The Beetles

A Tally Tail Journey

“Well, all my bags are packed for my next big adventure to go and see cousin Tiger Beetle,” says Beetle.

“Let’s see, do I have everything? **Humus*** for a snack on the road - check, ‘*How to Improve Your Soil*’ textbook - check, and my best buddy Mite to accompany me?”

“Bark Bark Bark!” Mite confirms excitedly.

"I am so excited to go see Tiger Beetle and visit somewhere new, nice, and warm!"

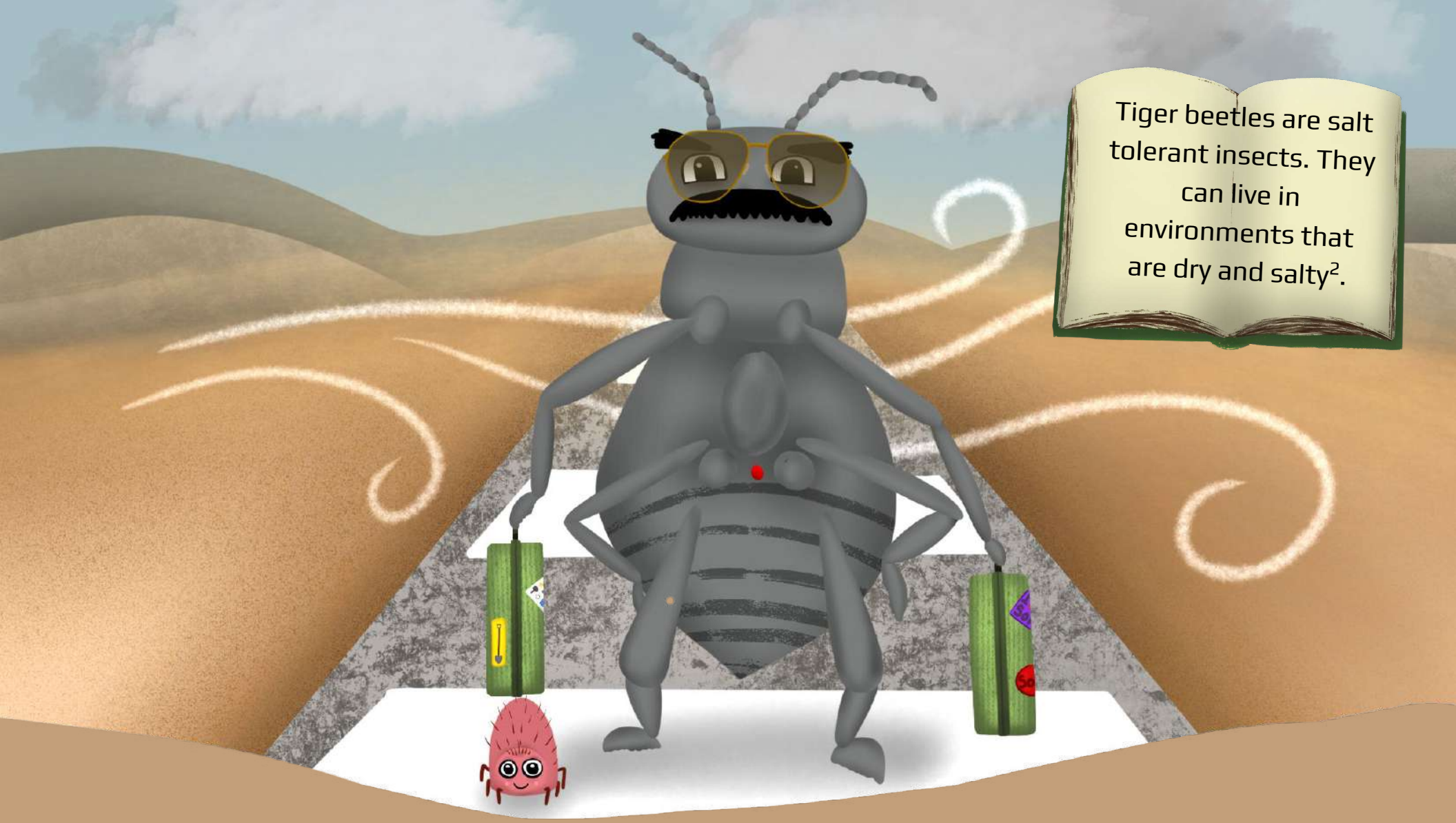
*Learn more about bolded words on page 16

"All aboard the pigeon express flight!" booms Captain Pigeon. "Prepare for take-off."

They continue, "We are expecting a smooth flight today with a few bumps along the way. Your destination is going to be a hot and sunny 35 degrees celsius with frequent wind storms. As you know this area is having issues with soil salinity, and the increasing temperatures are not very helpful. As always, we want you to know you are a valued customer, and thank you for flying Pigeon Express."

"What!?!" cries Beetle "I didn't know Tiger Beetle is having salinity issues!"

Did you know that soil salinization caused by inappropriate irrigation practices affects approximately 60 million ha, or 24% of all irrigated land worldwide[1]?
South Asia, Central Asia, and Africa are the regions most affected by this type of soil degradation[1].



"Cousin!" cries Tiger Beetle, "What a relief to see you!"

"Tiger! It's been too long! I have to say this reunion is not as sweet as I imagined. What's going on here? What is this? I thought you lived in a thriving ecosystem!"

Mite licks a salt flake. Beetle kicks the **salt crust** at the surface of the soil. "There are almost no plants in sight!"

"Indeed, there's a lot to discuss. But we're going to have to take cover, a windstorm is brewing," says Tiger.

Beetle scoops Mite up. The cousins do their best to cover themselves as they are plummeted by salty soil bits.

“What was with that storm?”

“Bark Bark!”

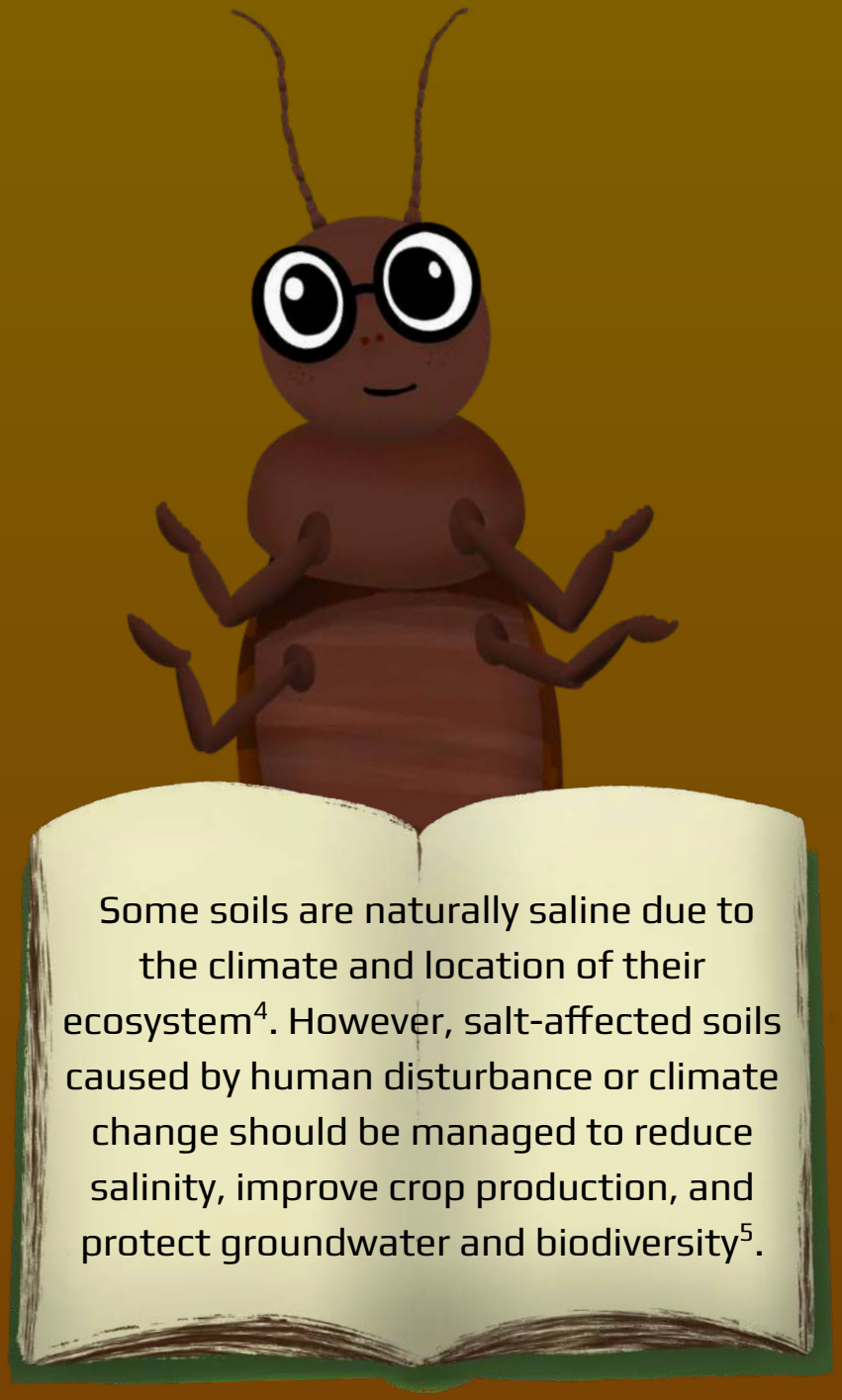
“Oh dear, Mite is thirsty. Would you have a glass of fresh water?” asks Beetle.

“Well cousin, I only have a little left, but even our **groundwater** has become salty.”

“Is it that bad?”

“Where do I even begin? There used to be farmers here, growing gorgeous leafy crops. They watered their plants, but the water they used had salts in it. As the water evaporated, too many salts stayed behind, and over the years things started to get bad. Plants don’t grow well in salty soil—‘**saline** soil’ they call it. The plants can’t get enough water or nutrients to grow, there’s no balance! Personally, I’m okay with the salt, but many of my friends and prey were getting sick and had to go. Eventually the farmers had to move to the city—they couldn't afford to be here anymore. I’m lonely now… so that’s why I invited you! “

“Oh Tiger! I’m so sorry you are going through a hard time,” says Beetle “I should have came sooner.”



Some soils are naturally saline due to the climate and location of their ecosystem[4]. However, salt-affected soils caused by human disturbance or climate change should be managed to reduce salinity, improve crop production, and protect groundwater and biodiversity[5].

“And what about this storm?”

“Well, this salt thing is a problem all over the world. Somewhere not too far away they have a similar situation. The salt they have is called **sodium**, and their soil is ‘**sodic**’. It makes the **soil structure** crumble apart, and now the wind is blowing that soil over here—and the sodium with it. It’s even worse than before because my soil is crumbling now! Don’t you see?! The walls are falling down around us!”

“Cousin, I thought I was coming to relax, but we have to do something about this.”

“Well… rumour has it some new farmers are on their way, and they are bringing a small human, Perhaps the small one will listen to us?” says Tiger Beetle.

“Tiger, that’s it!” exclaims Beetle “The small ones are usually good at taking our advice, so maybe there’s hope! We can give them ideas to solve this. Why don’t we read my textbook for some answers."

"Tiger! The human offspring has arrived! We have to give them guidance!" exclaims Beetle.

The beetle cousins wave to the child, who spots the beetles and kneels down curiously.

"Hello young human, we are here to warn you about about how these soils have been mismanaged and become super salty and what you can do about it!" says Tiger.

Salty soils that are mismanaged can affect soil, plant, and microbial health[4]. This is particularly challenging for farmers since it could lead to crop losses, increases in management costs, and in some cases, total business loss and farm closure[5].

A couple of days later...

"WOOoow, what is that?! An earthquake?!" says Beetle

"Look there! The humans are on their tractors! They are doing something to the soils," says Tiger.

"OH NO! ARE THEY **TILLING**? WE HAVE TO GET OUT OF HERE NOW!" screams Beetle.

"Calm down Beetle! We just read about this: laser-levelling! They are making the soil surface more even. This way, the water has time to enter the soil instead of washing over the surface and taking soil with it," explains Tiger. "It seems they are listening to the tiny human we spoke to."

"OH YEAH!!" exclaims Beetle. "And over there I can see they are digging a trench around the farm. It must be for drainage. When it rains or the soil is watered, the salts will have a way to wash out."

Soil salinity can be reduced by a combination of flushing water and management practices that improve water infiltration and drainage over the long-term. Ex: Tile drainage, laser leveling the soil surface, digging trenches, and low-tillage practices[5].

A few days later….

"Tiger, your house is still falling apart and Mite is getting thirsty again," says Beetle

"I know Beetle," says Tiger. "The sodium salt is making the walls crack more and more with every minute that passes. "

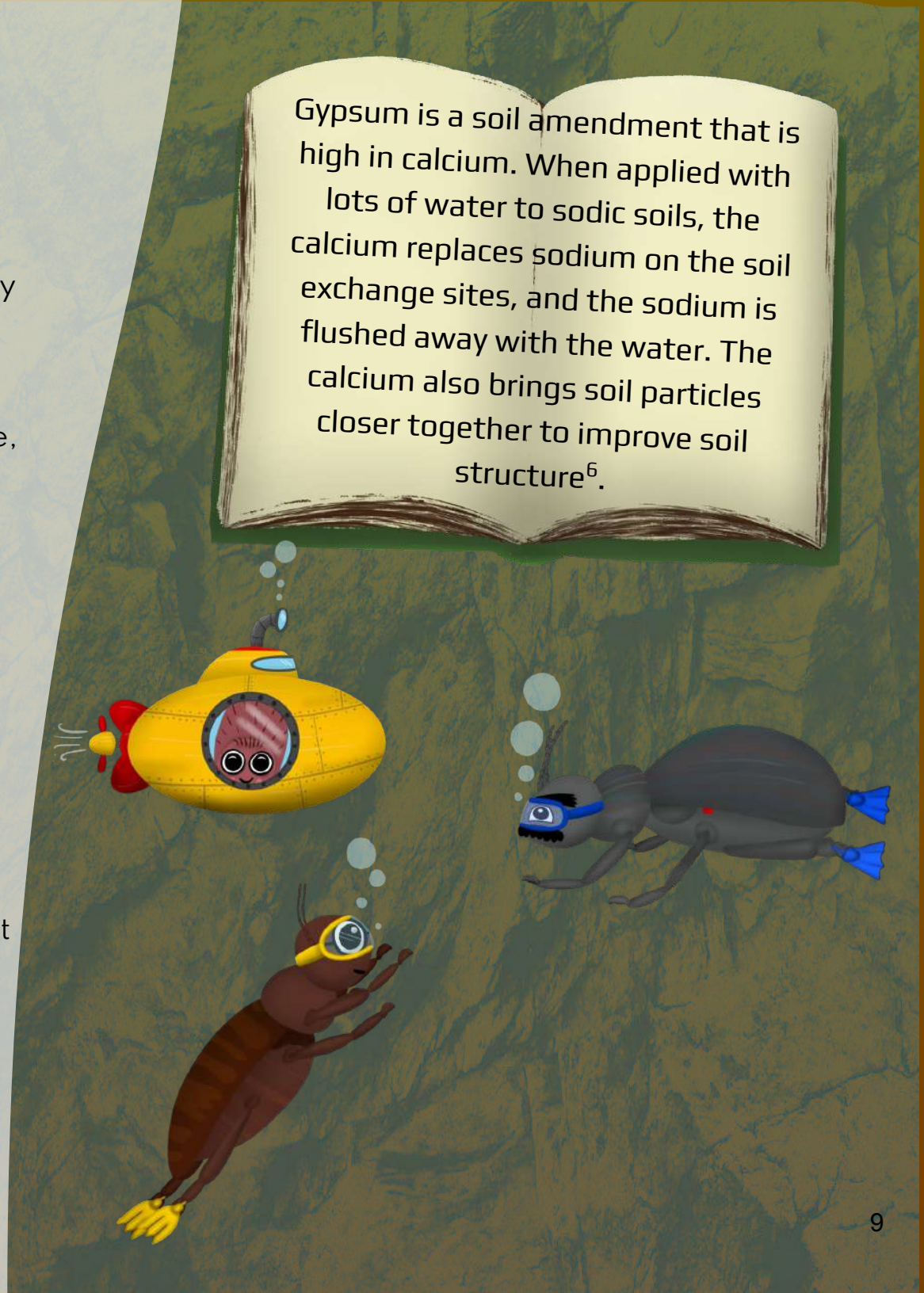
A rotten egg smell suddenly wafts into Tiger's house. "Ew, what's that smell?!" complains Beetle, covering his nose "Did you fart?"

"Ha! It's the humans! They are spreading some type of powder in the soil, and it's pretty stinky!" says Tiger, as water sprinklers start spraying and the soil becomes wet. "And they are finally watering! Hold onto something we are about to get wet…"

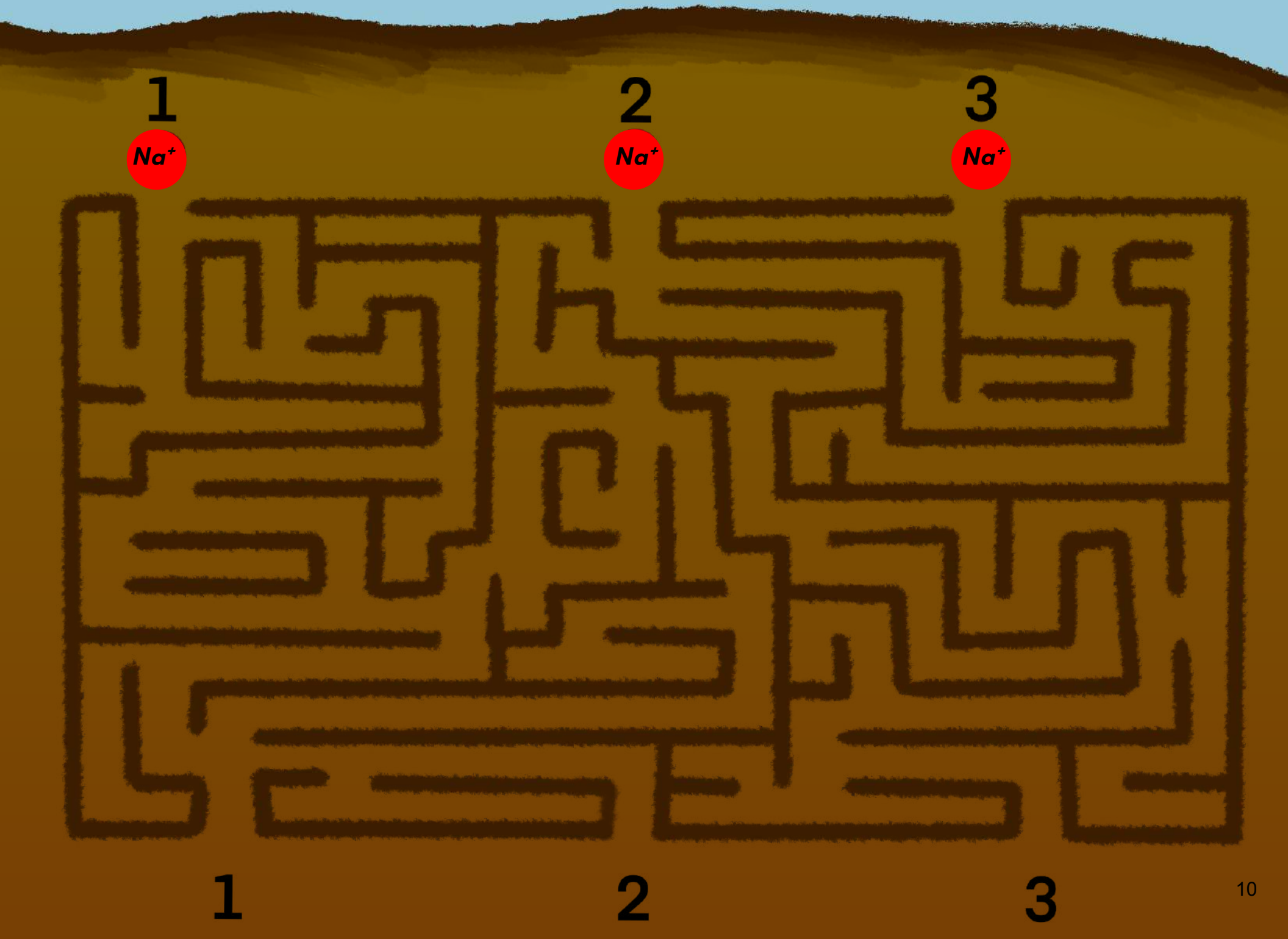
Water starts rushing through the house, draining shortly afterwards.

"Well that is what I call a good soil bath. It's great for the cuticle! I feel rejuvenated" says Tiger. "And look, Mite doesn't look so thirsty anymore."

"Oh yes!" recalls Beetle. "This is the gypsum we read about. It helps get rid of the sodium, remember? Look cousin, your walls have stopped cracking! What the tiny human lacks in size, is made up for in brains!"



Help Beetle and cousin Tiger Beetle get the salt out of the soil!



A few weeks later...

"Well, things are looking better around here. But we still have some extra salts," says Tiger Beetle "Look! I see the humans are planting and putting out some yummy **compost** too!

"I thought plants did not grow well in these salty soils?" wonders Beetle.

"These must be special plants, remember we read that some plants don't mind the salt so much? Like me! These will grow well while we keep working on fixing the salt issue, and the compost also gives them extra nutrients."

"Look the plant roots are dispensing goop in other words, sugary glue! These will help strengthen your walls. We'll get this place in tip top shape in no time! We were right to put our trust in the child."

Sodium causes the **dispersion** of soil **aggregates** which can lead to loss of soil carbon and increase carbon dioxide (CO_2) emissions to the atmosphere[4,5].

By adding organic matter and plants we can help boost the formation of soil aggregates[5].

A Farewell to Salt

Well, you might cook with salt and oil,
But too much salt will spoil our soil
Plants will shrivel, friends will leave.
In **aggregates** it's hard to breathe.

Soil tests help us diagnose
Salinity? Sodicity? How morose!
What to do to make it right?
Is our soily future bright?

Don't give up, no don't despair—
With management we can repair!
Get some drainage, flush away
But careful with your neighbours, eh!

When you water, know from where.
Could there be sea intrusion there?
Chemical fertilizers? Take it easy!
Too much extra makes us queasy.

Laser levelling's a tool
to help stop runoff—very cool!
Add **compost**, mulch, **organic matter**
Microbes will come—pitter patter!

You might even just decide
To make that field a set-aside
Once the salts have been reduced
biodiversity will have a boost!

See we can fix the situation
If we halt soil **salinization**!
So treat soils well and carefully
To boost soil productivity!

Did you know that salt water intrusion and excessive fertilizer use can also cause soil salinization? When salt water from the sea enters rivers, lakes or aquifers, it contaminates potential irrigation water with salts[7]. When plants cannot use all the nitrogen from fertilizers, the extra nitrogen forms new salts in the soil and raises salinity[8].

“I miss all my snacks and my friends. Maybe with all these improvements my friends will come back to live here,” says Tiger.

“They will, trust me! I’ve seen it happen in my community! Just give it time.”

“I hope you are right Beetle, I truly do.” says Tiger. “Hey, I think I smell the gypsum again?!”

Halt soil salinization, boost soil productivity!

How to determine soil quality at home: Slaking or Dispersion Test

(Modified from: https://www.fao.org/fileadmin/templates/nr/kagera/Documents/LADA_manuals/part2_d.pdf)

Soil scientists use this test to determine soil quality. You can perform it at home with soils from your own region.
By adding table salt to one of your soil samples you can observe how sodium affects soil structure.
Slaking describes how a soil aggregate (or clump of soil) will break down into smaller pieces or micro aggregates.
Dispersion describes the breakdown of these soil aggregates into smaller primary particles of sand, silt, and clay.

What you will need

- Soil
- 2 Glass jars (or clear containers)
- 2 teaspoons table salt (sodium chloride)
- Water

Steps

1. Find soil - for example, you can use a soil from underneath the grass outside or soil from a garden bed. Find a large clump (or aggregate) of soil approximately 5 cm in diameter.
2. If the soil is wet, allow the soil aggregates to dry out for a day.
3. Fill two glass jars (or plastic containers) with water
4. Add 2 teaspoons of salt to one of the cups of water. Mix well to dissolve the salt. Label to make sure you know which one is salty.
5. Drop an air-dried aggregate into each jar.
6. Completely submerged aggregates below the water.
7. After 10 minutes in the water, examine the aggregates to determine which one has slaked or dispersed more than the other.

Do the aggregates look the same? Which cup has muddier or cloudier water? Which aggregate held its shape better?

The soil aggregate that remained more intact is likely the soil without the added table salt. Other factors can affect the stability of soil aggregates. Higher amounts of organic matter, higher clay content, careful soil management (low tillage, direct seeding, mulching, cover crops, intercropping), biological activity (roots, fungi, worms), and physical processes (shrinking/swelling, wetting/drying) can all help soil aggregates stick together.





DID YOU KNOW?

Aggregates are mini clumps of soil made up of individual soil particles and organic matter that have bound together. Aggregates provide habitat for soil organisms, allow for air and water movement through the soil, create space for roots to grow, and store carbon.

Biodiversity refers to the many living organisms in a particular habitat, the more organisms the higher the biodiversity!

Carbon (C) is the element of life. All living things are made of carbon and it is also in things that are not alive! This means that you, me, a giraffe, an apple, and a rock all have carbon within us.

Compost is a soil amendment made of partly decomposed organic matter. It is used to fertilize and improve the soil.

Dispersion is the process of soil particles separating from one another. This is often caused by an excess of sodium (Na) in the soil and it is not desirable as it weakens soil structure and prevents aggregate formation.

An **ecosystem** is the physical area where organisms and nonliving factors (like water and air) interact with one another.

Groundwater is water found underground in the space between rocks, sand, and soil.

Humus is a complex type of soil organic matter that has been transformed by decomposition. It is usually dark brown.

Infiltration is the process of water on the surface of the ground entering the soil.

Salinization is the process through which water-soluble salts build up in the soil.

Salt crusts are hard layers at the soil surface that form due to salinity.

Sodium (Na) is an element that readily forms salt compounds. High levels of sodium in soils can harm plants and cause the dispersion of aggregates. We commonly use sodium in cooking, because table salt (sodium chloride) is formed with sodium!

Soil is a layer of the Earth's surface, made up of interacting minerals (sand, silt, clay), organic matter, air, water, and living organisms. It is where we grow food and is vital for ecosystem functions. Soil is not dirt!

Soil organic matter refers to the dead plant and animal tissues at different stages of decomposition in the soil.

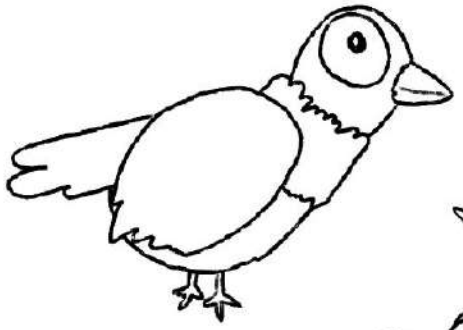
Soil Structure is the relative arrangement of soil particles in the soil. This organization is dependent on how these particles clump and bind together to form different types of soil aggregates.

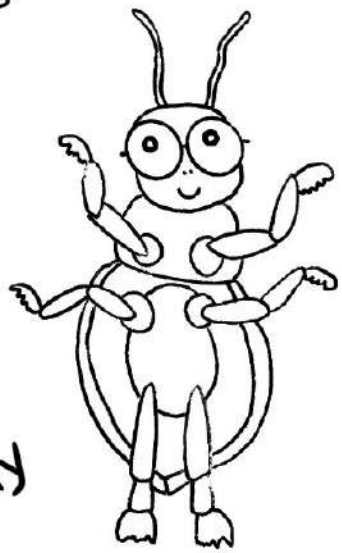
Tilling is the mechanical action of overturning and crumbling the soil to prepare it for cultivation of crops. This is mainly done by heavy machinery (tractors) and often leads to the destruction of many insect habitats.

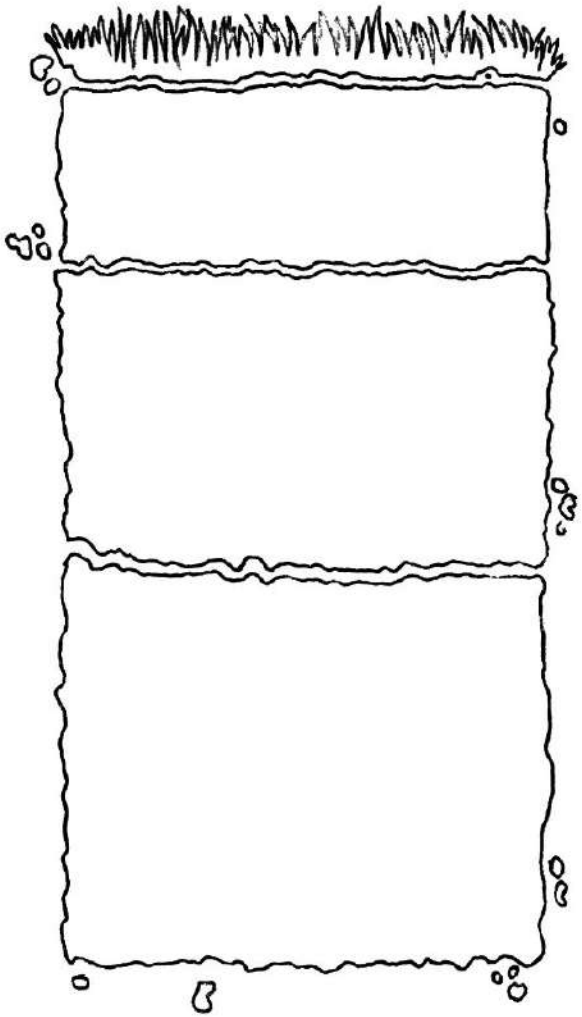
REFERENCES

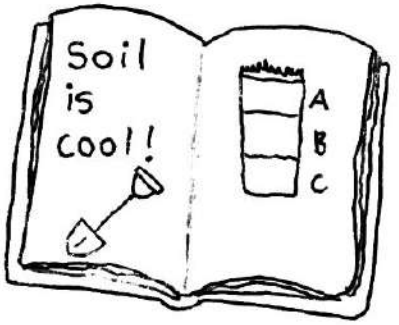
1. Umali, D. L. (1993). *Irrigation-induced salinity: A growing problem for development and the environment*. World Bank Publications. https://doi.org/10.1596/0-8213-2508-6. **2.** Duran, D. P., & Roman, S. J. (2021). Description of a new halophilic tiger beetle in the genus eunota (coleoptera, cicindelidae, cicindelini) identified using morphology, phylogenetics and biogeography. *PloS One, 16*(10), e0257108-e0257108. https://doi.org/10.1371/journal.pone.0257108. **3.** Lamond, Ray E., & David A. Whitney. (1992). Management of saline and sodic soils. Cooperative Extension Service, Kansas State University, Manhattan, Kansas, document MF-1022. **4.** Krzic, M., Walley, F. L., Diochon, A., Paré, M. C., & Farrell, R. E. (2021). Soil Salinity and Sodicity. In *Digging into Canadian soils: An introduction to soil science*. Pinawa, MB: Canadian Society of Soil Science. Retrieved from https://openpress.usask.ca/soilscience/. **5.** Food and Agriculture Organization of the United Nations (FAO). (n.d.). *Salt-affected soils*. Retrieved April 11, 2021, from https://www.fao.org/soils-portal/soil-management/management-of-some-problem-soils/salt-affected-soils/more-information-on-salt-affected-soils/en/. **6.** Bello, S. K., Alayafi, A. H., AL-Solaimani, S. G., & Abo-Elyousr, K. A. M. (2021). Mitigating soil salinity stress with gypsum and bio-organic amendments: A review. *Agronomy (Basel), 11*(9), 1735. https://doi.org/10.3390/agronomy11091735. **7.** Bayabil, H. K., Li, Y., Tong, Z., & Gao, B. (2021). Potential management practices of saltwater intrusion impacts on soil health and water quality: A review. *Journal of Water and Climate Change, 12*(5), 1327-1343. https://doi.org/10.2166/wcc.2020.013. **8.** Han, J., Shi, J., Zeng, L., Xu, J., & Wu, L. (2015;). Effects of nitrogen fertilization on the acidity and salinity of greenhouse soils. *Environmental Science and Pollution Research International, 22*(4), 2976-2986. https://doi.org/10.1007/s11356-014-3542-z.

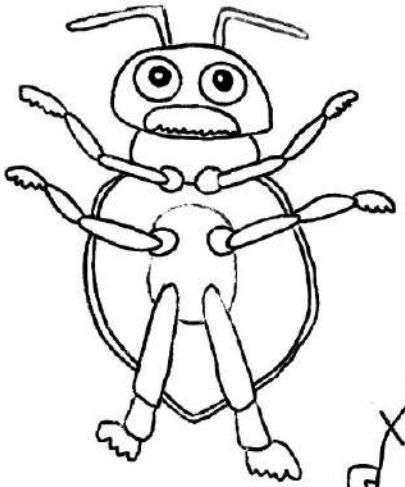
Halt Soil Salinization

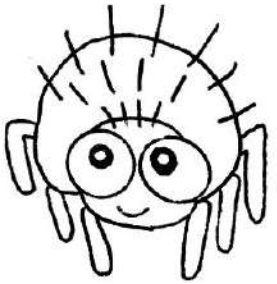












#worldsoilday
2021

Boost Soil Productivity