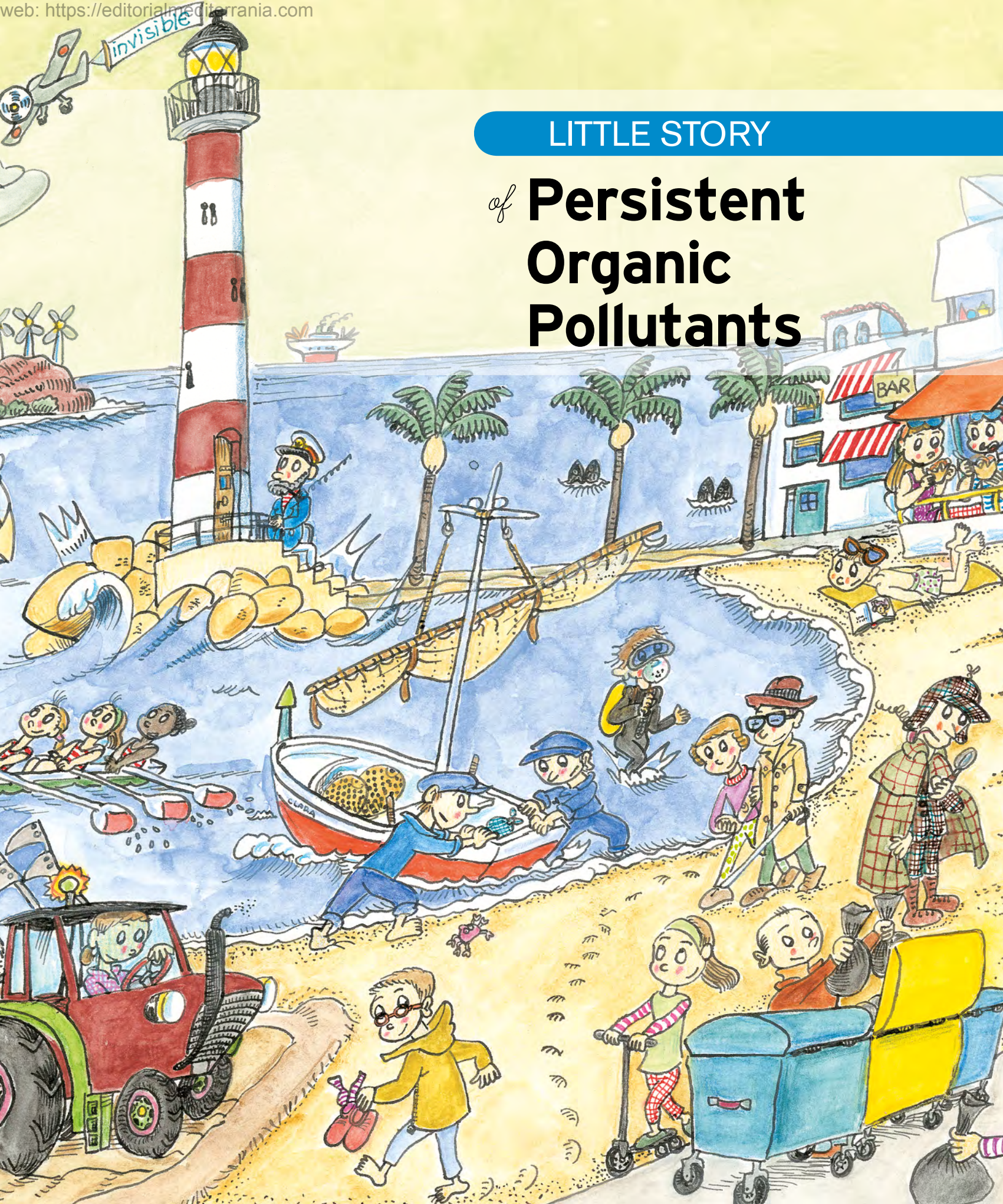
LITTLE STORY

# of Persistent Organic Pollutants



LITTLE STORY

of Persistent Organic Pollutants

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Illustrations: Pilarín Bayés

Introduction

Before you start reading, it's important to explain the reason behind the creation of this story.

This book was commissioned by MedWaves, a centre established in 1996 through a collaboration agreement between the Spanish Ministry of Environment and the Government of Catalonia, within the legal framework of the Mediterranean Action Plan (MAP). MAP is linked to the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and is part of the United Nations Environment Programme (UNEP).

Later, in 2009, MedWaves also became a regional centre for a second United Nations treaty: the Stockholm Convention on Persistent Organic Pollutants (POPs).

It is within this framework of fighting pollution that a book like this was created. In it, we have tried to explain, as rigorously as possible, a very complex problem that far too often goes unnoticed. If we don't reach out to all generations, it will be very hard to raise awareness and tackle the issue.

On the other hand, you've just seen the front and back covers, which depict a coastal scene full of different characters and actions. The aim was to show a seemingly clean sea, with no visible pollution. Yet no detail has been left to chance (just as with any of the illustrations you will find on the following pages!).

We hope that, after reading, you'll be encouraged to look at these illustrations again to discover which elements might be related to POPs. If we succeed, we will have achieved the second goal of this book: that you continue to be eager to learn and see the world with a more critical eye.

Enjoy the reading!

MedWaves the UNEP/MAP Regional Activity Centre for SCP · UN environment programme · Mediterranean Action Plan Barcelona Convention · Stockholm Convention · Gobierno de España · Generalitat de Catalunya

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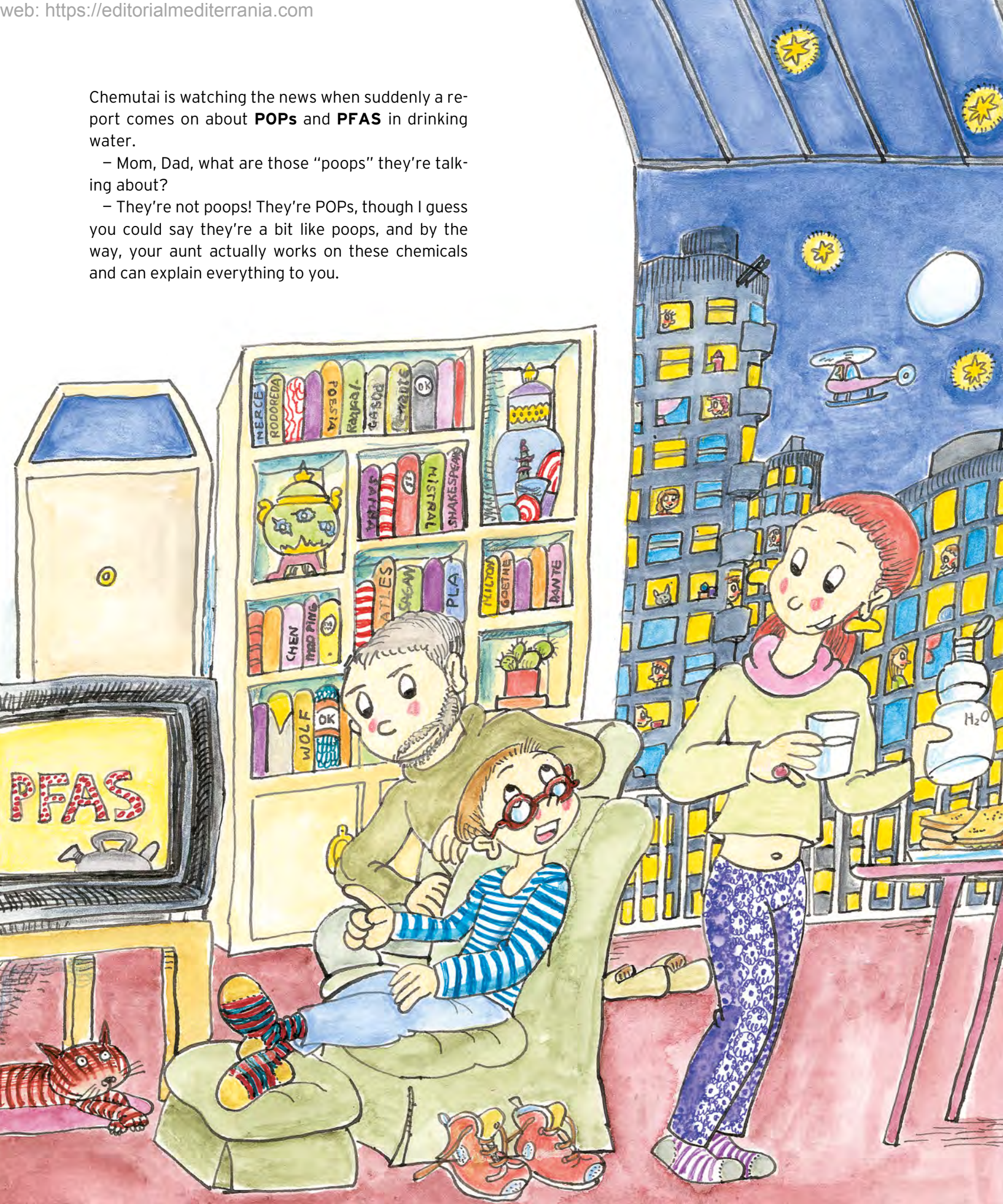
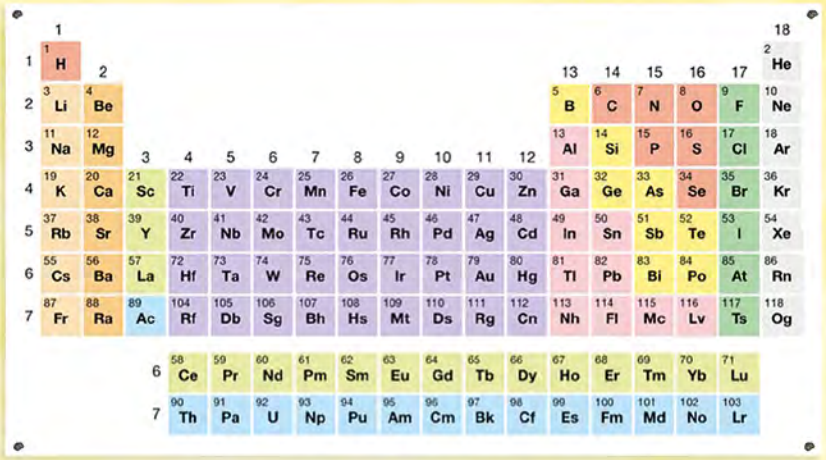
Chemutai is watching the news when suddenly a report comes on about **POPs** and **PFAS** in drinking water.

– Mom, Dad, what are those "poops" they're talking about?

– They're not poops! They're POPs, though I guess you could say they're a bit like poops, and by the way, your aunt actually works on these chemicals and can explain everything to you.



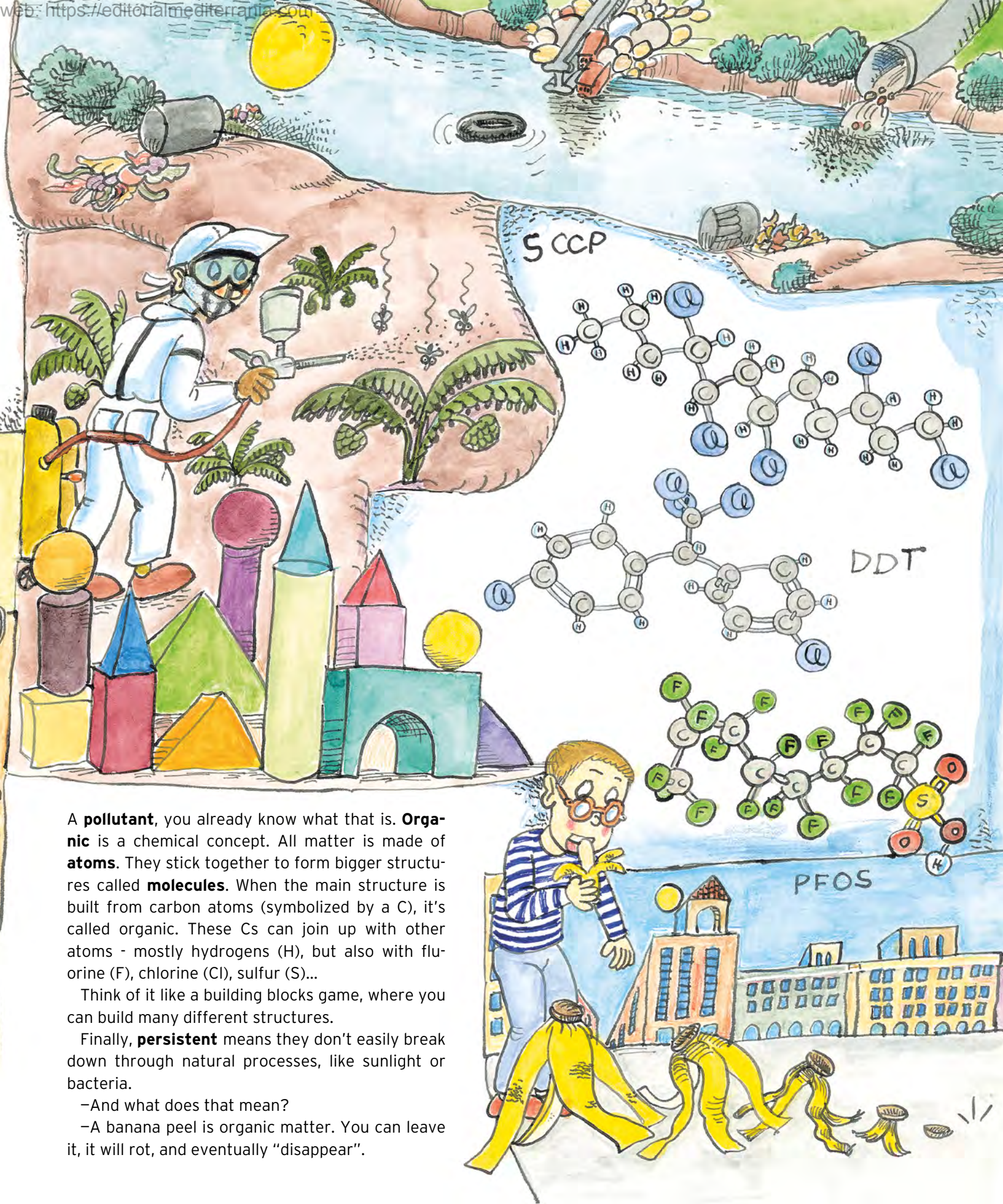


The next day, they decide to visit her at the lab.

—So, you came to see me because of some news you saw yesterday?

—Yes, about the "poops".

—I love that name, because it's actually a perfect description of what we're talking about! Let's start from the beginning: POPs stands for P in **Persistent**, O in **Organic**, and P in **Pollutants**. As you can see, that's three words:



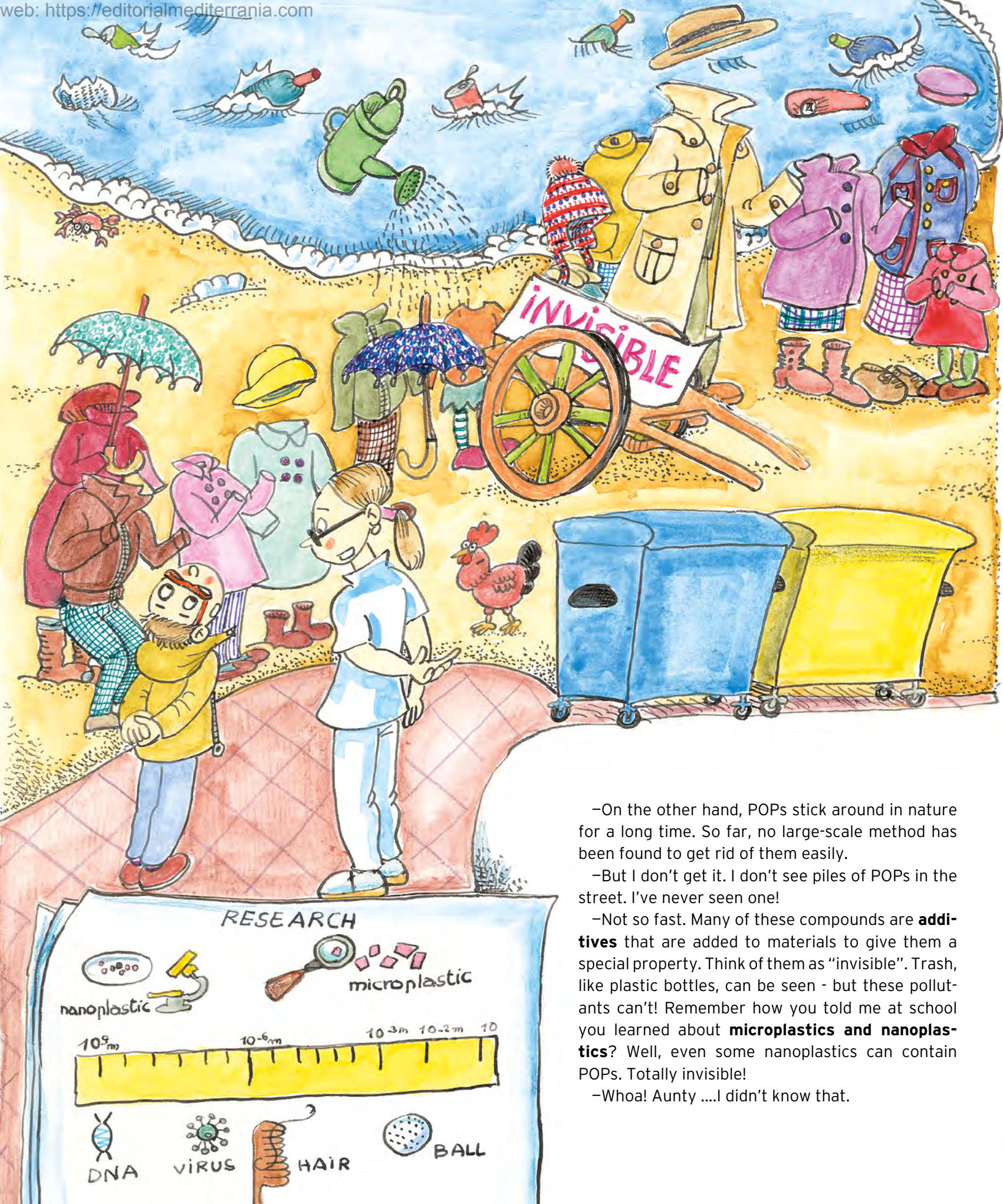
A **pollutant**, you already know what that is. **Organic** is a chemical concept. All matter is made of **atoms**. They stick together to form bigger structures called **molecules**. When the main structure is built from carbon atoms (symbolized by a C), it's called organic. These Cs can join up with other atoms - mostly hydrogens (H), but also with fluorine (F), chlorine (Cl), sulfur (S)...

Think of it like a building blocks game, where you can build many different structures.

Finally, **persistent** means they don't easily break down through natural processes, like sunlight or bacteria.

—And what does that mean?

—A banana peel is organic matter. You can leave it, it will rot, and eventually "disappear".



—On the other hand, POPs stick around in nature for a long time. So far, no large-scale method has been found to get rid of them easily.

—But I don't get it. I don't see piles of POPs in the street. I've never seen one!

—Not so fast. Many of these compounds are **additives** that are added to materials to give them a special property. Think of them as "invisible". Trash, like plastic bottles, can be seen - but these pollutants can't! Remember how you told me at school you learned about **microplastics and nanoplastics**? Well, even some nanoplastics can contain POPs. Totally invisible!

—Whoa! Aunty ....I didn't know that.

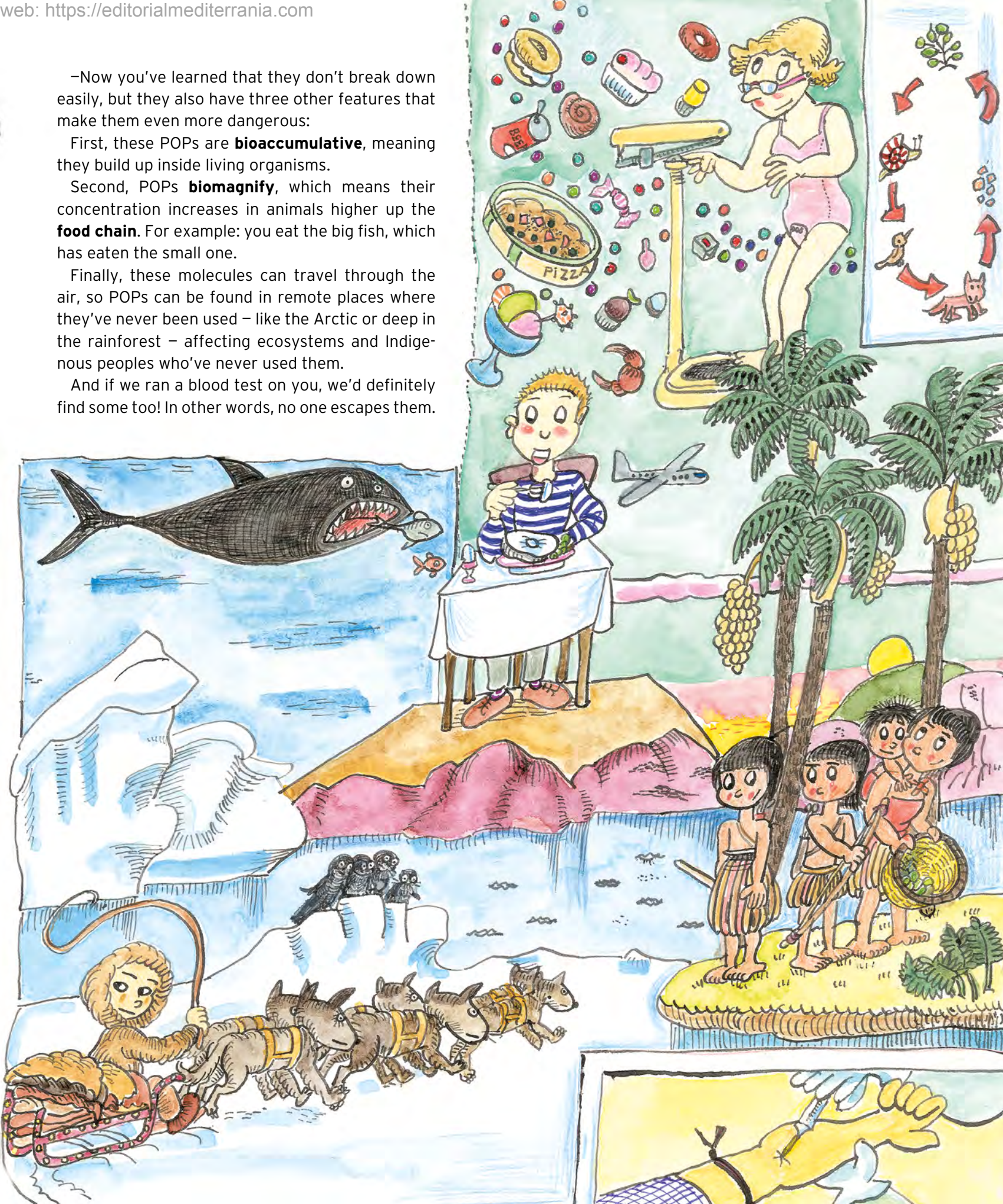
—Now you've learned that they don't break down easily, but they also have three other features that make them even more dangerous:

First, these POPs are **bioaccumulative**, meaning they build up inside living organisms.

Second, POPs **biomagnify**, which means their concentration increases in animals higher up the **food chain**. For example: you eat the big fish, which has eaten the small one.

Finally, these molecules can travel through the air, so POPs can be found in remote places where they've never been used — like the Arctic or deep in the rainforest — affecting ecosystems and Indigenous peoples who've never used them.

And if we ran a blood test on you, we'd definitely find some too! In other words, no one escapes them.



And before you ask why the news is covering this —it's because POPs can harm your health: they can cause cancer, disrupt hormones, and lead to breathing problems. In short, they're very harmful to people

—But how many POPs exist?

—POPs include many **compounds** with these characteristics. Most of them were created and began to be used from the 1940s onwards, and since then many new ones have been **synthesized**. Let me give you a quick overview with some examples so you can see why they have been - or still are - used: DDT is a pesticide that is still used to fight malaria, an infectious disease transmitted by mosquitoes. PCBs were used in large quantities as a coolant in transformers because of their excellent electrical insulation properties. In construction, insulators containing HBCD were also used as flame retardants — meaning that, in case of fire, they prevent the rapid spread of flames. SCCPs could be added as plasticizers and fire-resistant agents in cables. There are also more recent ones, such as UV-328. With that name, it might sound like a spaceship, but it's an additive added to plastics and paints to protect them from the sun's UV rays and prevent degradation. And the list goes on... Fun fact, you can even find PFAS in some guitar strings!

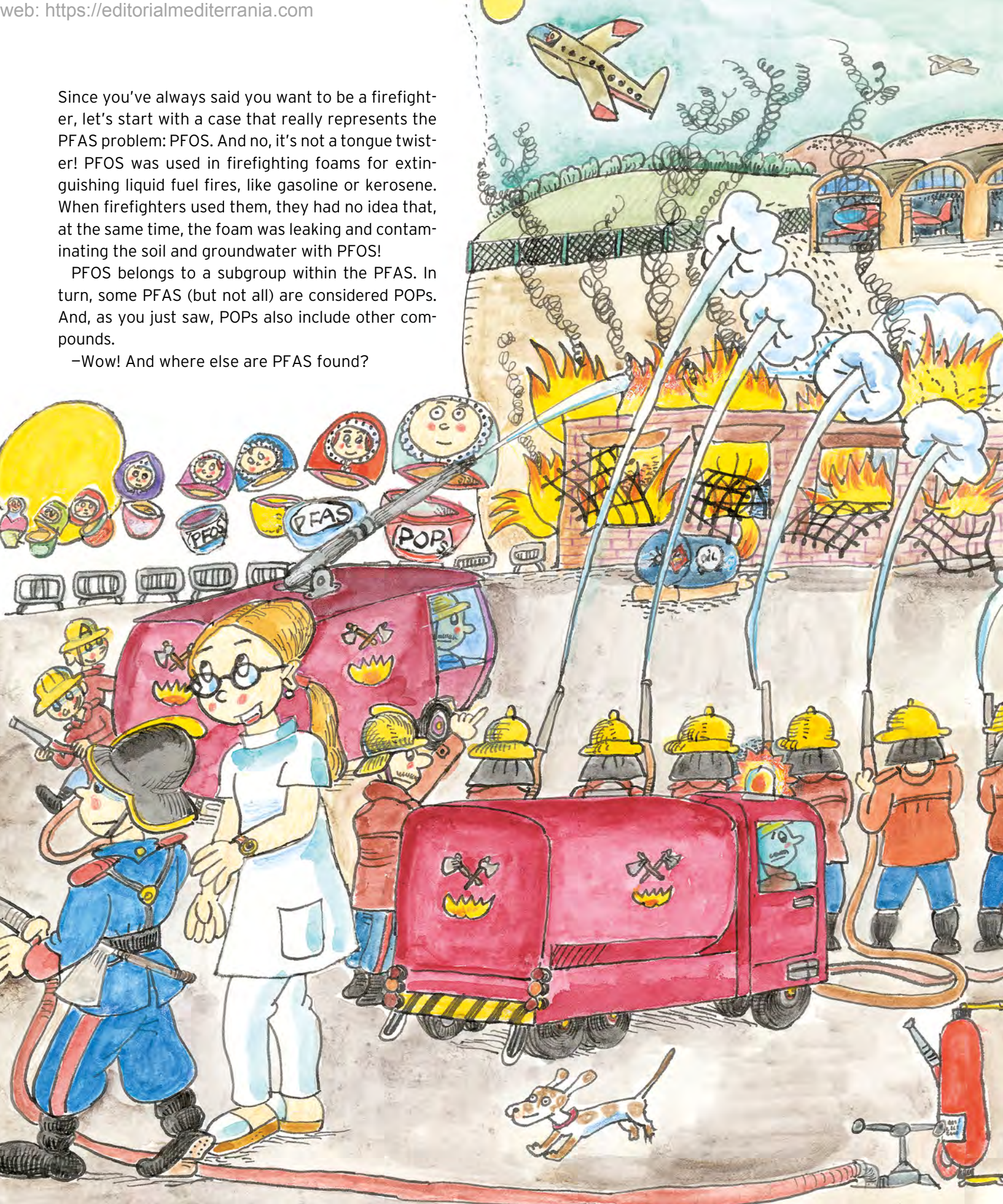
—They were also talking about PFAS on the news!

—PFAS are a class of thousands of compounds.

Since you've always said you want to be a firefighter, let's start with a case that really represents the PFAS problem: PFOS. And no, it's not a tongue twister! PFOS was used in firefighting foams for extinguishing liquid fuel fires, like gasoline or kerosene. When firefighters used them, they had no idea that, at the same time, the foam was leaking and contaminating the soil and groundwater with PFOS!

PFOS belongs to a subgroup within the PFAS. In turn, some PFAS (but not all) are considered POPs. And, as you just saw, POPs also include other compounds.

—Wow! And where else are PFAS found?



—In things like non-stick cookware, waterproof clothing, pizza boxes, makeup, batteries, sunscreen, wood finishes, stain-resistant fabrics, and even solar panels! That's because one of their properties is that they repel water, grease, and dirt.

—So... they're everywhere. Damn! I can't touch anything!

—Hey, that doesn't mean every product has them. Industries are also looking for alternatives, and there are already many being used. Everything is evolving very quickly, which means that not all products with these characteristics contain them.

Since they're so widespread, it's easy to see why they're always in the news.

—But the news talks about PFAS in drinking water.

—You know that when you pour oil into water, it stays on top and doesn't mix: it's insoluble. In contrast, sugar dissolves very well in water, meaning it is soluble. In this case, PFAS are among the POPs that are

most soluble in water. There are others that are less soluble and need to be detected in other **matrices**.

To understand the problem, think about when you go skiing and wax your skis. Some of these waxes contain PFAS. These PFAS stay in the snow, for example. Then, when the snow melts, the water goes into rivers. Wastewater treatment plants can't remove them completely, and they can end up in your tap water, bottled water, or even be absorbed by vegetables and fruits when irrigated with water heavily contaminated with PFAS. But don't worry! Regulations exist, and monitoring is ongoing.

—But who makes sure this is done?

—Each country passes the laws it considers necessary. But for a problem this large, affecting everyone (since air moves, and river water flows too...), a global solution is needed.

—Makes sense, health has to be equally important no matter where you live!

—Exactly! Even a child can see that! Using this logic to tackle global problems, countries decided to create international agreements to try to prevent and address them. In the case of POPs, the main and most important one is the **Stockholm Convention**, adopted in 2001 and named after the city where it was approved.

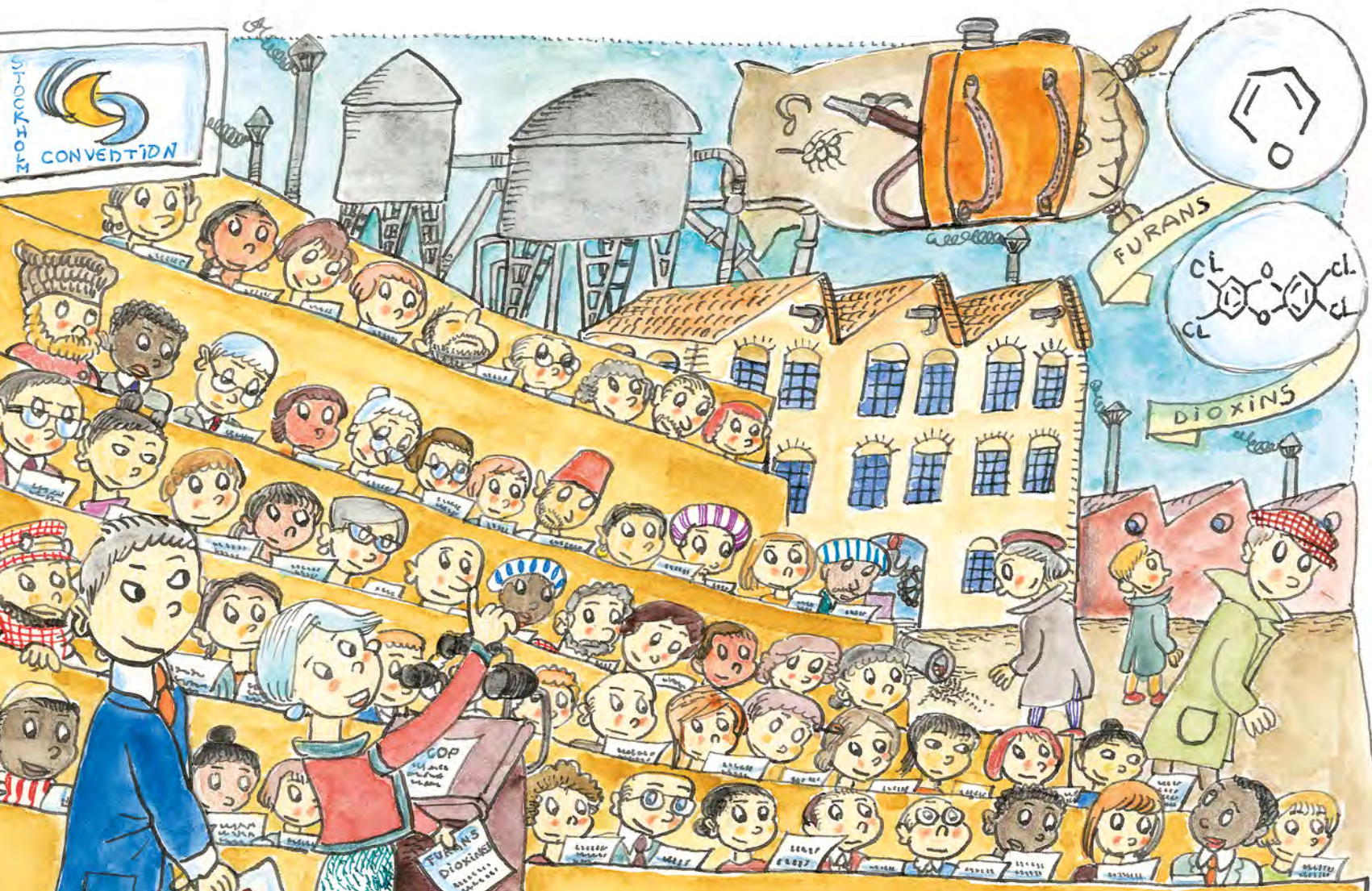
This convention is active. That means when it was adopted, it only included the ban of 12 POPs. Soon it will regulate nearly forty, because a summit is held every two years. At this summit, the participating countries decide whether to add new POPs, assess if the measures taken are effective, and determine how to monitor POPs. What is approved is mandatory for all countries that have ratified it. Remember, this is the main treaty on POPs, but there are other international organizations and conventions that also work to fight chemical pollution. I know you're not a big fan of rules, but in a case like this, it's the only way it works!

—If all this is fine... but wouldn't it be easier to just ban the production of all of them immediately?

—No!! It's not that simple. There are so many limitations to consider. You collect minerals and like birds, right?

—Exactly! I love everything about nature, and I always enjoy observing and classifying them.

—That's what I wanted to hear! You know, classifications are created to bring some order to what could otherwise be a mess. In the case of POPs, they are usually grouped into three categories. The first group is pesticides, which, as you know, are associated with agriculture and pests. The second group is industrial POPs. This group includes POPs created to have specific properties. Most of the examples I've mentioned fall into this category. Is it important that a house doesn't burn down immediately, or that materials last? If you want the same product with the same properties, a substitute has to be found. New molecules are created every year. Some of them could have POPs-like characteristics. Therefore, it's very important that the cure is not worse than the disease — and unfortunately, that has happened! The third group is unintentional, meaning those that nobody created on purpose and nobody wanted. They are products of other industrial processes or unwanted combustion. Some examples of this group are **furans** and **dioxins**.



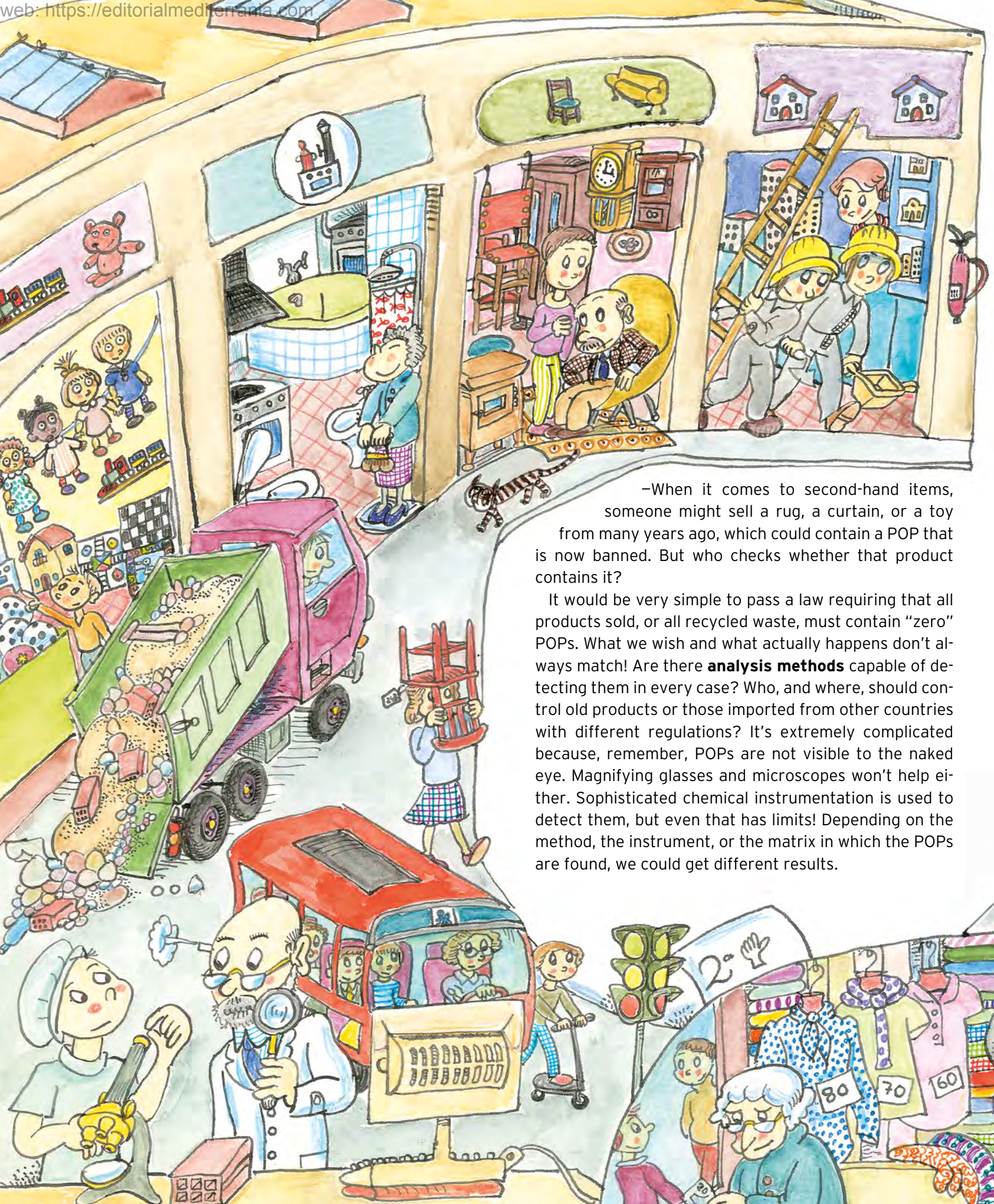
For instance, dioxins can be formed when plastic containing chlorine is burned at high temperatures without proper control. On the other hand, these three groups are not rigid, because just like with birds or minerals, POPs can belong to more than one category: HCB was used as a pesticide, but it also appears as a result of some industrial processes.

—Wow... this really is complicated!

—There's an even more complex problem. What do we do with everything that already exists and contains POPs? Imagine we demolish your grandparents' house. Some of the rubble could contain POPs. Cars from the 70s and 80s also had them in their plastics. The same goes for old computers, TVs, mobile phones, game consoles... they included POPs to prevent them from catching fire easily in case of a short circuit or overheating. However, if we now recycle or reuse these materials without taking this into account, we would be reintroducing old, banned POPs into the production chain! In this case, the result would be ineffective and harmful recycling.

Have you heard of the **circular economy**?

—Yes, they've explained it to us at school.



—When it comes to second-hand items, someone might sell a rug, a curtain, or a toy from many years ago, which could contain a POP that is now banned. But who checks whether that product contains it?

It would be very simple to pass a law requiring that all products sold, or all recycled waste, must contain "zero" POPs. What we wish and what actually happens don't always match! Are there **analysis methods** capable of detecting them in every case? Who, and where, should control old products or those imported from other countries with different regulations? It's extremely complicated because, remember, POPs are not visible to the naked eye. Magnifying glasses and microscopes won't help either. Sophisticated chemical instrumentation is used to detect them, but even that has limits! Depending on the method, the instrument, or the matrix in which the POPs are found, we could get different results.

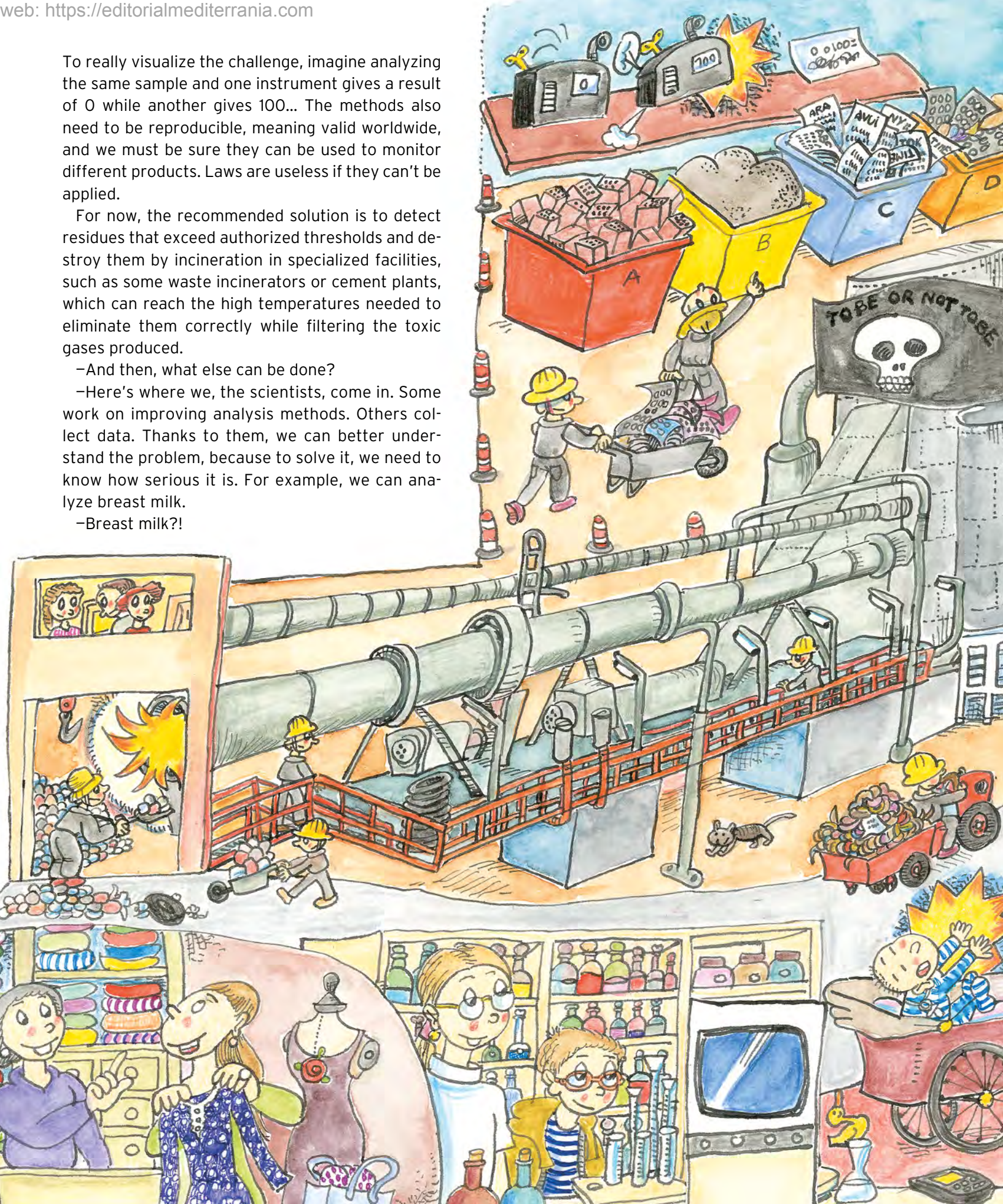
To really visualize the challenge, imagine analyzing the same sample and one instrument gives a result of 0 while another gives 100... The methods also need to be reproducible, meaning valid worldwide, and we must be sure they can be used to monitor different products. Laws are useless if they can't be applied.

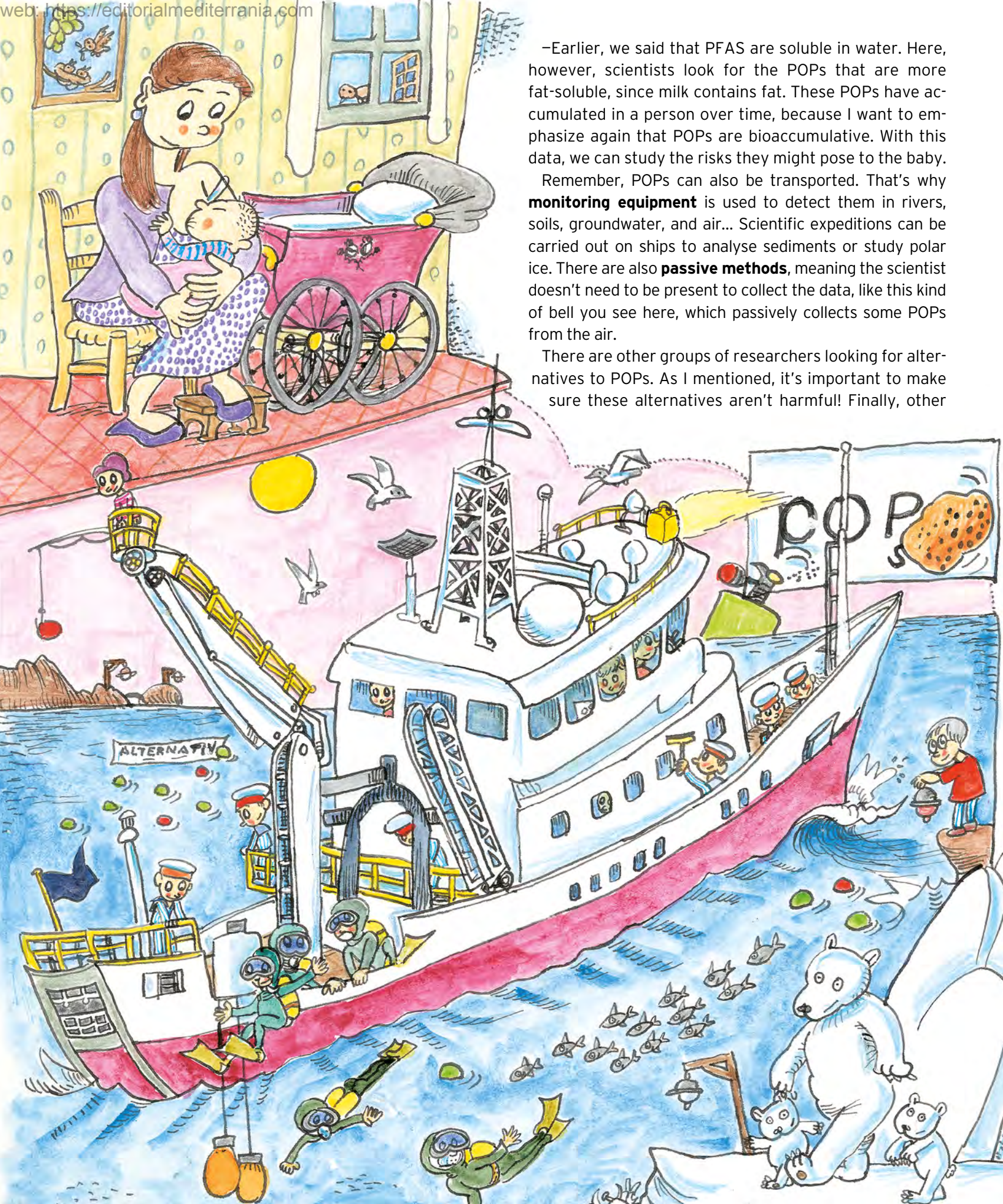
For now, the recommended solution is to detect residues that exceed authorized thresholds and destroy them by incineration in specialized facilities, such as some waste incinerators or cement plants, which can reach the high temperatures needed to eliminate them correctly while filtering the toxic gases produced.

—And then, what else can be done?

—Here's where we, the scientists, come in. Some work on improving analysis methods. Others collect data. Thanks to them, we can better understand the problem, because to solve it, we need to know how serious it is. For example, we can analyze breast milk.

—Breast milk?!





—Earlier, we said that PFAS are soluble in water. Here, however, scientists look for the POPs that are more fat-soluble, since milk contains fat. These POPs have accumulated in a person over time, because I want to emphasize again that POPs are bioaccumulative. With this data, we can study the risks they might pose to the baby.

Remember, POPs can also be transported. That's why **monitoring equipment** is used to detect them in rivers, soils, groundwater, and air... Scientific expeditions can be carried out on ships to analyse sediments or study polar ice. There are also **passive methods**, meaning the scientist doesn't need to be present to collect the data, like this kind of bell you see here, which passively collects some POPs from the air.

There are other groups of researchers looking for alternatives to POPs. As I mentioned, it's important to make sure these alternatives aren't harmful! Finally, other

groups study how to clean up or remove POPs that have already contaminated the environment.

Cleaning up contaminated areas is very expensive. When I say "very", I mean that countries would have to invest so much money that it's not a viable solution right now, unless we are talking about places where it is truly vital because the situation is already extreme. We have to trust that better solutions will be found in the future!

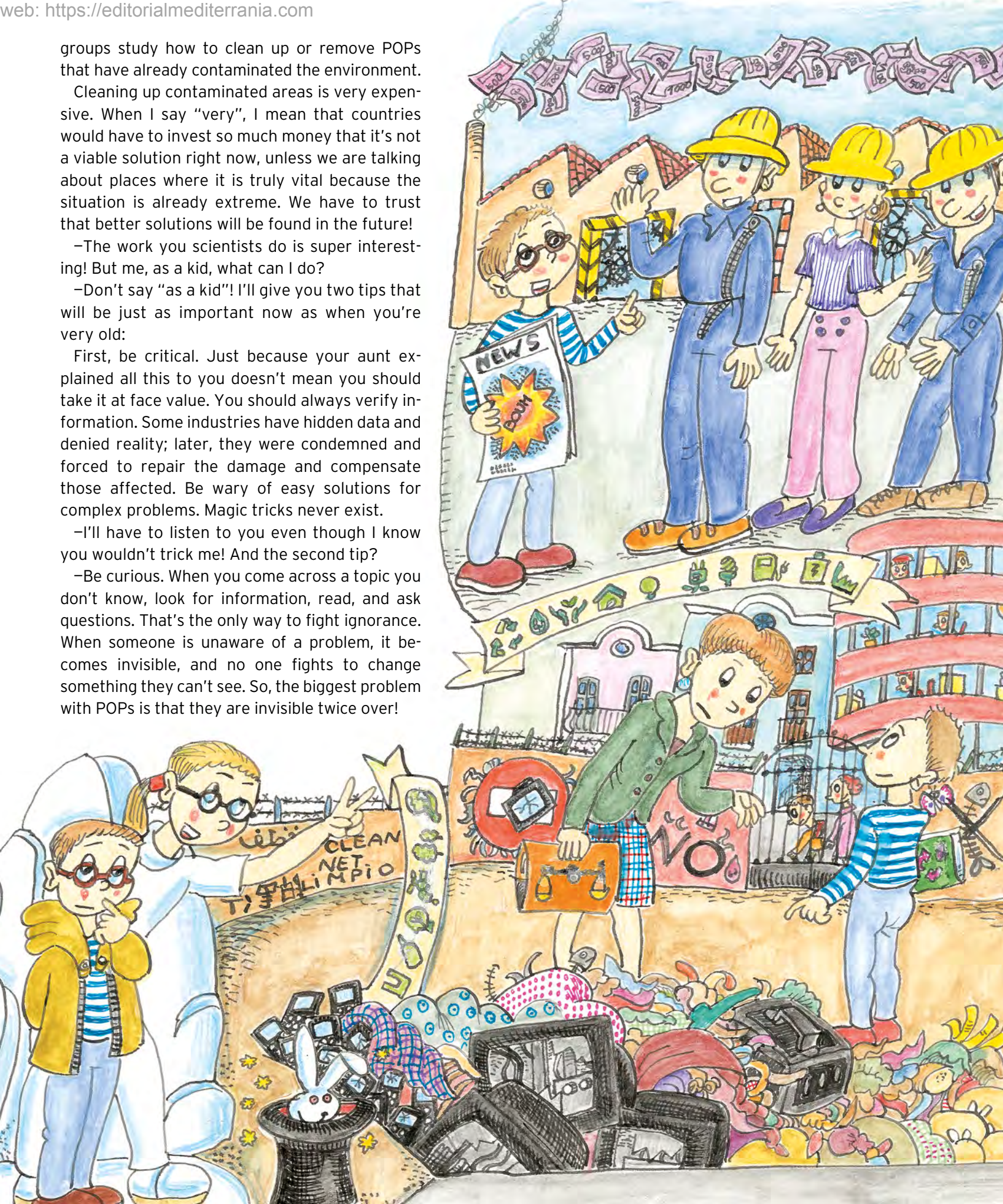
—The work you scientists do is super interesting! But me, as a kid, what can I do?

—Don't say "as a kid"! I'll give you two tips that will be just as important now as when you're very old:

First, be critical. Just because your aunt explained all this to you doesn't mean you should take it at face value. You should always verify information. Some industries have hidden data and denied reality; later, they were condemned and forced to repair the damage and compensate those affected. Be wary of easy solutions for complex problems. Magic tricks never exist.

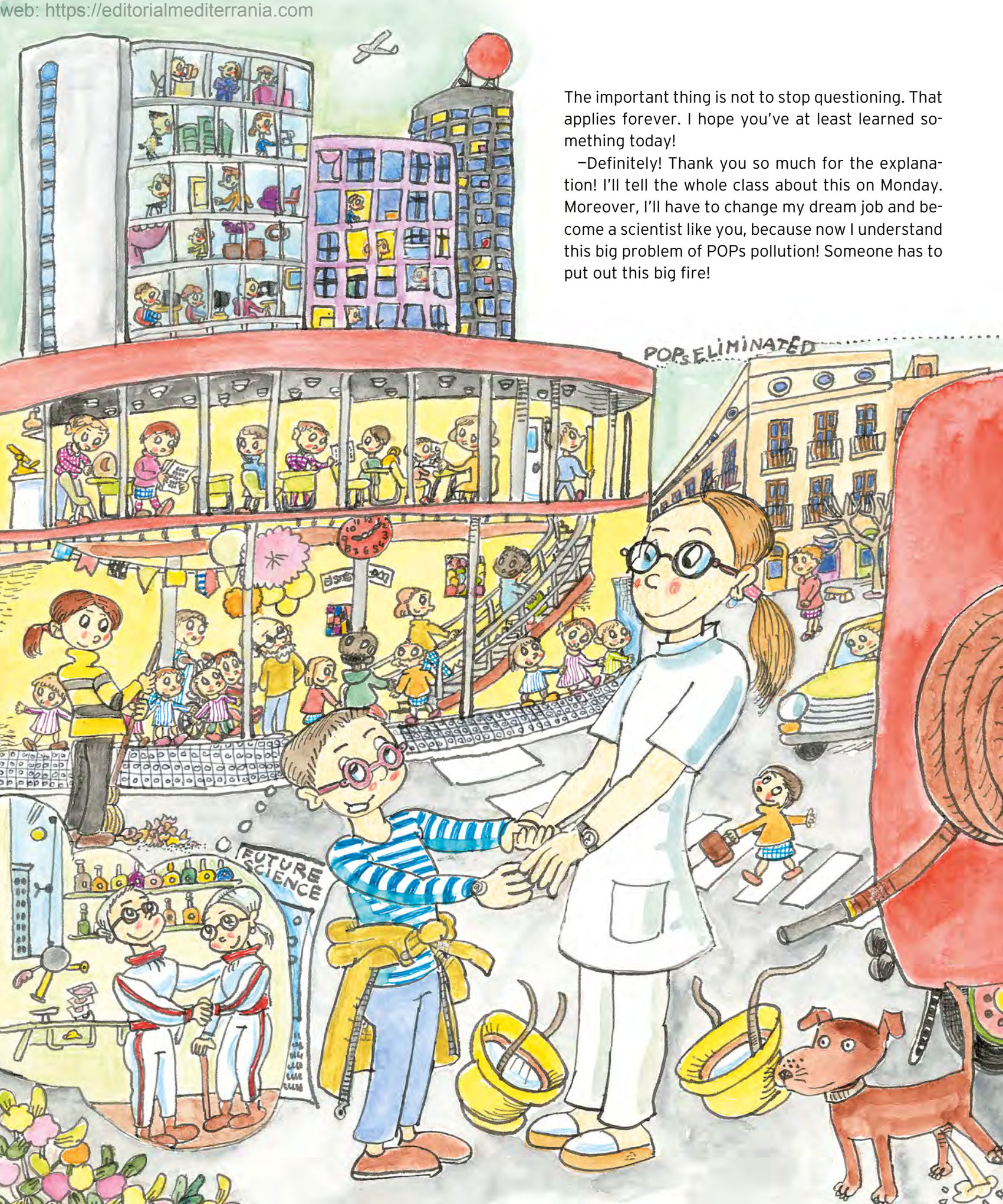
—I'll have to listen to you even though I know you wouldn't trick me! And the second tip?

—Be curious. When you come across a topic you don't know, look for information, read, and ask questions. That's the only way to fight ignorance. When someone is unaware of a problem, it becomes invisible, and no one fights to change something they can't see. So, the biggest problem with POPs is that they are invisible twice over!



The important thing is not to stop questioning. That applies forever. I hope you've at least learned something today!

—Definitely! Thank you so much for the explanation! I'll tell the whole class about this on Monday. Moreover, I'll have to change my dream job and become a scientist like you, because now I understand this big problem of POPs pollution! Someone has to put out this big fire!



Vocabulary

Additive: A substance added in small amounts to improve the properties of a product.

Analysis method: A technique used to detect and/or measure a substance in a sample.

Atom: A very small particle that makes up all matter. It is the simplest unit of a chemical element.

Bioaccumulative: A substance that builds up inside living organisms over time.

Biomagnification: The process by which some substances increase in concentration as they move up the food chain.

Chemical compound: A substance made of two or more chemical elements joined together.

Circular economy: An economic model where products and materials are reused, repaired, and recycled many times instead of being thrown away, to reduce waste and protect the environment.

Dioxins and furans: Toxic chemical compounds that often form during combustion or industrial processes.

Equipment for monitoring: A device or set of instruments used to detect or measure substances.

Food chain: A representation of "who eats whom" in nature, showing how living beings are connected through what they eat.

Matrix: A medium or material where a substance can be found (for example: water, air, soil, milk...).

Microplastics and nanoplastics: Very small plastic fragments; microplastics range in size from 0.5 cm to 0.0001 cm, while nanoplastics are smaller than 0.0001 cm. Both pollute water, air, and soil, and can enter living organisms.

Molecule: A particle made up of atoms bonded together; it is the smallest unit of a substance.

Organic: Made up of compounds that contain carbon.

Passive method: A technique that collects samples or substances without needing a person to be present.

Persistent: Lasting for a long time without disappearing or breaking down.

PFAS: A family of synthetic chemical compounds that are highly persistent and difficult to remove, used in products such as non-stick cookware, firefighting foams, and water-repellent fabrics.

Pollutant: Any substance that can harm the environment or health.

POPs (Persistent Organic Pollutants): Toxic chemical substances that remain in the environment for a long time and build up in living organisms.

Stockholm Convention: An international agreement that regulates and limits the use of certain Persistent Organic Pollutants (POPs).

Synthesize: To produce a chemical substance in a controlled way, usually in a laboratory or industrial process.

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