3×10^1	0.77
UV-327	2.1%	PE fragment	Northern fulmar	5.8	0.24
		PE fragment	Northern fulmar	8.6×10^2	1.6×10^1
		PE pellet	Northern fulmar	3.5×10^1	0.47

Potential for long-range transport –
4) Uptake of UV-328 from ingested plastics



Report

Current Biology

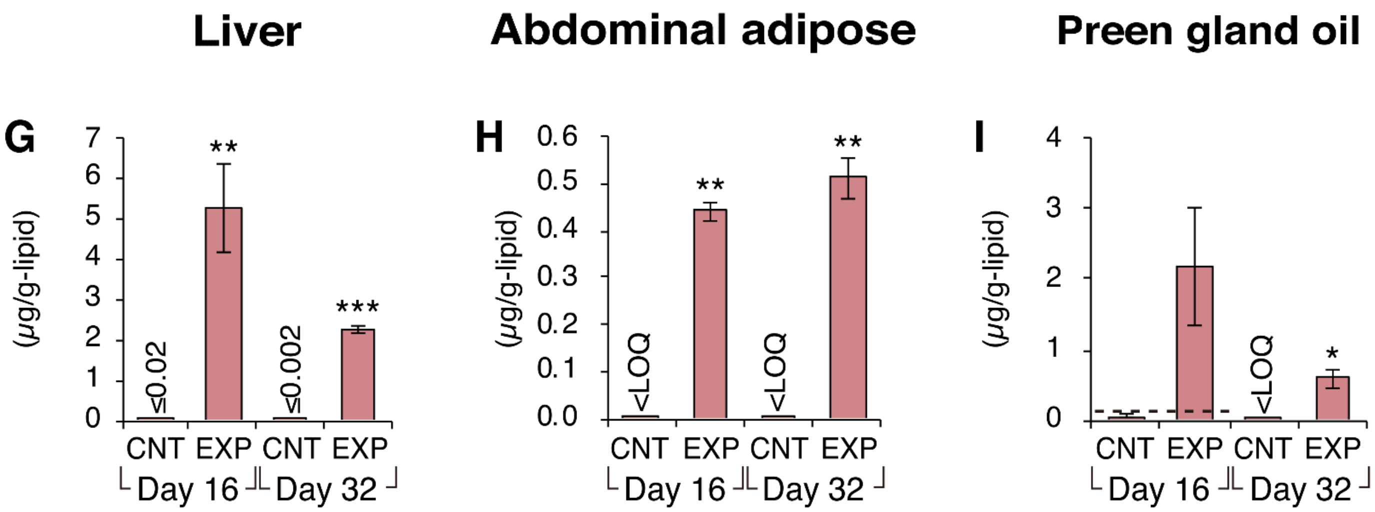
***In Vivo* Accumulation of Plastic-Derived Chemicals into Seabird Tissues**

Authors

Kosuke Tanaka, Yutaka Watanuki, Hideshige Takada, ..., Michelle Hester, Yoshinori Ikenaka, Shouta M.M. Nakayama

Tanaka et al., 2020, Current Biology *30*, 1–6
February 24, 2020 © 2019 Elsevier Ltd.
https://doi.org/10.1016/j.cub.2019.12.037

Results for UV-328



CNT – control, EXP – plastic exposure group

Potential for long-range transport – Transport with plastics in water

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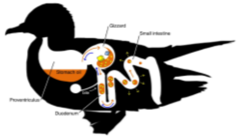


4) Uptake of UV-328 from ingested plastic debris

Additional evidence for the hypothesis:

UV-328 found in preen gland oil from 12 seabird species sampled across the world

More details in presentation by Prof. Hideshige Takada

→ **UV-328 does undergo LRT**

Adverse effects – Repeated-dose toxicity

- A diet containing UV-328 for 49 (short-term) and 90 (subchronic) days (test protocol similar to OECD TG 408, non-GLP, 1968) for female and male rats affected their liver and kidneys.

- The NOAEL was 100 ppm of a UV-328 dose, equivalent to 22 mg/kg bw/day for rats

- Focal necrosis of the liver and tubular nephrosis at the feeding level of 52.7–98.7 mg/kg bw/day met the criteria of significant toxicity to human health, at concentrations meeting guidance values for category STOT RE 2. The calculated LOAEL was of 10 mg/kg bw and the NOAEL was < 10 mg/kg bw.

Adverse effects – Repeated-dose toxicity

- Beagle dogs were given UV-328 via diet for 90 days in a concentration range of 15–240 mg/kg bw/day. The main target organs were again liver and kidney.

- Some animals of the higher-dose groups also had alterations in reproductive organs. The NOEL in this study was < 15 mg/kg bw/day and the NOAEL was 30 mg/kg/day.

- The histopathological effects observed in dogs exposed to 60 mg/kg bw/day met the criteria defined in the CLP regulation. The changes in the activity of several enzymes in serum and changes observed in protein pattern in serum in animals exposed to > 15 mg/kg support classification as STOT RE.

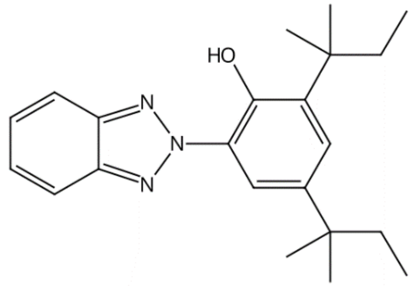
→ **UV-328 fulfils the criteria for adverse effects**

Reasons for concern

Several monitoring data points are near to or exceeded the predicted no-effect concentration (PNEC) or the derived no-effect level (DNEL):

	PNEC/DNEL	Monitoring
Freshwater	10 µg/L	7–85 µg/L in Narragansett Bay
Marine water	1 µg/L	ND–0.3 µg/L in seawater from Okinawa Island beach sites
Sediment (freshwater)	451 mg/kg dw	300 mg/kg in Narragansett Bay
Secondary poisoning	13.2 µg/g **food**	Up to 7 µg/g **lw** in preen gland oil of seabirds from remote islands
Oral exposure (systemic, long-term)	140 µg/kg bw/day ≙ 9,8 mg/day	Up to 1.3 mg/kg crayfish from Canada ≙ 0.65 mg/day (assuming a daily consumption of 500 g crayfish)

Conclusion



- Based on the presented data, UV-328 meets the screening criteria in Annex D for persistence, bioaccumulation, LRTP, and adverse effects under the Stockholm Convention

- UV-328 is emitted into the environment from a wide range of human activities, e.g. manufacturing processes, consumer products, and disposal and management of waste

- The presence of UV-328 is an issue in remote locations and the environmental long-range transport of free UV-328 is aggravated by the long-range transport of plastic debris in water that acts as a continuous source of UV-328 during its circulation in the environment

- Under the REACH regulation, UV-328 is an SVHC and was listed in Annex XIV (authorisation) in February 2020