



 Swedish Society for Nature Conservation

## Report Chemicals – up close

Plastic shoes from  
all over the world

# Preface

The Swedish Society for Nature Conservation (SSNC) has been working to protect nature and the environment in Sweden for more than 100 years, and working with consumer power for 20 years. In many respects, Sweden is a role model when it comes to environmental issues. Nevertheless, products containing chemicals that are harmful to health and the environment are still sold in Swedish shops.

The SSNC conducts product surveys every year, and in recent years has investigated e.g. the presence of chemicals harmful to health and the environment in sun protection products, t-shirts, hand towels and impregnation sprays. On this occasion we have investigated plastic shoes. The investigation has been conducted in collaboration with six organisations:

- EcoWaste in the Philippines
- Toxics Link in India
- GroundWork in South Africa
- NAPE in Uganda
- Envirocare in Tanzania
- Balifokus in Indonesia

The SSNC collaborates with these organisations, and through this investigation it intends to extend this collaboration, broaden discussions about chemicals that are harmful to health and the environment that are present in goods, and to spread the use of consumer power to bring about change.

This investigation shows that shoes purchased all over the world contain substances such as softeners that are harmful to the reproductive system, toxic tin organic compounds, as well as the heavy metals cadmium and lead. The aim of the SSNC and the co-operation organisations is to use this investigation to get politicians to realise that tighter legislation is required in order to limit the use of chemicals that are harmful to health and the environment. To date, the sector has not shown itself able to assume responsibility for the health of consumers and the best interests of the environment.

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Note: If there is any uncertainty regarding the interpretation of the text, the Swedish version always prevails.

# Contents

Summary	4
Introduction	5
Business partners	6
Production and consumption of shoes	7
Chemicals in plastic shoes	8
Environmental and health properties of the tested chemicals	9
Phthalates	9
Heavy metals	9
Azo dyes	11
Tin organic compounds	11
PAH (polyaromatic hydrocarbons)	12
Legislation in Sweden and the EU	13
Phthalates	13
Heavy metals	14
Azo dyes	14
Tin organic compounds	14
Shoes as waste – the spread of the chemicals in the environment	15
Method	16
Selection of products for analysis	16
Analysis method	19
Halogens	19
Phthalates	19
PAH	19
Azo dyes	20
Tin organic compounds	20
Heavy metals	20
Checking compliance with the law as regards consumer information	20
Results	22
Discussion	26
Advice and requirements	30
References	31

# Summary

The shoe industry is one of the most globalised industries in the world. Shoes, and in particular plastic shoes that have been analysed in this study, have become a throwaway item for many people the world over.

Many different types of chemical that can cause health and environmental problems are used in the manufacture of plastic shoes. These chemicals can cause harm to the workers who handle the chemicals or the shoes. They can harm the environment as the shoes wear out and when they are discarded. The chemicals can also cause health problems for the people who wear the shoes. However, a person who buys a pair of shoes seldom knows which chemicals they contain or where the shoes were made.

This study has been conducted in collaboration with six of the SSNC's co-operation organisations in the Philippines, India, South Africa, Uganda, Tanzania and Indonesia. Each organisation has purchased shoes and then analysed them with regard to a number of chemicals that can cause environmental problems in the country where they are produced or where the shoes are worn and discarded. The chemicals have been selected as they can also cause health problems for the people working in the factories or for those who buy and wear the shoes.

The analyses showed that 17 of the 27 shoes that were tested contained one or more of the tested phthalates. The phthalate DEHP, which is harmful to reproductive systems, was present in various amounts in all 17 of these products. The highest content, 23.2%, was found in a pair of flip-flops from South Africa.

DEHP is one of seven prioritised substances on the EU's candidate list for particularly harmful substances, known as SVHC (Substances of Very High Concern). The European Commission may decide that it will be necessary to obtain authorisation in order to use these substances in specific cases.

The analyses that have been conducted also show that several shoes contain PAH (polyaromatic hydrocarbons), tin organic compounds and heavy metals. Two pairs of shoes contained mercury and several contained lead and cadmium.

The study shows that the content of chemicals is not linked to where the shoes are manufactured or purchased. Neither is it possible to draw any conclusions regarding the chemical content based on the price of the product.

Through this report, the SSNC and the participating organisations aim to demonstrate the environmental and health problems that are related to a normal consumer product. Based on the results, we also want to challenge consumers to ask for products that do not contain chemicals that are harmful to health and the environment, and to challenge the shoe industry to accept its share of responsibility for people's health and for our shared environment by ensuring that shoes are produced without containing hazardous substances.

The results in the report also indicate the need for tighter legislation at an international level, an EU level and a domestic level, leading to the phasing out of hazardous chemicals in products.

# Introduction

Over the course of several years, the Swedish Society for Nature Conservation has worked to bring the attention of the Swedish textile industry to the way in which chemicals in textiles can harm people and the environment, both in the country where the products are made and in the country where they are used. In recent years, many companies in the textile sector have had their eyes opened to the problems that the textile industry is causing. Some of these are now working actively to bring about a change.

Like textiles, shoes are a major global commodity and a fashion item, where the trend is moving towards buying new shoes increasingly often. The aim of the SSNC and the co-operating organisations is to use this investigation to demonstrate that shoes can also cause problems from an environmental and health perspective, and to show that the legislation that exists in this area is insufficient.

One purpose of this study is to show the extent of the problem involving hazardous chemicals such as phthalates, tin organic compounds and heavy metals. The purpose has also been to show that the problem of chemicals that are harmful to health and the environment in products is the same all over the world, even though the legislation differs.

Analysing everyday products with regard to chemicals that are harmful to health and the environment is a very effective method of encouraging ordinary consumers to get involved in environmental and chemical issues. This has also been one of the aims of the investigation. This method has become more widespread in Sweden, and is now used by many different trade organisations, including in other countries.

# Business partners

This study has been carried out in collaboration with six of the SSNC’s co-operation organisations in the Southern Hemisphere.

## EcoWaste

The Ecological Waste Coalition of the Philippines, EcoWaste, is a network of more than 75 active trade groups and movements, operating in the Philippines, that was established in 2000. EcoWaste is working to achieve “Zero Waste” by 2020, in part by providing information about the most climate friendly and ecologically sustainable methods of handling waste. EcoWaste is also working to bring about the non-toxic production of goods. In co-operation with the SSNC, EcoWaste is working to inform the general public and decision-makers that chemicals in production and when using goods can represent a problem for people’s health and the environment.

## Toxics Link

Toxics Link, India, started life in 1996 as a platform for the exchange of information, and now works both at local level and at policy level through various networks. Toxics Link is working to achieve a toxin-free health sector and toxin-free foods, and works with electronic waste, product safety, sewage and recycling. With the aid of the financial support that Toxics Link receives from the SSNC, the organisation can in turn support and teach smaller non-profit organisations regarding chemical issues.

## GroundWork

GroundWork in South Africa belongs to Friends of the Earth International and was founded in 1999. GroundWork is renowned for its successful work regarding industrial chemicals and for the way the organisation reinforces the voice of the weaker members of society, highlighting the unfair situation whereby poor people often live in the most polluted areas and have poor access to natural resources. GroundWork operates primarily in South Africa, although it also conducts

activities in neighbouring countries, both at local and at policy level.

## NAPE

The National Association of Professional Environmentalists in Uganda, NAPE, was established in 1997. NAPE works with areas such as sustainable chemicals handling and the preservation of natural resources such as water, energy, forest and wetlands. NAPE also works actively with gender issues and human rights. NAPE’s collaboration with the SSNC involves informing the general public and decision-makers that chemicals used during production and in goods can represent a problem for human health and the environment.

## Envirocare

Envirocare in Tanzania was founded in 1993. Envirocare is endeavouring to incorporate issues regarding human rights, gender and HIV/AIDS in its work. Sustainable chemicals handling, entitlements to forest and land, increased organic agriculture and increased tree planting in Tanzania are all prioritised areas. Envirocare’s collaboration with the SSNC involves helping workers at textile factories in Tanzania, as well as reducing emissions from these factories.

## Balifokus

Balifokus in Indonesia was established in 2000 and is working to increase quality of life and society’s capacity from social, health and economic perspectives. Balifokus aims to improve the environment in towns and cities by controlling pollution and emissions, with particular focus on chemicals. For example, Balifokus is working to develop cost-effective water treatment plants for small-scale industry, and has launched several different sanitation and waste programmes on Bali. In collaboration with the SSNC, Balifokus has launched the Indonesia Toxics Free Network to support and teach other environmental organisations in their work on chemicals issues.

# Production and consumption of shoes

## Global

The shoe industry is now one of the most globalised industries in the world. A shoe that is designed in Sweden may be manufactured in China and contain parts that have been produced in other countries. Shoes are sometimes transported to Italy, for example, where they undergo final handling before being sent on to the country where they are to be sold.

The Swedish organisation *Rena Kläder*, in its report *Hur skor vi oss?* [“How do we shoe?”], writes that the globalised shoe industry frequently causes major problems for the workers manufacturing the shoes. Adhesives, hardeners and cleaning agents can cause skin irritation, dizziness and, in the worst case scenario, leukaemia. Many factories lack protective equipment and the workers rarely receive information about the risks associated with the production process.<sup>1</sup>

## Sweden

Sweden’s shoe industry had its heyday between 1930 and 1940. In the 1950s, the importing of shoes was unleashed. This resulted in stiff competition for Swedish manufacturers and many went bankrupt.<sup>2</sup>

According to Statistics Sweden (SCB), imports of shoes to Sweden increased from 42,349 tonnes in 1998 to 55,815 tonnes in 2008, or from barely SEK 9 billion to almost SEK 12 billion over the same period.

From SCB’s statistics, it is possible to ascertain specific figures for the import of plastic shoes, through category “6 402 Shoes with outer soles and uppers made of rubber or plastic”. This group excludes watertight shoes and can thereby be said to be representative of the type of shoes included in this study.

In 2008, 8,923 tonnes of plastic shoes were imported into Sweden, at a value of almost SEK 1 billion. This represents an increase of more than 55% over ten years.

The majority of shoes in this specific category were imported from China, which was responsible for 5,438 tonnes in 2008. This is almost half of all the plastic shoes that were imported to Sweden. Imports of shoes from China to Sweden have increased by almost 800% over the past 10 years. The six largest players on the Swedish shoe market are Eurosko, Vagabond, Nilson Group, ANWR, Scorett and Ecco.<sup>1</sup>

Companies that import textiles, clothes, leather goods and shoes are included in the Swedish trade organisation entitled the Textile Importers’ Association in Sweden. This body is working to encourage the EU to abolish all import restrictions. It is also working with environmental issues and codes of conduct, and has developed a chemicals guide for its members. Some of the Association’s members sell shoes, such as Stadium, Intersport, H&M and Lindex.<sup>3</sup> Pure shoe companies are not currently members of the Textile Importers’ Association in Sweden.

# Chemicals in plastic shoes

Plastic and rubber that are used as raw materials in the shoes we have tested in this study contain chemical residues from the actual raw material. They can also contain chemicals that have been added to provide the raw material with a specific property or that have been used during manufacture. When colouring plastic or rubber, auxiliary chemicals are used that remain in the shoe to some extent. The shoes can also be treated with anti-bacterial substances, for example. When shoes are glued together, adhesive is used that often contains hardeners and solvents.<sup>1,2</sup>

Solvents can be harmful to the health of those who manufacture and handle the product or who use it. Solvents can cause everything from dizziness to leukaemia and paralysis

when inhaled. Solvent residues can also remain in the product when it reaches the shops. If the substance is allergenic, it can also cause problems for allergic individuals and shop staff.<sup>1,2</sup> In this investigation, the analysed shoes have not been tested for the presence of solvents. There are several reasons for this. These include economic reasons, as well as the fact that solvents are volatile, which means that the problem with solvents is primarily a working environment problem. This study does not focus on the working environment, which is another reason for solvents not having been included for analysis. However, the shoes have been analysed for the presence of PAH, as these substances can be present as a contaminant in the rubber raw material.

# Environmental and health properties of the tested chemicals

## Phthalates

### *Areas of application*

Phthalates are a group of chemicals that are primarily used as softeners in polyvinyl chloride (PVC) plastic. Without adding softeners, PVC plastic would be stiff and brittle. Many consumer products, including building and furnishing materials, packaging materials for food as well as toys, can contain PVC plastic. Phthalates are also used in cosmetics, for example as a denaturant for alcohol (a substance that makes the alcohol undrinkable) and as an aroma enhancer in perfumes.

### *Environmental and health properties*

The phthalate DEHP is classified as toxic to reproduction category 2, R60 (can cause reduced fertility) and R61 (can harm the unborn child). DBP and BBP are classified as toxic to reproduction categories 2 & 3, R61 (can harm the unborn child) and R62 (possible risk of reduced fertility). Other analysed phthalates do not at present have an official classification.

Phthalates are not chemically bound to PVC plastic, which means that they leach into water over time, or evaporate from the plastic into the air. People are exposed to phthalates from the foetal stage and throughout the rest of our lives, via the food we eat, the air we breathe and through direct skin contact.

The exposure of people to the phthalate DEHP (diethylhexyl phthalate) has been carefully studied. On average, this is 3-30 µg DEHP/kg of body weight and day<sup>4</sup>. This means that we may sometimes be exposed to concentrations that exceed the guidelines of 37 µg DEHP/kg of body weight and day<sup>5</sup>, or 20 µg DEHP/kg of body weight and day<sup>5</sup>, determined as tolerable by the EU and the US Environmental Protection Agency.

Exposure to other phthalates is not as well known. Several phthalates, such as DBP (dibutyl phthalate) and BBP (benzyl butyl phthalate)<sup>4,5</sup>, are used in volumes that are approaching DEHP use. There are also phthalates whose use

is expected to increase as a substitute for DEHP, such as DINP (diisononyl phthalate) DONP (dinoctyl phthalate) and DIDP (diisodecyl phthalate)<sup>6</sup>.

Phthalates are associated with serious health risks. In animal experiments, it has been observed that exposure to the phthalates DBP, BBP, DIDP, DINP and DEHP during pregnancy can lead to foetus death, serious deformities, permanently impaired testicular function and reduced birth weight<sup>5,7</sup>.

Phthalate exposure during the foetal stage may lead to incomplete testicular development and reduced penis size in boys<sup>8</sup>. Exposure to certain phthalates during the foetal stage may also change the way cells respond to sex hormones in adults, and this may be one of the causes of reduced fertility among men<sup>9</sup>.

Knowledge about the environmental effects of phthalates is limited, which is worrying considering that phthalates are found in water, sediment, soil and organisms. However, different organisms that have been exposed to phthalates in laboratory trials indicate the effects we can anticipate in the environment. This applies to everything from harm at an individual level, such as cell damage and altered enzyme activity, to structural changes in the ecosystems.

## Heavy metals

Some metals have no known biological function, such as arsenic, cadmium, chromium, lead and mercury. Other metals are required in order for cells to function normally, such as copper, nickel, iron and zinc. Most metals are toxic in high concentrations<sup>10</sup>. The metals that do not have a biological function can also be toxic in very low concentrations<sup>10</sup>.

### *Areas of application*

Heavy metals are used as a pigment in some dyes. In some cases, heavy metals are also used as stabilisers to make plastic materials more durable.

*Environmental and health properties*

Heavy metals are elements and differ from light metals due to higher density. Most heavy metals and their compounds are toxic, particularly lead, cadmium and mercury. Heavy metals are, as a rule, hazardous to users, with with carcinogenic or allergenic properties, and are also toxic to aquatic animals and plants.

**Arsenic**

Arsenic is classified as carcinogenic according to IARC group 1 (carcinogenic for people). Arsenic can also give rise to various types of chromosome damage and foetal damage.<sup>2, 12</sup> Arsenic is highly toxic to aquatic organisms. Arsenic compounds are an extreme irritant to the skin, eyes and mucous membranes.<sup>12</sup>

**Lead**

Lead is used as an additive in paints and as a stabiliser in plastic in order to make the plastic material more durable<sup>20</sup>.

Lead is one of the worst environmental toxins and can accumulate in the body, primarily in the skeleton where it can damage the bone marrow and impair the body's formation of red blood cells<sup>2</sup>. Lead affects neurological functions that can be measured in the form of declining intelligence. The EU classifies lead compounds as “hazardous when inhaled or consumed” and states that they “can accumulate in the body and cause damage”, “harm the unborn child” and be a “possible cause of impaired fertility”.<sup>12</sup>

Lead and lead compounds are highly toxic to aquatic organisms.<sup>12</sup>

**Cadmium**

Cadmium is used as a pigment in paint<sup>2</sup>. Cadmium is also used in plastics to make the plastic material more durable.

Cadmium is one of the worst environmental toxins and can cause damage to the kidneys, the nervous system and the endocrine system, as well as genetic damage, damage to the unborn child and impaired fertility. Cadmium is highly toxic

when inhaled and can cause cancer. Cadmium is highly toxic to fish, crustaceans and algae, and can also bioaccumulate.<sup>12</sup>

**Cobalt**

Cobalt can be included as a pigment in paint. Cobalt is classified within the EU as allergenic when inhaled and in the event of skin contact. Cobalt is suspected of being carcinogenic according to IARC (International Agency for Research on Cancer) class 2B, possibly carcinogenic in people. Cobalt is toxic to aquatic organisms and has a high potential to bioaccumulate in fish.<sup>12</sup>

**Copper**

The copper ion is highly toxic to aquatic organisms and can cause adverse long-term effects in the aquatic environment. Copper has a relatively low potential to bioaccumulate in fish, although bioaccumulation does occur in phytoplankton (small algae and certain bacteria that float freely in the water).<sup>12</sup>

**Chromium and chromium compounds**

Chromium can be included as a pigment in strong paints. Chromium occurs in several oxidation states, with chromium 3+, chromium 6+ and metallic chrome (chromium 0) being the most common. Chromium 6+ is the most toxic form.<sup>12</sup>

Chromium 6+ is carcinogenic. The substance is mutagenic, which means that it damages the cells' genetic material. The substance is extremely allergenic and can cause eczema in the event of repeated skin contact. When large amounts are consumed, effects on the kidneys, liver and blood as well as reduced fertility have been observed. Chromium 6+ is highly toxic to aquatic organisms and can cause adverse long-term effects in the aquatic environment.<sup>12, 13</sup>

**Mercury**

Mercury is one of the worst environmental toxins and can accumulate in the body and damage the kidneys and the central nervous system. Allergies can arise in the event of contact with the skin. Mercury is toxic, harmful to the environment and highly toxic to aquatic organisms, and has a very high capacity to bioaccumulate in fish.<sup>12</sup>

**Manganese**

When inhaled or consumed in drinking water, manganese can cause neurological damage with symptoms such as weakness, muscle pain and apathy. Manganese is toxic to aquatic organisms and has a very high capacity to bioaccumulate in fish.<sup>12</sup>

**Nickel**

Nickel can cause contact eczema. Nickel has been deemed to be potentially carcinogenic for people (IARC 2B) and nickel compounds have been deemed to be carcinogenic when inhaled (IARC 1)<sup>14</sup>. Nickel is relatively non-toxic to fish and crustaceans, although highly toxic to certain algae. Nickel has a low capacity to bioaccumulate in fish.<sup>12</sup>

**Zinc**

Zinc is used as a pigment in paint<sup>2</sup>.

Inhalation of vapour containing zinc can cause a sore throat, fever, the shivers and muscle pain<sup>2</sup>. Zinc is classified as highly toxic to aquatic organisms and can cause adverse long-term effects in the aquatic environment. Zinc can bioaccumulate, but is not enriched in the food chain.<sup>12</sup>

**Azo dyes***Areas of application*

Azo dyes produce clear, strong colours. They are used primarily when colouring cotton, although also within other areas. They are easy to use and relatively cheap. Azo dyes are a group of organic compounds. Their function is in the colouring azo group (N=N).

*Environmental and health properties*

The azo group is often found in dyes bound to an aromatic ring. The dye can then be broken down into an aromatic amine, an arylamine. Some of these arylamines are, or are suspected of being, carcinogenic. Most azo dyes are water-soluble and are thus easy for the body to absorb through skin contact and inhalation. Arylamines absorbed by the body are probably accumulated<sup>15</sup>. Certain arylamines entail a risk of cancer and allergic reactions in the event of skin contact. They can also be an irritant for the eyes, be toxic when inhaled or consumed, or highly toxic when inhaled, consumed or in the event of skin contact.<sup>15</sup>

Azo dyes can also be toxic or very toxic to aquatic organisms.<sup>15</sup>

**Tin organic compounds**

Tin organic compounds can be divided up into various groups depending on how many organic groups are included and which organic groups these are. In this study, three different groups of tin organic compounds have been tested: TBT (tributyltin), DBT (dibutyltin) and TPhT (triphenyltin).

*Areas of application*

Tributyltin (TBT) is a compound that has been used in boat bottom paints and as an antifouling agent.

Dibutyltin compounds (DBT) are used primarily as stabilisers in PVC plastic. They are added to prevent the plastic from breaking down during the heating that is required in order to shape the plastic. The substance also protects the plastic in the event of long-term exposure to sunlight.<sup>16</sup>

Dibutyltin compounds are also used as catalysts when producing e.g. polyurethane plastics.

*Environmental and health properties*

TBT, DBT and TPhT are classified as highly toxic to aquatic organisms and can cause adverse long-term effects in the aquatic environment.

The substances are harmful to the immune and endocrine systems of animals, and can be harmful to the reproductive system and have mutagenic effects. They can also be irritants to the stomach's mucous membranes. Animal experiments have shown that high quantities of inorganic tin can result in anaemia and damage to the liver and kidneys of the tested animals.<sup>12</sup>

When exposed to heat and UV light, TBT and DBT migrate into sebum<sup>17</sup>.

### **PAH (polyaromatic hydrocarbons)**

#### *Areas of application*

PAH are compounds in certain plastic raw materials. If PAH are present in the plastic, this means that it is of a low quality, i.e. insufficiently purified, or recycled from products that are not intended to come into contact with the skin, such as car tyres.

#### *Environmental and health properties*

Naphthalene can be absorbed through inhalation, in food and through skin contact<sup>20</sup>. The substance is potentially carcinogenic in people, IARC 2B<sup>20</sup>. Naphthalene is also highly toxic to aquatic organisms<sup>11</sup>. The substance can also bioaccumulate and can be absorbed easily through the skin, can affect the central nervous system and can form methemoglobin in the blood<sup>21</sup>.

Anthracene is highly toxic to aquatic organisms. The substance can also bioaccumulate. Anthracene can produce hypersensitivity reactions in the skin in the event of exposure to sunlight.<sup>21</sup>

# Legislation in Sweden and the EU

The EU has no specific legislation that defines the chemical content of shoes. However, the EU's chemicals regulation REACH (EC 1907/2006), which now applies in full as Swedish law, includes authorisation and prohibition rules that are of relevance to certain chemicals within this study.

According to REACH, authorities must highlight particularly harmful chemicals (*substances of very high concern*) on a candidate list. This list in turn forms the basis for the prioritisation of a number of chemicals for which the European Commission may demand authorisation. A particularly hazardous substance may be permitted if certain conditions are satisfied, for example if the controls are deemed to be robust or if the social benefits provided by a substance are deemed to be greater than its social cost. The burden of proof in the actual authorisation process lies with the party that wants to use the chemical, although public bodies have to produce the comprehensive information that is required in order to list a substance for authorisation.

There are currently only 15 substances on the candidate list. Seven of these have been given the highest priority.<sup>23</sup>

According to REACH, any party that manufactures or sells goods that contain more than 0.1 percent by weight of a substance on the candidate list is obliged to notify its customers of this so that the goods can be handled safely (article 33). This information must include the name of the substance as a minimum. The information must be provided to consumers within 45 days at the consumers' request. The current candidate list (2009) includes the phthalates DBP, DEHP and BBP.<sup>23</sup>

The section of REACH relating to various types of restriction (prohibitions) recently replaced the EU's previous limitation directive (76/769/EEC), although the main requirements that are stipulated are more or less the same. The burden of proof lies entirely with public bodies.

The Swedish laws that apply to the shoes product group are the Swedish general rules of consideration and certain chemical-specific rules in the Environmental Code. Section 2 of the Environmental Code states that "Chemicals that entail a risk to human health or the environment must be replaced with less harmful alternatives". This is known as the substitution principle.

Alongside the Environmental Code are the Product Safety Act (2004:4519) and the Product Safety Ordinance (2004:469), which state that consumer products must be safe from a health perspective in order to be sold.

## Phthalates

The environmental risks from phthalates have been noted in both the EU and the USA, but environmental legislation regarding phthalates is limited. The US Environmental Protection Agency has identified DEHP, DMP, DEP, DBP and DOP as prioritised pollutants that are to be kept under review<sup>11</sup>. The only phthalate that is regulated in rules regarding environmental quality in the EU is DEHP, through the Water Directive (EU Directive 2000/60/EU).

According to Annex 17 of the EU's REACH chemicals legislation (formerly the limitation directive), the phthalates DEHP, DBP and BBP may not be used in toys and child care items if the total content exceeds 0.1% (by weight), due to the negative health properties of phthalates. For the same reason, three other phthalates, DINP, DIDP and DOP, may no longer be used in toys and child care items that can be put in the mouth if the total content exceeds 0.1% (by weight).

CMR substances (Carcinogenic, Mutagenic and Reprotoxic substances), such as DEHP and DBP, are not permitted in cosmetic or hygiene products, according to the EU's Cosmetics Directive (76/768 EEC).

**Heavy metals**

Cadmium may not be used as a surface treatment, stabiliser or colouring agent. Goods that contain this substance may not be sold or imported (Annex 17 of REACH).

**Azo dyes**

According to Annex 17 of REACH (formerly the limitation directive), certain azo dyes that can emit arylamines are prohibited in shoes. Azo dyes may not be present in shoes if, through reductive splitting, they may give off one or more aromatic amines in concentrations of over 30 ppm in the shoes or their coloured parts.

**Tin organic compounds**

The use of tin organic compounds is prohibited in boat bottom paints (EC 782/2003) and restricted as regards its use as a biocide (Annex 17 of REACH). However, there is no legislation in the EU that regulates content in imported products.

## Shoes as waste – the spread of the chemicals in the environment

When shoes are worn, the soles abrade against the ground and the chemicals that are present in the plastic are spread into the environment. Phthalates are not firmly bound to the plastic in which they are found, but leach out and spread. This leaching occurs both when the shoe is worn and when it is discarded and placed in landfill sites<sup>2</sup>. PVC products that are deposited in landfill sites leak phthalates via water to the surrounding environment<sup>18</sup>. In addition to phthalates, shoes that are broken down in landfills can leak organic metal compounds (such as tin organic compounds) and heavy metals.<sup>2,16</sup>

In Sweden, it has been prohibited in principle to deposit flammable waste in landfills since 2002. For this reason, Swedish waste is usually taken to an incineration plant. In other parts of the world, it is common for waste to end up in landfills.

Modern incineration plants can achieve high temperatures and, as a result, more or less complete incineration. In the event of complete incineration, all the organic substances are broken down. The flue gases from the incineration are directed through a textile purification filter. Heavy metals that are not broken down during combustion are captured here. Organic tin compounds are broken down in the event of complete incineration, and form carbon dioxide, water and tin oxide. Tin is also caught in the filter. Phthalates and azo dyes that are incinerated form nitrogen, carbon dioxide

and water. The filters from the incineration plants are deposited in landfills. There are currently no methods for recovering metals from the filters.<sup>19</sup>

During all incineration (both complete and incomplete incineration) of halogenated material (such as PVC), dioxins and furans can be formed<sup>22</sup>. Dioxins and furans are halogenated environmental toxins that are among the most toxic substances known to man<sup>22</sup>. They can harm the reproductive systems of mammals and cause cancer in people<sup>22</sup>.

The amount of dioxins and furans that are formed during incineration depends on a number of factors, such as the amount of halogenated material, the incineration temperature and the temperature of the flue gases<sup>22</sup>. If incineration takes place in an incineration plant, a large proportion of the dioxins and furans are captured in purification filters. However, this means that the problem of dioxins and furans may be transferred to the filters, and that the substances then leach from these depending on how they are discarded.<sup>22</sup>

Dioxins can also be formed in the atmosphere after the flue gases have passed the purification filters. In this way, additional dioxins reach the environment.

In older incineration plants, there is a considerable risk that the incineration will be incomplete. If there are any tin organic compounds in the waste that is being incinerated, they will be transported via the flue gases or the ash from the incineration process.<sup>16</sup>

# Method

## Selection of products for analysis

A total of 27 pairs of shoes were purchased in various countries during April and May 2009 (see table). Four pairs of shoes were purchased in each country, of which one pair was for children. The only exception was India, where three

pairs of shoes were purchased (no children's shoes). All the shoes were purchased from major chains and are common everyday shoes in the country of purchase. Both the sole and the upper are made of plastic or rubber, with a few exceptions. The shoes comprised sandals, clogs and flip-flops.



Number	1	2	3	4	5	6	7
<b>Producer/ Agent</b>	Blooming Handkerchiefs Mfg. Corp	Chaya Style and Fashion	BRCI	World Balance	Bata	Modello	Sanrio PT Halimjaya Sakti
<b>Country of purchase</b>	Philippines	Philippines	Philippines	Philippines	Indonesia	Indonesia	Indonesia
<b>Shop of purchase</b>	SM North EDSA Department Store	Puregold Supermarket, Cubao	SM North EDSA Department Store	SM North EDSA Department Store	PT. Ramayana Lastari Sentosa, TBK	PT. Ramayana Lastari Sentosa, TBK	Dobel M Shoes & Bags Shop
<b>Name of shoe</b>	Adorable Dora Sandals	Chaya Slipper	Beach Walk Sandals	World Balance Sandals	Island Sandal	Skywalk Sandal	Hello Kitty/ Ando
<b>Type of shoe</b>	Children's slipper	Flip-flop	Ladie's slipper	Men's slipper	Slipper	Men's slipper	Flip-flop
<b>Colour</b>	White & pink	Orange	White & red	Blue	Blue	Black	Blue
<b>Country of manufacture</b>	Philippines	China	Philippines	Philippines	No data	No data	No data
<b>Price. Domestic currency</b>	PhP 299,75	PhP 99,75	PhP 109	PhP 250	Rp 59 900	Rp 29 900	Rp 28 900
<b>Price. US Dollar</b>	6	2,1	2,3	5,2	5	2,5	2,4



Number	8	9	10	11	12	13	14
<b>Producer/ Agent</b>	Mighty delta Investments	Reebok	Ipanema	Lollipop	Elegance	Carter's	Ocean Sandals company
<b>Country of purchase</b>	Indonesia	South Africa	South Africa	South Africa	South Africa	Tanzania	Tanzania
<b>Shop of purchase</b>	Mall Ball Galeria	The Hub	Woolworths	PEP stores	Selfast Da Fashion Fibre Zone	Foot step shop	Foot step shop
<b>Name of shoe</b>	Naruto Sandal	Reebok Toe thong RBK NVY	Ipanema glitter	Lollipop	Elegance, Kathy flatty	Carter's	Cheetah
<b>Type of shoe</b>	Children's flip-flop	Men's slipper	Ladie's flip-flop	Children's slipper	Ladie's slipper	Children's slipper	Flip-flop
<b>Colour</b>	Blue & black	Blue	Gold	Pink	Pink & black	Transparant	Green
<b>Country of manufacture</b>	No data	Lesotho	Brazil	China	South Africa	Taiwan	No data
<b>Price. Domestic currency</b>	Rp 34 900	R 99	R 89,95	R 34,99	R 19,99	TZS 3000	TZS 3000
<b>Price. US Dollar</b>	2,9	12	11	4,3	2,5	2,3	2,3

CHEMICALS – UP CLOSE



Number	15	16	17	18	19	20	21
Producer/ Agent	Ocean Sandals company	Ocean Sandals company	Din sko	Björn Borg	Skopunkten	Crocs	Gliders Liberty
Country of purchase	Tanzania	Tanzania	Sweden	Sweden	Sweden	Sweden	India
Shop of purchase	Foot step shop	Foot step shop	Din sko	Euro Sko	Skopunkten	Team Sportia	Liberty retail revolutions LTD
Name of shoe	Ocean Fashion sandals	My Guess	Din sko	Björn Borg	Plastic	Crocs Cayman	Gliders
Type of shoe	Ladie's slipper	Ladie's slipper	Children's slipper	Flip-flop	Ladie's slipper	Slipper	Slipper
Colour	Brown	Black	Red	Brown & Pink	Pink	Yellow	Black & White
Country of manufacture	No data	No data	No data	No data	No data	China	No data
Price. Domestic currency	TZS 7000	TZS 9000	SEK 129	SEK 199	SEK 49	SEK 225	Rs 199
Price. US Dollar	5,4	7	16,4	25	6,2	28,6	4



Number	22	23	24	25	26	27
Producer/ Agent	Bata	Power	Pedo shoe company	Space Dove	BR Shoes (U) LTD	Sandak by Bata
Country of purchase	India	India	Uganda	Uganda	Uganda	Uganda
Shop of purchase	Bata shoe store	Bata shoe store	Abasi Enterprises	Abasi Enterprises	Abasi Enterprises	Bata shop
Name of shoe	Sandak	Power	Pedo	Space Dove plastic light sandal	Brilliant shoe	Sandak
Type of shoe	Flip-flop	Flip-flop	Slipper	Flip-flop	Children's slipper	Slipper
Colour	Blue	White	Beige	Yellow	Beige	Brown
Country of manufacture	No data	No data	Uganda	China	Uganda	No data
Price. Domestic currency	Rs 129	Rs 199	UGX 2300	UGX 2100	UGX 1600	UGX 5500
Price. US Dollar	2,7	4	1,07	0,98	0,75	2,56

### Analysis method\*

#### Halogens (PVC screening)

A screening test according to Beilstein was initially conducted on the various parts of all the clogs. This test is an indication of the occurrence of halogens.

Parts of the material are melted onto warm copper wire, which is then inserted into a gas flame. When materials containing halogen are combusted, acid is formed that attacks the copper wire, and this produces a flame with a very distinctive green colour. The most common reason for the presence of halogens in materials of this type is that they are made from PVC that contains a large amount of chloride. However, this test is not specific solely to PVC. Other halogen compounds can also produce the same result. However, they have to be present in large amounts in the material.\*

The screening was carried out as a selection process prior to the analysis of phthalates. These are often present in PVC materials, and using the screening it was possible to reduce the number of tested materials to some extent.

#### Phthalates

The analysis of phthalates was carried out on those parts of the clogs that, in the preceding test, had indicated the possible presence of PVC. The content is specified as a percentage by weight, and is calculated for the specific component that has been analysed, not for the clog as a whole (except in those cases where it is suspected that the entire clog is made of PVC). If only the clog's strap has been analysed, the content determination applies solely to the strap.

The analysis limit for the individual phthalates is 0.01 percent by weight. The analysis has been carried out according to the upcoming standard prEN 15777:2008. Equipment of type Dionex ASE200 has been used for the extraction of the phthalates.

Exactly 1.00 g of the material has been cut up into pieces with a maximum thickness of 1 mm. The pieces have been packed in an 11 ml extraction cell together with clean sand. The sand is added to fill up the cell and reduce the amount of solvent. The cell is filled with n-hexane under a pressure of 2000 psi and heated up to 120°C for 15 minutes. After that, the cell is emptied into a collection vial and the cycle is repeated once. The total extraction time, including the heating phase, is 40 minutes per sample.

An internal standard is then added to the extract, and the extract is then analysed with GC-MS. Two GC analyses are carried out on each extract, a SIM analysis on mass 149 for quantification and a SCAN analysis to verify that the correct phthalate has been identified.

#### *Analysed phthalates:*

DBP (dibutyl phthalate), DEHP (diethylhexyl phthalate), BBP (benzyl butyl phthalate), DnOP (dinooctyl phthalate), DiNP (diisononyl phthalate) and DiDP (diisodecyl phthalate).

#### PAH

During the SCAN analysis of the phthalates, other compounds that can be analysed using the same type of extraction were also screened. During this screening, it is possible to demonstrate the presence of polyaromatic compounds, although the exact content cannot be determined.

This analysis is only indicative, and must be followed up with an adapted analysis of PAH in order to verify and quantify the occurrence.

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\*] Even though the analysis is not specific for PVC, Swerea considers that a clear green flame indicates the presence of more than 10% chlorine, a content so high that it has to be present in the plastic, and only PVC plastic normally contains such high levels of chlorine.

## Azo dyes

Nine clogs were selected for the tests, based on their colour. Clogs in bright colours were selected, as well as clogs in dark colours with an inclination towards brownish-red.

During the analysis, colouring agents are extracted from the plastic through reflux boiling in chlorobenzene. After this, the azo bonds in the extracted colouring agents are reduced with dithionite, followed by cleaning through columns packed with diatomic soil. The eluate from the columns is analysed with GC-MS.

The occurrence of certain aromatic amines from the azo dyes was determined according to SS-EN 14362-2:2003 and SS-EN 14362-2/AC:2005, indicating the use of certain azo dyes accessible through extraction.

Number of determinations per sample material: 1

One sample was analysed per material.

Test weight: 1.00 g per sample material

Quantification method: internal standard and calibration solutions containing aromatic amines.

Detection method: GC-MS (gas chromatograph-mass spectrometer), Scanteknik.

Detection limit per amine: 20 mg/kg

## Tin organic compounds

All clogs were analysed with regard to the content of tin organic compounds.

One sample per clog has been analysed. The sample has been taken from those parts of the clog that could come into direct contact with the skin, primarily the inner sole and parts of the upper.

In those cases where PVC has been indicated, the sample has been taken from these parts of the clog.

During the analysis, the tin organic compounds are extracted to a synthetic sweat solution that is kept at 40° C in an ultrasound bath for 60 minutes. The sample is finely distributed by being cut into small parts, and wetting agent is added to facilitate extraction. These conditions have been selected to resemble the exposure to which a person may be

subjected in the event of direct contact with the material. After the extraction, the tin organic compounds are derivatised using a borate reagent and cleaned up with the aid of SPE (Solid Phase Extraction). The analysis is carried out with GC-MS.

The following tin organic compounds have been analysed: DBT (Dibutyltin), TBT (Tributyltin) and TPhT (Triphenyltin). The analysis limit is 0.015 mg/kg for the individual compounds.

## Heavy metals

All the clogs were analysed for the presence of heavy metals. As a large quantity of material is required for the analysis, the samples have primarily been taken from the soles of the clogs. In those cases where the sole is layered, a generic sample has been analysed. The analysis has been performed by ALS Laboratories in Luleå in accordance with instructions from Swerea IVF. The samples have been finely distributed through grinding, and then fused in a microwave oven under pressure in a mixture of nitric acid and hydrogen peroxide. This mixture oxidises that material and holds any formed metal salts in solution.

The analysis of the obtained solution has been carried out with ICP-OES and ICP-MS in accordance with modifications of the methods EPA 200.7 and EPA 200.8.

## Checking compliance with the law as regards consumer information

In June 2009, the SSNC contacted the two Swedish shops that had sold shoes containing the phthalates DEHP and DBP, which are included in the candidate list in REACH. The two shoes were number 18, which was sold by Eurosko, and number 19, sold by Nilson group. The shops were contacted by e-mail, and the SSNC's employee posed as a "normal consumer". In the e-mail, we asked whether the specific shoes contained any substance that was included in the REACH candidate list. Eurosko responded that they were not aware of the candidate list or of REACH. After being informed that

this was the European chemicals legislation, they contacted Björn Borg who had sold the shoe to them. According to Björn Borg, the shoe did not contain any substances on the candidate list.

Nilson group AB, which sold shoe number 19, was asked the same question. The company analysed the shoe and gave notification that the product contained substances that are on the candidate list. The company apologised for this and stated that it would withdraw the product from the market on the basis of this new information.

## Results, part 1

Sample no.	Country of purchase	Halogen/PVC	Phthalates						Tin organic compounds			PAH	
			DBP	DEHP	BBP	DnOP	DiNP	DiDP	TBT	DBT	TPhT	Anthracene	Naphthalene
1	The Philippines	Decoration (butterfly, flower) and band for securing the clog	-	6,90%	-	-	-	4,70%	-	-	-	-	-
2	The Philippines	Entire clog	-	8,60%	-	-	-	-	-	-	-	-	-
3	The Philippines	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
4	The Philippines	Upper (band over the foot)	9,60%	0,90%	-	-	-	-	-	-	-	-	-
5	Indonesia	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
6	Indonesia	Entire clog	0,81%	12,70%	-	-	-	-	-	0.22 mg/kg	-	X	X
7	Indonesia	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
8	Indonesia	Inner sole with pictures	0,17%	6,70%	-	-	-	-	-	-	-	X	X
9	South Africa	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
10	South Africa	Entire clog	-	23,20%	-	-	-	-	-	-	-	-	-
11	South Africa	Inner sole with pattern	0,24%	6,80%	-	-	-	-	-	-	-	-	-
12	South Africa	Sole	0,01%	7,20%	-	-	-	1,20%	-	0.13 mg/kg	-	X	X
13	Tanzania	Outer sole and upper (band over the foot)	0,02%	11,30%	-	3,60%	-	-	-	-	-	-	-
14	Tanzania	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
15	Tanzania	Inner sole	-	16,80%	-	19,40%	-	-	-	-	-	-	-
16	Tanzania	Inner sole	-	4,30%	-	-	3,20%	-	-	-	-	-	-
17	Sweden	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
18	Sweden	Strap over the foot and between the toes	8,40%	0,36%	-	-	-	-	-	-	-	-	-
19	Sweden	Entire clog	7,40%	5,00%	-	-	-	-	-	0.27 mg/kg	-	-	-
20	Sweden	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
21	India	Decal and upper (band over the foot)	0,02%	18,60%	-	-	-	-	-	-	-	-	-
22	India	Entire clog	-	-	-	-	-	-	-	-	-	-	-
23	India	Upper (band over the foot)	0,39%	18,10%	-	-	-	-	-	0.14 mg/kg	-	X	X
24	Uganda	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
25	Uganda	Strap over the foot and between the toes	7,90%	0,07%	-	-	-	-	-	-	-	X	X
26	Uganda	None	not tested	not tested	not tested	not tested	not tested	not tested	-	-	-	-	-
27	Uganda	Entire clog	0,03%	15,80%	-	-	-	-	-	-	-	X	X

x = occurrence, quantitative content not determined      - = tested, content below detection level

## Results, part 2

Sample no.	Country of purchase	AZO dye	Heavy metals mg/kg									
			Arsenic	Cadmium	Cobalt	Chromium	Copper	Mercury	Manganese	Nickel	Lead	Zinc
1	The Philippines	not tested	1,39	2,39	0,0589	1,11	1,58	<0,09	9,42	0,571	8,77	7750
2	The Philippines	-	<0,8	<0,05	<0,05	<0,3	<1	<0,1	<0,4	<0,4	<0,4	7,52
3	The Philippines	not tested	1,2	0,0966	0,882	15,3	17,1	<0,09	22,4	5,88	6,84	4450
4	The Philippines	not tested	<0,8	0,086	0,0623	0,588	556	<0,1	18,8	0,533	1,94	3050
5	Indonesia	not tested	<0,7	<0,04	<0,04	0,439	366	<0,09	63	<0,3	0,702	2440
6	Indonesia	-	1,49	117	0,575	34,5	33,8	0,0956	48,6	2,06	915	201
7	Indonesia	not tested	<0,8	0,0862	0,0963	97,8	61	<0,09	6,88	0,787	389	4550
8	Indonesia	not tested	<0,8	13,4	0,105	1,93	132	<0,1	12,5	0,645	7,63	3070
9	South Africa	-	<0,7	0,0901	0,147	0,734	482	<0,09	4,41	<0,4	1,15	296
10	South Africa	not tested	<0,7	<0,05	0,0465	1,16	1,84	<0,09	12,3	<0,4	5,08	1080
11	South Africa	not tested	<0,7	2,23	0,639	3,49	2,08	<0,09	125	0,714	13,9	1250
12	South Africa	not tested	2,63	6,01	0,883	87,6	20,4	0,104	86,9	2,39	2220	384
13	Tanzania	not tested	<0,8	0,298	<0,05	<0,3	<1	<0,1	3,23	<0,4	<0,4	668
14	Tanzania	not tested	2,02	0,202	0,213	1,29	51,4	<0,09	86,2	0,747	7,08	51,9
15	Tanzania	-	<0,7	18,6	0,183	9,42	2,17	<0,09	2,94	<0,4	53,1	342
16	Tanzania	not tested	<0,8	14,5	0,222	<0,3	17	<0,1	1,88	<0,4	0,733	269
17	Sweden	-	<0,7	<0,04	<0,04	1,42	1,84	<0,09	34,4	1,21	1,42	7120
18	Sweden	not tested	1,15	0,452	0,724	14,4	30,1	<0,09	42,4	5,89	7,13	5340
19	Sweden	-	<0,7	<0,04	<0,04	<0,3	<0,9	<0,09	<0,4	<0,4	<0,4	8,81
20	Sweden	-	<0,8	0,0597	<0,05	<0,3	<1	<0,1	0,431	<0,4	<0,4	2310
21	India	not tested	<0,8	24,2	1,06	265	28,7	<0,1	55,5	0,525	1330	8010
22	India	not tested	<0,7	6,64	<0,05	10,9	1,96	<0,09	0,612	<0,4	60,6	<2
23	India	not tested	<0,7	0,0784	0,0509	0,309	3,38	<0,09	19,1	0,882	1,68	4720
24	Uganda	not tested	<0,7	<0,05	<0,05	0,433	<0,9	<0,09	5,51	<0,4	<0,4	3590
25	Uganda	-	9,33	1,02	0,309	0,893	42,4	<0,09	273	2,1	17,1	7810
26	Uganda	not tested	1,77	0,0984	0,109	3,19	3,39	<0,1	17	0,927	1,04	7200
27	Uganda	-	1,12	<0,05	0,0733	1,85	21,5	<0,1	4,61	0,646	0,932	290

x = occurrence, quantitative content not determined

- = tested, content below detection level

# Results

## Phthalates

Out of the 27 tested shoes, 18 contained PVC\*. Some shoes were made entirely of PVC, while others had parts (inner sole, straps between the toes, etc.) made of PVC. 17 shoes contained one or more of the six tested phthalates. Shoe number 22 (India) contained PVC although none of the tested phthalates. This shoe probably contains another phthalate or some other type of softener.

The most common softener was DEHP. Out of the 18 shoes that were made entirely or partially of PVC, 17 also contained DEHP. The amounts of DEHP in the shoes varied considerably. One shoe (Uganda) only contained 0.07 per cent by weight of DEHP (measured in those parts that consisted of PVC). However, the same shoe contained a significantly higher content, 7.9%, of the phthalate DBP. On average, the whole shoes, or those parts that were made of PVC, contained around 10% DEHP. Shoe number 10 (South Africa) had the highest content of DEHP (23.20%). This shoe consisted entirely of PVC, and the analysed DEHP value consequently applied to the entire shoe. This value means that this pair of shoes contained a total of 76 grams of DEHP. Two pairs of shoes from India, numbers 21 and 23, contained more than 18% DEHP in those parts that were made of PVC.

Only two of the shoes only contained DEHP out of the six tested phthalates. Most contained two or three different types of the tested phthalates.

DBP was the phthalate that was present in the next highest number of the tested shoes or shoe parts. This phthalate was present in 12 of the 18 shoes that contained PVC. The levels of DBP were generally lower than the levels of DEHP, on average 2.3%. DBP was never present on its own in the product, but in all cases was found together with DEHP. The highest content was found in shoe number 4 (Philippines), at 9.6% DBP. In this shoe, it was the upper that contained

PVC and that was therefore analysed with regard to phthalates. Shoe number 18 (Sweden) also had a high content of DBP, 8.4%, in the part that was made of PVC.

None of the analysed shoes contained the phthalate BBP. Two shoes, numbers 13 and 15 (Tanzania), contained DNOP. Number 15 contained DNOP, 19.4%, in the inner sole. DINP was only found in one shoe, number 16 (Tanzania). DIDP was found in two pairs of shoes, number 1 (Philippines) and number 12 (South Africa). The levels of both of these phthalates were considerably lower than the levels of DEHP.

If we calculate the total content of the six analysed phthalates in the 17 relevant shoes, the average value is 13% phthalates in those parts that are made of PVC. The levels of phthalates in these shoes vary between 6 and 23%.

## Tin organic compounds

The total content of tin organic compounds in the shoes was not analysed in the study. Instead the extractable content was analysed, i.e. the content that can disappear from the shoe and possibly be absorbed by the skin. Of the three different types of tin organic compound that have been analysed, only DBT, dibutyltin, was found. This substance was confirmed in four pairs of shoes: number 6 (Indonesia), 12 (South Africa), 19 (Sweden) and number 23 (India). The highest content was found in the shoe from Sweden. The contents were in the range 0.13 mg/kg to 0.27 mg/kg.

## PAH

The shoes were also tested for the occurrence of PAH. No further quantifying analysis has been carried out, which is why no content values are specified in the results table. Anthracene and naphthalene were present in 6 of the 27 tested shoes. Two shoes, numbers 6 and 8 (Indonesia), contained these PAHs, as did numbers 25 and 27 (Uganda).

\* ) In these 18 cases, a bright green colour was obtained in the analysis, which in all likelihood indicates that it is a PVC plastic (see note on page 18).

Shoe number 12 (South Africa) and number 23 (India) also contained anthracene and naphthalene.

### Azo dyes

Nine out of the 27 shoes included in the investigation were tested for the occurrence of azo dyes. The shoes that were selected had bright colours or dark colours with an inclination towards brownish-red. None of the tested shoes contained azo dyes.

### Heavy metals

All the shoes contained one or more of the ten different heavy metals that were analysed. Two pairs of shoes contained all 10 of the heavy metals that were analysed, in levels above the detection limits.

#### Arsenic (As)

Around half of all the tested shoes had an arsenic content above 0.8 mg/kg. One shoe had a significantly higher content of the substance than the others, shoe number 25 (Uganda), at 9.33 mg/kg.

#### Cadmium (Cd)

Shoe number 6 (Indonesia) had a significantly higher cadmium value than the others, at 117 mg/kg. This was around 5 times higher than the shoe with the second-highest level of cadmium, shoe number 21 (India).

#### Cobalt (Co)

Shoe number 21 (India) had the highest content of cobalt, at 1.06 mg/kg.

#### Chromium (Cr)

The levels of chromium varied considerably in the analysed shoes, ranging from metal contents below the detection limit of 0.3 mg/kg up to very high values. The highest value, 265 mg/kg, was found in shoe number 21 (India).

#### Copper (Cu)

The highest level of copper was found in shoe number 4 (Philippines). This one stood out in the test, along with number 5 (Indonesia) and number 9 (South Africa), by having significantly higher levels of copper than the other shoes.

#### Mercury (Hg)

Two shoes had a detectable content (above 0.1 mg/kg) of mercury, number 6 (Indonesia) and number 12 (South Africa).

#### Manganese (Mn)

The levels of manganese in the shoes varied significantly. Shoe number 25 (Uganda) had the highest content, at 273 mg/kg.

#### Nickel (Ni)

More than half the shoes contained nickel. Shoe number 18 (Sweden) had the highest content, at 5.89 mg/kg. Shoe number 3 (Philippines) had more or less the same nickel content, at 5.88 mg/kg.

#### Lead (Pb)

Five of the 27 tested shoes did not contain any lead (or have levels below the detection limit of <0.4 mg/kg). Other shoes contained lead in varying amounts. The highest lead content was in shoe 12 (South Africa), at 2,220 mg/kg. This value is equivalent to 0.22% of the sole, which was the part of the shoe that was tested in this case.

#### Zinc (Zn)

The levels of zinc vary greatly in the tested shoes. One shoe (number 22) displayed no occurrence of zinc in the analysis. Shoe number 21 (India) had the highest content of zinc, at 8,010 mg/kg. This value is equivalent to 0.8% of the shoe's weight. 12 pairs of shoes have values above 2,000 mg/kg.

# Discussion

The analyses that have been conducted in this study show that there are a large number of hazardous chemicals in normal shoes. These can affect the person wearing the shoes, above all if the wearer is going barefoot and perspires in the shoes on warm days. Heat causes chemicals that are fat-soluble to be absorbed more easily by the body. The health risks entailed by exposure to these very harmful and occasionally toxic chemicals are unacceptable.

The chemicals present in the tested shoes can also cause environmental and health problems during manufacture. The extent of these problems depends on factors such as what protective equipment the workers in the factories have and how much they know about the chemicals they are handling and the risks associated with them. However, this study does not include any investigation of the working environment or of the production process as such. No information has been collected regarding how and where the analysed shoes were manufactured.

In many cases, the chemicals present in shoes can also affect the environment. The chemicals in the shoes are spread when the shoes are worn, become abraded and are discarded, primarily if they are deposited in landfills, but also if they are handled in an incineration plant.

In order to compare the results with other similar studies and relevant limits, two analytical studies have been used, one sector-specific chemicals guide for shoes and the EU's official eco-label, the EU Flower.

The EU Flower has eco-labelling criteria for shoes. For example, these criteria stipulate demands regarding the content of arsenic, cadmium, chromium and lead in the final product. The criteria specify that these substances may not be present in the products and that this must be verified through a specific testing method. The testing method specifies the detection values, which in practice are the eco-labelling limits. The detection value for chromium is 10 mg/kg (10 ppm). The detection value for lead, arsenic and cadmium is 100 mg/kg (100 ppm). These are significantly higher detection values than those used in this investigation and on which the labelling could be based.

Companies that import textiles, clothes, leather goods and shoes can be members of the Swedish trade organisation entitled the Textile Importers' Association in Sweden. The Association has developed a chemicals guide for its members. This lists the substances and in certain cases the limits that they recommend their members to follow for the products they sell.

In 2007, the SSNC analysed some 20 hand towels for the occurrence of azo dyes, nonylphenol ethoxylates and heavy metals. The report was entitled *Hand towels with a murky past*. In general it can be said that the shoes tested in this study contain significantly more and higher levels of most of the analysed heavy metals.

## Softeners

DEHP is used as a softener in PVC and has documented properties that are harmful to reproductive systems. They can cause harm to the unborn child and impair people's ability to have children. High levels of DEHP were discovered among the tested plastic shoes. In one case, it emerged that almost a quarter of the shoe's total weight comprised DEHP. Contents at this level are really worrying. DEHP can be absorbed by the skin and affect the potential to have children<sup>9</sup>.

The Swedish Society for Nature Conservation feels that DEHP, DBP, BBP, DINP, DIDP and DNOP should be prohibited in at least all consumer products. Other phthalates should also be prohibited in consumer products unless they have been carefully tested and proven to be harmless. This means that a group classification should be carried out until we know more – in other words, phthalates that have not undergone sufficient testing should be handled as hazardous phthalates until the opposite has been proved.

*Arsenic*

Shoe number 25 (Uganda) contained 9.33 mg of arsenic per kg, which is well below the requirement of 100 mg/kg found in the EU Flower's criteria. Despite this, the SSNC feels that it is unacceptable for arsenic, a substance that has been recognised as being toxic for centuries, to be present in normal consumer products.

*Cadmium*

Shoe number 6 (Indonesia) had a cadmium value of 117 mg/kg, which is above the EU Flower's limit for cadmium of 100 mg/kg. The Textile Importers' Association in Sweden's Chemicals Guide<sup>20</sup> lists cadmium as one of the substances that should not be used as a stabiliser in plastic. According to a decision by the Swedish Parliament in 2001 regarding the Government bill relating to a non-toxic environment, newly produced goods should, as far as possible, be completely free of cadmium by 2010 at the latest<sup>25</sup>. The SSNC considers that cadmium should definitely not be present in consumer products.

*Chromium*

The highest value for chromium, 265 mg/kg, was found in shoe number 21 (India). This is well above the EU Flower's limit of 10 mg/kg for chromium. Seven of the 27 tested shoes were above the eco-label's value, including shoe number 18 (Sweden). Chromium should not be present in products like shoes, and the SSNC considers that the large variation proves that it is not necessary.

*Copper*

The three shoes with the highest copper values stood out by virtue of the fact that they were blue, and the high copper content was probably due to the dye. The variation witnessed in the investigation shows that copper is present unnecessarily in many shoes and that it should be phased out from the product category, in the opinion of the SSNC.

*Mercury*

The fact that two shoes (numbers 6 and 12) proved to contain mercury, even though in low quantities, is remarkable. Many individual countries have long worked to phase out mercury from areas of application where bans have not already been introduced. At an international level, the UN's environmental programme UNEP is co-ordinating efforts to reduce the use of mercury, against the background of the realisation that current measures are insufficient.<sup>26</sup> The SSNC considers that it is unacceptable for mercury to be present at all in normal consumer products. It should be completely phased out from the ecocycle.

*Lead*

The highest lead content of 2,220 mg/kg, found in shoe number 12 (South Africa), is a massive 22 times above the EU Flower's eco-labelling criteria. This is remarkable bearing in mind the international commitment entered into at the UN's summit meeting on sustainable development in Johannesburg in 2002, which entailed phasing out sources of human exposure to lead, particularly exposure among children<sup>27</sup>. In many countries, work to phase out lead has been in progress for an extended period. Shoe number 21 (India) contained 1,330 mg/kg of lead, and shoes number 6 and 7 (Indonesia) contained 915 mg/kg and 389 mg/kg respectively. The Textile Importers' Association in Sweden's Chemicals Guide<sup>20</sup> lists lead as a substance that should not be used as a stabiliser in plastic or as a pigment in paint. A toxic substance like lead should normally not be present at all in consumer products, and should generally be phased out of the ecocycle, in the opinion of the SSNC.

*Insufficient legislation*

In summary, the investigation shows that the legislation is far too weak. On a global level, it is important to develop legally binding agreements in the field of chemicals that result in the phasing out of hazardous chemicals. The UN's environmental programme UNEP must be strengthened, as

must the resources for – and the implementation of – the international collaboration within the framework of SAICM, the Strategic Approach to International Chemicals Management.

As regards the EU's new REACH regulation, it will not be able to deal with these problems for a long time to come. There are many uncertainties and weaknesses in the regulation regarding chemicals in products, particularly when it comes to imported goods. In the European Commission's first discussion document on REACH, *the White Paper on Strategy for a future Chemicals Policy*<sup>24</sup>, it is stated that around 1,400 chemicals could be subject to authorisation, but that at present there are only 15 substances on the candidate list. Seven of these have been given the highest priority<sup>23</sup>. It is not yet clear whether and when the European Commission will decide to demand authorisation for the specific use of these seven particularly hazardous chemicals.

The authorisation processes under REACH have barely begun, and they could result in the continued use of toxins being permitted. Even if they lead to limitations, the current slow rate means that it will take several years before the majority of the hazardous substances are subject to authorisation. The resources in the Member States and within the EU bodies are far too limited for the work to go any faster.

At the same time, the restriction opportunities within REACH are affected by problems related to high demands for evidence from the authorities and long-winded administration. In this case, too, the authorities' resources are insufficient.

The Swedish substitution principle is also insufficient, and the authorities' resources are insufficient to analyse and control hazardous chemicals in consumer products. Chemicals that have clearly been established as toxic are present in shoes that people wear every day.

#### *Toxic substances can be avoided*

In many cases, the content of substances that are harmful to health and the environment varies between the tested shoes.

The levels range from very high to undetectable. This shows that it is possible to manufacture shoes without these problematic substances. This is largely a quality issue and possible a cost issue in some stages, although not in the stage to the consumer.

Most consumers are not aware of the harmful and hazardous substances that are present in plastic shoes, and the industry has consequently not been subjected to demands for higher quality. Chemicals that are known to be problematic and that society has long tried to phase out should naturally have been phased out by companies on a voluntary basis long before now.

Another example is the stabiliser DBT, which Sweden has long been working to phase out from consumer products etc. This study shows that despite this, DBT can be extracted from four of the analysed shoes, of which one pair was purchased in Sweden. Significantly more shoes, 18 out of 27, contained PVC, which shows that PVC can be stabilised using other substances without this affecting the price to the consumer.

#### *Same problems the world over*

The investigation shows that it does not matter which country the shoes are produced or sold in. They contained more or less the same problematic substances, regardless of where in the world they were purchased. In other words, there are no guarantees that shoes purchased in Sweden or the Philippines are any better than shoes purchased in India or Tanzania, or vice versa. Neither does the price appear to be linked in any way to which hazardous substances are present in the shoes. In Sweden, one of the more expensive shoes contained the largest number of problematic substances, compared to the other tested shoes purchased in the country. Furthermore, purchasing well-known brands is no guarantee of low levels of substances that are harmful to health or the environment.

Regardless of whether the worn out shoes end up in a landfill or are incinerated, it is difficult to prevent chemicals

spreading in the environment. It is therefore important, both from an environmental and health perspective and from a working environment perspective, for the shoes to contain as few hazardous chemicals as possible.

As a consumer, it is impossible to know which chemicals are present in the shoes you are thinking of buying, unless you buy eco-labelled shoes. The SSNC and the co-operating organisations challenge all consumers to ask for information in the shop, from the supplier and from the manufacturer. This will hopefully lead to the issue coming up on the agenda for manufacturers and importers, enabling a change to take place.

#### *Consumers' right to information*

Some companies did not provide correct information regarding chemical content when asked by a consumer. As a result, it is not only obvious that companies are not prioritising the environment and the health of their employees and customers, but also that they or their suppliers may have broken the law. Consumers in the EU are currently entitled to find out which products and goods contain the 15 substances on the candidate list. Consumers are entitled to find out about 15 substances, out of the tens of thousands that are present on the market. Some shoe companies do not even know about these 15. This is astounding.

# Advice and requirements

## Demands on politicians

### *The world*

- Do not allow substances that are harmful to health or the environment in consumer products.
- Develop the international ambitions to phase out hazardous chemicals such as mercury and lead into a binding convention.
- Strengthen the resources for the national authorities that are responsible for chemical issues
- Strengthen the resources for the work on chemicals within the UN's environmental body (UNEP) and for the implementation of SAICM, the Strategic Approach to International Chemicals Management.

### *Sweden*

- Do not allow substances that are harmful to health or the environment in consumer products. This demands tighter chemicals legislation, both in Sweden and the EU. If the EU processes are moving too slowly, which is the case at present, Sweden should take the lead itself.
- Strengthen the chemicals authorities' resources. The Swedish Chemicals Agency must be given increased appropriations to inspect consumer products and conduct business at an EU level, for example to list the substances on the candidate list and to initiate restriction processes.

## Demands on manufacturers & purchasers

- Demand that suppliers provide information about which chemicals are used in shoe manufacture and are present in the finished shoes.
- Do not purchase shoes that contain hazardous substances or if the manufacturer cannot provide any information on this matter.

- Work actively to phase out substances that are harmful to people or the environment.
- Manufacture and import shoes of a high level of quality and that offer good durability.
- Work towards strict legislation that prevents hazardous substances in shoes.

## Advice to consumers

### *The world*

- Ask for PVC-free shoes when you buy plastic shoes.
- Buy second-hand shoes and give away shoes that you are no longer using.
- Wear your shoes for a long time, take them to a shoe-repairer if they need to be mended, do not discard shoes unnecessarily and do not buy new shoes if you do not need them. This saves both money and the environment.
- When the shoes have to be discarded, ask your local refuse collection department where they should be discarded in order not to cause harm to health or the environment.

### *Europe*

- Ask in the shop whether the shoe contains any of the particularly hazardous substances listed according to the REACH chemicals legislation. Companies are obliged to provide you with information within 45 days.
- Ask for eco-labelled shoes. The EU Flower eco-label has criteria for shoes. At present there are only a small number of eco-labelled shoes, and unfortunately no plastic ones, but there could be a much larger selection if more people demand eco-labelling.

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