English Edition
Spring 2014
Vol. 3

The Aha! Moment of Science

Science Window

Special Issue for National Cherry Blossom Festival 2014

Science Window

"Science Window" is a quarterly Japanese publication. It has been published by Japan Science and Technology Agency (JST) since its first issue in 2006. On occasion, special editions of the magazine are also issued. Approximately 39,000 of both public and private schools in Japan subscribe to this magazine for free. Fifty Japanese schools in United States also receive the magazine from the JST Washington DC office.
Science Window is regarded as an educational science magazine for teachers and students to build-up scientific literacy. It has introduced a lot of easy, useful, and interesting scientific themes through some fundamental scientific experiments, biological topics, and a variety of articles from a wide range of science and technology fields. It is part of the supportive material for STEM education.
The Science Window English edition has been issued by the JST Washington DC office annually since 2012. The Spring 2014 issue is the third English edition.
See Science Window Japanese Edition online at http://sciencewindow.jp/

A Message from the Director

Takashi Ohama, Director, JST Washington DC Office

It is my great pleasure to present you the third Science Window Special Issue for the National Cherry Blossom Festival. We started issuing this English version in 2012 in honor of the centennial anniversary of the gift of 3,000 cherry blossom trees from Japan to the United States. From the original Japanese Science Window, we have been selecting the articles which celebrate spring or tell us Japanese culture, nature, science and technology. The English Science Window has been enjoyed by the visitors to the Sakura Matsuri Japanese Street Festival which celebrates the long relationship between the U.S. and Japan. I hope you also enjoy reading this edition.

Spring 2014 Special Issue

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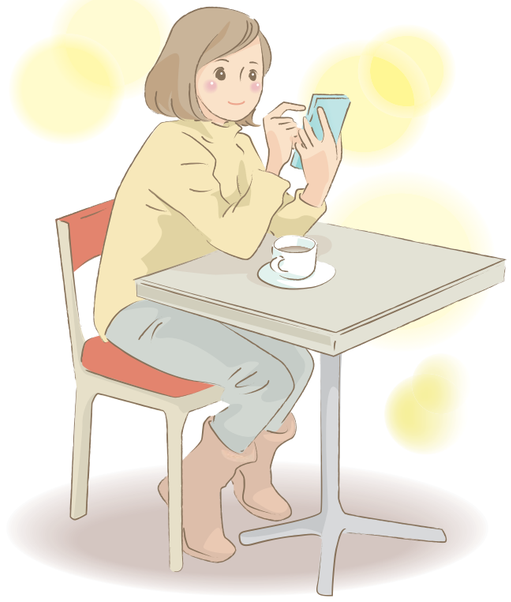
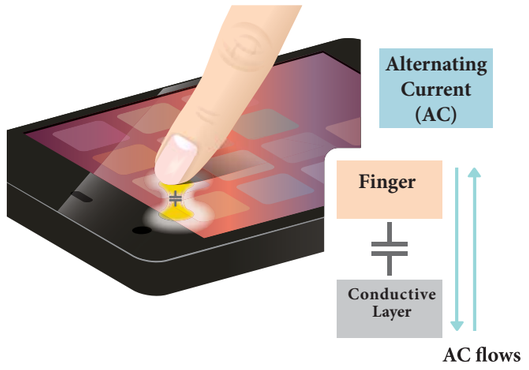


How do touchscreens work ?

A lot of people now own smartphones. You often see people using their fingers to touch, tap, and slide over the phone's screen.

Even computers with touchscreens are on the market now. But do you know how it works? What kind of devices make them work?

Touchscreen Smartphone



On smartphones

An alternating current inside the device creates a capacitor effect between the finger and conductive layer, generating an electric current between them.

Do touchscreens always work by using any objects instead of fingers?

Can you get a smartphone nearby? If yes, please try this.

First of all, touch the screen by using the tip of your fingernail. Does it work? I know it does not work, even if you press down hard. It works only by using your whole fingertip.

So then, we can assume that the principle of the touchscreen devices has nothing to connect each other by the amount of pressure that you apply to the surface.

Next, touch the screen with a fairly wide metal object like a large iron nail head, and it works, doesn't it? Also you can try a eraser or a wooden object. It does not work, does it? The touchscreen works only by using an electrically conductive object - like your finger or a nail head.

What if you put on a glove and touch the screen? If the glove is made of cotton or leather, you will not get a response. If you wear a glove specially designed for smartphones, the touchscreen will work just fine.

Now, what if you use two fingers at once? The screen recognizes your fingers and lets you do like zoom in on pictures. However, if you try to use two fingers simultaneously on a laptop's touchscreen, the cursor will zoom off in a random direction. Even though both are touchscreens, they are different types.

from Science Window Winter 2013 issue • By Chisato Hara • Illustrations by Tomoko Monobe

Capacitors are key

A smartphone's screen looks like it is made of durable glass. Why does simply touching the screen make it work? Kenji Nakatani, who is the director of product development from Touch Panel Laboratories, Co., has the answer: "Touching the surface with your finger sends small electrical impulses through the screen. The smartphone's processor uses software to analyze the data and determine the features of each touch."

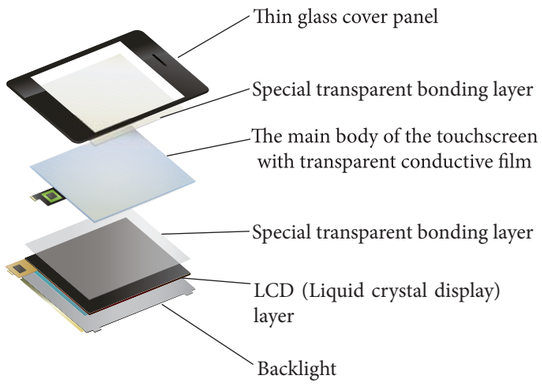
What makes electrical impulses travel through the screen when you touch it? Mr. Nakatani says a component known as a capacitor is the key. Simply put, a capacitor is a device that splits electrical currents and stores electricity. As you can see in the bottom diagram on the left, sending a direct electrical current through two separated metal plates ("electrodes") causes a lot of electrons to gather on one plate. This is a type of electrical storage, and the energy stays stored even when you switch off the power. Connecting the tips of the capacitor with a conducting wire will discharge the electric current (the "charge").

In that case, what happens when you send an alternating current of electricity – which changes directions many times per second – into the capacitor? According to Mr. Nakatani, "The capacitor begins to charge and discharge repeatedly, and this creates a constant flow of electricity." In other words, the device's insulator prevents direct current (DC) from forming a connection, but when you use alternating current (AC), a charge-discharge electric current forms and travels through, just as if a connection existed. Mr. Nakatani says that touchscreen "magic" is really the result of harnessing this special property.

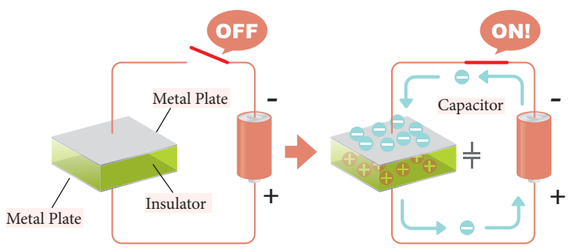
Inside the smartphone display, there is a transparent conductive film that lets through both light and electricity. That part is covered by a transparent glass insulator that does not conduct electricity (see the diagram on the right). Alternating current flows through the conductive layer. When you put your finger on the insulator glass, the conductive layer and your finger act like the two sides of a capacitor, creating a constant flow of electricity.

▲ Transparent conductive film used for touch panels. (Photo: Nitto Denko Corporation)

Smartphone Display Screen Structure

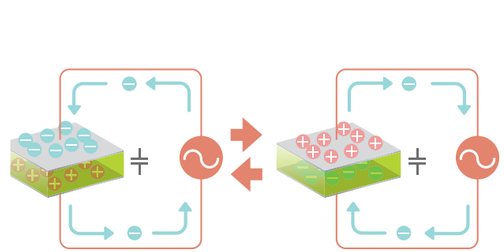


Capacitor Structure



DC (Direct Current) — The electricity is stored.

Electrodes gather in one of the metal plates, giving that plate a negative charge and creating a positive charge in the opposite plate. A capacitor in this state is storing electricity. Invisible electricity is generated between the two metal plates. Wider plates, a narrower gap between them, and higher voltage result in greater power.



AC (Alternating Current) — The electricity flows.

The direction of AC electricity changes repeatedly. It follows that a charge and discharge process forms like a electric circuit. As the result of this phenomenon, the electricity flows constantly.

Electricity at your fingertips

Sodium and potassium are dissolved in water inside our bodies. This creates ions, and ions conduct electricity. When you touch the glass, sandwiching it between your finger and the conductive layer, you create a capacitor. When an alternating current is sent through the conductive layer, a tiny amount of electricity begins to flow between your body and the touchscreen. In other words, electricity flows between the smartphone and the person touching it.

The human body is able to store electricity just like a large metal plate, so the small amount of electricity that flows from the smartphone is fully stored and released. "The device registers the change in this electric current, and its electronic circuits instantly calculate your finger's position," explains Mr. Nakatani. It is astounding to think that such a complicated process happens inside this small screen. Since the current is very weak, thinner insulating glass is more effective, and most devices use glass that is between 0.02 and 0.04 inch (0.5 and 1 mm) thick. Touchscreens will not respond to gloved fingers, either because the glove material does not conduct electricity or because the material puts too much distance between your finger and the conductive layer. Touchscreens do respond to gloves designed specifically for smartphones because the gloves have conductive fibers in their fingertips.

In addition, whether you are using your finger or a metal object, if the surface in contact with the screen is too small, the capacitor effect will be too weak and the touchscreen will not respond. The best way to improve the response is to make the contact surface larger, but you can also moisten the tip of your finger to make it conduct electricity more efficiently.

Japan: A touchscreen panel pioneer

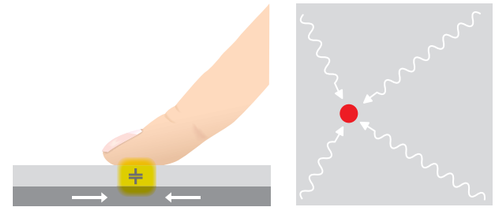
"There are many other types of touchscreens besides the ones mentioned in this article, but the type explained here, in which the user's finger forms a capacitor and generates current, is the type that is mainly used in smartphone touchscreens. In scientific terms, it's known as an "electrostatic capacitance type". The principle behind it is not anything new, but people have begun to notice it because of the way it looks and feels, and because it's quite durable," says Mr. Nakatani.
One of the most important elements in direct contact touchscreen panels is the transparent conductive film. According to Mr. Nakatani, Japanese fiber manufacturers actively worked to develop these films, and Japan is a leader in global smartphone touchscreen component technology.

"People often say that smartphone batteries lose power quickly, and there is a huge demand for technology that can use very low voltage to operate a highly sensitive touchscreen. In addition, manufacturers are coming up with new techniques and producing even thinner touch panels," he says.

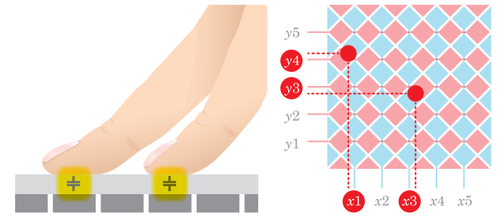
Computers with touch panels are also available now, and as touchscreens become more popular and more sophisticated, computer keyboards and mice may eventually be phased out. In the not-so-distant future, typing away like mad on a keyboard may be a thing of the past.

Touchscreen Types

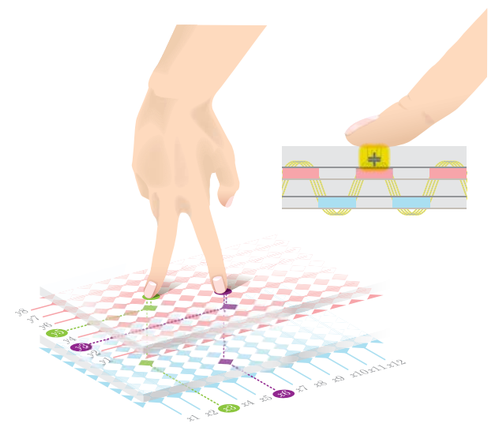
There are many types of touchscreens available. Smartphones usually use the electrostatic capacitance type. This type includes several subtypes, and the following three are the most common.



▲ **Surface capacitive type**
AC voltage is sent into the four corners of the transparent conductive layer. When a finger touches the screen, the contact creates a capacitor, and the electrical current is diverted from the four corners toward the finger. Greater distance equals more resistance and a weaker current, so changes in current strength are measured to determine the finger's position.



▲ **Projected-capacitive type (self-capacitive)**
This type of screen responds to simultaneous touch in multiple areas. The flow of the current is divided into two directions, the X-axis and the Y-axis. The screen detects which line is being touched to determine the finger's position. However, if you use two fingers at once, there are two X and Y coordinates, and the positions may not be detected accurately. For example, (x1, y4) and (x3, y3) may be detected as (x1, y3) and (x3, y4).



▲ **Projected-capacitive type (mutual-capacitive)**
This type does not detect touch incorrectly, and it is often used on smartphones. The horizontal axis and vertical axis conductive layers are separated by an insulator, creating capacitors all across the screen. The screen detects your finger's position by monitoring each capacitor moment to moment and registering changes in the electrical current.

Special thanks to Touch Panel Laboratories Co., Ltd

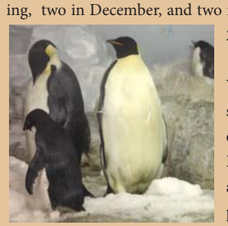
▲ Youbin at one day old. At 6 oz (167g), his weight was about 1/1000th of his mother's. (Photo: Adventure World)

▲ Youbin at five months old. Weight: 22 lbs (10kg). He is gnawing on bamboo for fun here, but he will not really eat it until he is a year old.

▲ Youbin, panda cub, playing with his mother, Liangbin

Adventure World

A large zoo complex is located on the temperate Kii Peninsula. The 0.3 square miles (800,000m²) facility is home to 1,400 animals from 140 different species. In addition to land animals, the park features dolphins, seals, sea otters, river otters, and other marine animals. Adventure World has teamed up with China's Chengdu Research Base of Giant Panda Breeding. The facility's current pandas include Youbin's father (Yongming) and mother (Liangbin), and their cubs. Adventure World had nine pandas up until December 2012, but several have been sent back to China for breeding, two in December, and two more in February 2013.



◄ Adventure World also successfully breeds emperor penguins. Emperor penguins are the biggest penguins on Earth. The Port of Nagoya Public Aquarium is the only other facility in Japan that has them.

[Address] 2399 Katata, Shirahama-cho, Nishimuro-gun, Wakayama, Japan
[Phone] 0570-06-4481
[Transportation] From JR Shirahama Station: Take the bus to the Adventure World stop. Travel time: About 10 min.
http://aws-s.com/english/index.php

Five cute and very popular giant pandas currently live at Adventure World in Wakayama, Japan. There are several indoor and outdoor exercise areas, but one in particular always draws a crowd: The one where Youbin, female panda cub, born in August 2012, and his mother Liangbin. Youbin never holds still, somersaulting and bouncing and playing with his mother. Zoo visitors cannot keep their eyes off them.

Norikatsu Yasuda, a zoo keeper, has been in charge of the pandas for five years. He carefully observes Youbin's growth, so he can build a correct sized ramp out of logs in the exercise area to help him strengthen his legs. Mr. Yasuda also sets up trees for Youbin to climb. Mr. Yasuda always keeps a close eye on his behavior.

The panda's diet is primarily bamboo. When pandas eat up all the bamboo, Mr. Yasuda restocks their cage with more. "Pandas have an acute sense of smell and hearing. They first sniff the bamboo, and then choose to eat the tastiest pieces", Mr. Yasuda said. All bamboo may look the same to humans, but it may taste different to pandas depending on when it was harvested and where it was grown.

Pandas like to lean back against something when they sit as if humans sit back and relax on a sofa. They can skillfully hold bamboo in their paws when they are eating it. Zoo visitors love to watch these cute behaviors.

▼Pandas use their molars to strip leaves from bamboo twigs.

Animal Secrets
Giant Panda

with a hidden "thumb" and five fingers

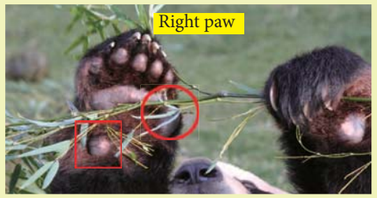
動物たちのないしょの話

The Giant panda

The West first learned of the giant panda in 1869. Giant pandas are living at high altitudes of the Tibetan Plateau in mid-western China. They are 2 feet 3 inches to 2 feet 7 inches (70 to 80cm) tall at the shoulder. They can weigh over 220 lbs (100kg). Their diet primarily consists of bamboo, but the zoo also feed them apples and special biscuits designed for animals. Giant pandas give birth to their cubs from July to September. At birth, the cub is extremely small at only 3½ to 7 oz (100 to 200g) in weight. According to Mr. Yasuda, "panda mothers are very affectionate with their babies and rarely put them down." During the mating season, adult pandas bleat like goats. In fierce fights, or when something unpleasant happens to them, they whine a little like dogs. The panda's numbers have dwindled due to expanding cities and the construction of roads through its natural habitat. Today it is estimated that only 1,600 pandas live in the wild. China is taking various steps to help wild pandas, such as limiting development in their habitats, expanding sanctuaries, and creating "green corridors" to link fragmented forest areas.

◄ A sitting panda leans back against a bench.

▲ A giant panda eats bamboo, grasping it in its paw. You can see its sharp fangs.



◄ The panda's paw has a "bump" (red circled) below the first finger to help hold objects like a human's thumb. The bump below the little finger (in the red square) may also be used for grasping.

Panda belong to the bear family, but they have some features that set them apart from other bears. As Mr. Yasuda explains, "Bears can hold food with their two front paws together, but they can not grasp their food in one paw, the way pandas can." The panda's paw has a unique bump called "panda's thumb" - actually a modified sesamoid bone - helps it to hold bamboo like the way human use their thumbs. Pandas hold a bamboo branch with the paw and pull the leaves off with the back teeth to eat bamboo. When the leaves are hanging out of its mouth, they grab a bunch of leaves and eat them like popsicles with their back teeth.

Youbin is Liangbin's fifth cub. Since there are only a small number of pandas left in the wild, one of the zoo's major missions is to increase their population. The panda's mating season only lasts for a few days each year. That's why Mr. Yasuda carefully observes them every day so as not to let any opportunities slip by. He said, "Looking at pandas in pictures just isn't the same as watching them in real life. Please come and see them in the zoo, and I guarantee you will not be disappointed. Also, please keep in your mind that there are not many wild pandas left in the world today."

from Science Window Spring 2013 issue • Photographs by Akira Sato

Bug watching in the Soil

Find some bugs, and you will have fun!

Lots of small creatures live in the soil. By using a few tricks, it is easy to observe small insects you could normally never see. Professor Yasunori Hagino, who is the assistant director at the Chiba Biodiversity Center in Japan, taught us several fun ways to observe these insects, such as turning over dead leaves to make them jump out of the soil or looking closely to spot bugs you would normally miss.

達人に聞く!! 自然観察法のイロハの

Soil and insects are neither dirty nor dangerous.

- When we look for bugs in soil, is it okay to touch the bugs?

Expert, Professor Hagino: It's fine… Unless the bugs are centipedes. Centipedes are poisonous, so you might want to wear gloves just in case.

- Are there certain places or seasons where it is especially easy to find lots of bugs?

Hagino: I recommend densely forested areas that don't get a lot of human visitors. The woods with lots of dead leaves on the ground are best (see bottom photo). The closer an area is to nature, the more bugs you'll find. As far as seasons are concerned, any time is fine unless it's been raining or very dry for many days on end.

▲ Expert: Professor Yasunori Hagino

Tips for soil observation

A: Make a frame and dig up the soil inside it.
B: Sprinkle a thin layer of soil on a white plastic sheet.
C: Use a microscope, and pay attention to insects' legs and wings.

◄ The soil deep in the woods is the home to a lot of insects. The round picture on the right shows a "Parafontaria ishiii Shinohara," a member of the millipede family that only exists in a handful of places in the Greater Tokyo Area.

- How should we collect soil?

Hagino: Find a place with soft, loose earth, then dig up a square that's about 20 inches (50 cm) per side and about 2 inches (5 cm) deep. It is a good idea to make a frame that size out of string and sticks, so you'll know exactly how much to dig up. Next, use a paring knife to cut around the edges of the square, then use a shovel to dig up the soil and put it in a bag. If you run into roots, use pruning scissors to cut them. If you're using a plastic bag to hold the soil, be sure to keep it open: If you close it, you'll suffocate the bugs (see next page).

Spread the soil thinly, look closely

- Once we take the bag of soil home, it's time to look for bugs, right?

Hagino: Spread out a white plastic sheet first, then scatter the soil - *just* the soil - on top of it. The thinner the soil, the easier it is to find bugs. At first the bugs won't move at all, so it's important to wait for a bit. They are very small, so look really closely and see what you can find. Hey, look at that. There is one here, and some more over there….

How to catch insects

▲ 1. Sift the dirt

▲ 2. Gently grasp a bug with tweezers

3. …Or use a bug vacuum ▶

- Whoa! I can see all kinds of bugs, walking bugs, flying bugs...

Hagino: You can use tweezers to pick them up, but for bugs that are hard to hold onto, there's a handy tool called a bug vacuum. Putting the bugs into some alcohol makes them easier to observe.

- We have got a lot of bugs here.

Hagino: Yes, there were a lot in that pile of soil. After you take a good look through the soil, search through the leaves and roots for more. There are still plenty to be found.

- Do you use a microscope?

Hagino: A lot of small creatures live in the soil, so I use a stereoscopic microscope to observe them in detail. We'll put these insects in a petri dish with alcohol, but we'll use a dropper to remove the excess alcohol.

▲ A view through the microscope

How to collect Soil

1

▲ Create a square frame that is 20 inches (50 cm) per side

2

▲ Use a paring knife to cut around the edges

3

▲ Use pruning scissors to cut away roots

4

▲ Put the soil in a bag

5

▲ Dig down about 2 inches (5 cm)

6

▲ Put all the soil into the bag

from Science Window Winter 2014 issue • By Fumi Hayano

Illustrations by Akio Makabe • Photographs by Hiroaki Kamei

- When we look at the bugs, what should we pay special attention to?

Hagino: Look closely at the legs and wings. Check to see if they have legs, and if they do, try to count how many pairs they have.

- It would be great to know what these bugs are called. How do we find out?

Hagino: Identify some of the bug's characteristics, then open the pictorial Entomology Guidebook and find a picture that looks like your bug. It's easy to identify a bug's characteristics and find out what group it belongs to if you use the search wheel diagram (see next page).

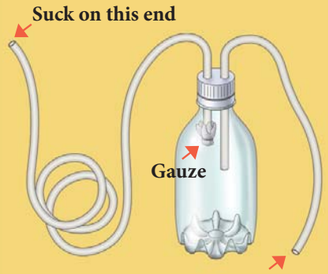
- Do the number and type of bugs differ depending on the area?

Hagino: You'd think there would be a lot of bugs in parks with plenty of trees, but there aren't because people rake up the leaves frequently. If you want to know how many bugs are in an area, it is best to collect soil samples from at least three places and calculate the average number of bugs. There are a lot of unknown creatures living in the soil, which means there's a lot out there to discover.

How to catch lots of bugs

◀ Tullgren Funnel

Roll a smooth piece of paper (such as a calendar page) into a cone shape, then cut the bottom of the cone so that the opening is about 0.6 inches (1.5 cm) in diameter.
Next set the cone in a hole cut into the top of a cardboard box, and fit a strainer into the top of the cone.
Place a jar with some alcohol in it underneath the cone, put soil in the strainer, and set the whole thing under a lamp with an incandescent bulb.
Let it sit for 12 to 24 hours. Bugs will start to burrow down to get away from the dry dirt, and they will fall through the cone.



▲Bug Vacuum

Find a plastic bottle, two tubes: one 20 inches (50 cm) long, one 8 inches (20 cm) long, and some gauze. Make two holes in the bottle cap and thread each tube into a hole. Cover the bottle end of the longer tube with gauze so that bugs will not get into your mouth. Point the shorter tube at bugs and suck through the long tube to collect them in the bottle.

Yasunori Hagino

Born in 1961, Professor Hagino is the assistant director at the Chiba Biodiversity Center and a senior researcher at the Natural History Museum and Institute, Chiba, Japan. His research focuses on Pauropoda. Published writings include "Pictorial keys to soil animals of Japan" (Tokai University Press 1991, contributing author).

Science Door

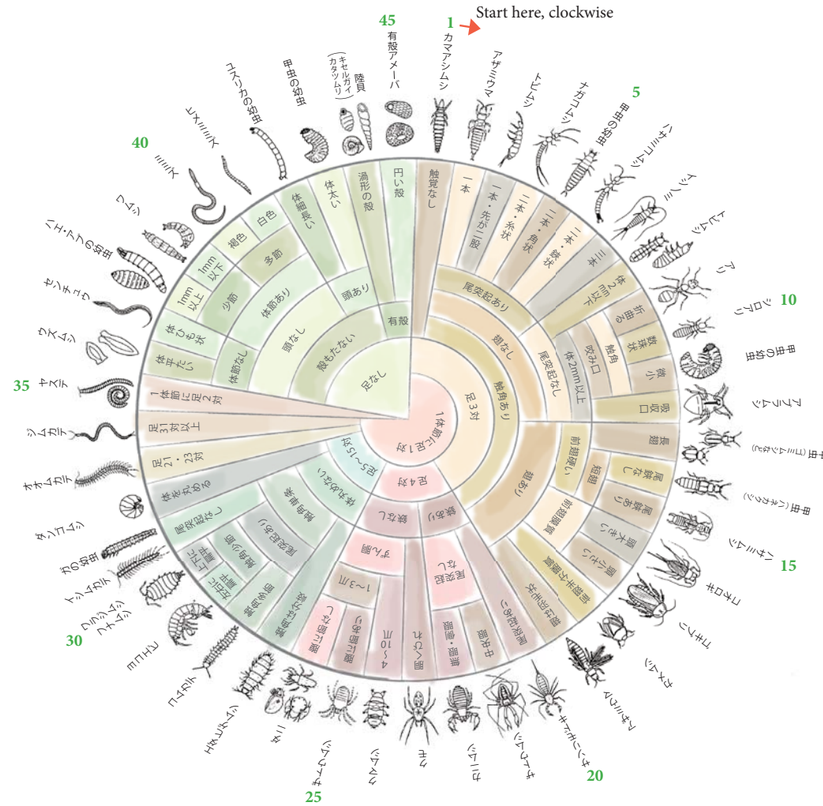
How to Classify Bugs into General Family Groups

Professor Junichi Aoki (honorary professor at Yokohama National University and director of the Kanagawa Prefectural Museum of Natural History) has created a soil insect classification table that is available on the next page.

Please check his Scientist Library on the website.
JT Biohistory Research Hall "What I Learned about nature with the oribatid mite classification"
https://www.brh.co.jp/en/seimeishi/journal/041/sl.html

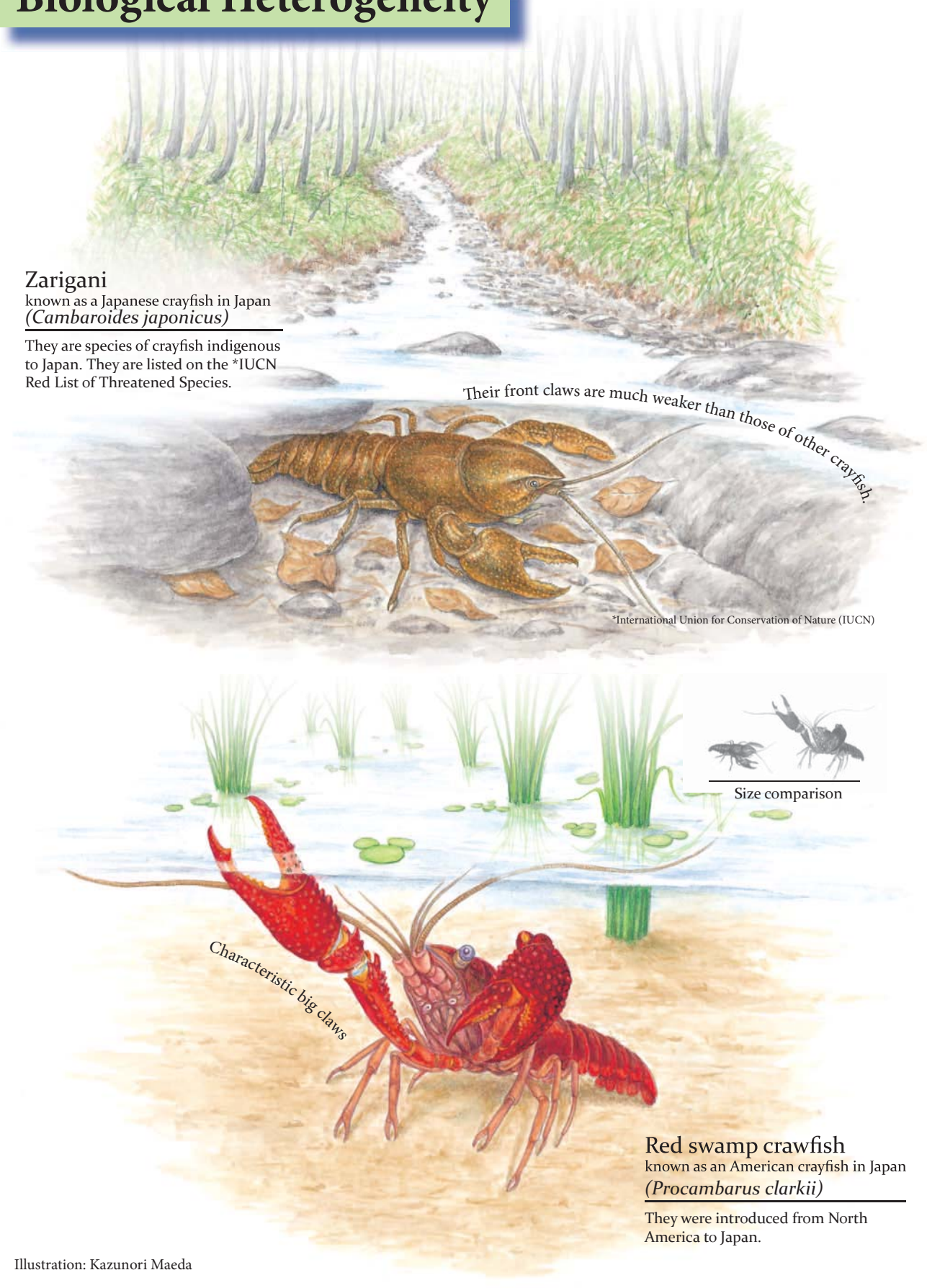
Soil Organisms Classification Guide Disk

Created by Jun-ichi Aoki
Professor Emeritus, Yokohama National University;
Director, Kanagawa Prefectural Museum of Natural History



1 telsontail	16 cricket	31 lithobiomorpha
2 thrips	17 cockroach	32 palmerworm
3 springtail	18 stink bug	33 wood louse
4 campodeidae	19 thrips	34 scolopendrid
5 beetle larvae	20 amblypygi	35 millipede
6 japygid	21 opiliones	36 tricladida
7 machilidae	22 book scorpion	37 nematode
8 springtail	23 spider	38 fly larva
9 ant	24 bear animalcule	39 rotifer
10 termite	25 opiliones	40 earthworm
11 beetle larvae	26 tick	41 enchytraeid worm
12 aphididae	27 pauropodidae	42 bloodworm
13 ground beetle	28 symphyla	43 beetle larvae
14 rove beetle	29 gammaridea	44 pulmonata
15 earwig	30 sow bug	45 testacean

Biological Heterogeneity



Zarigani
known as a Japanese crayfish in Japan
(Cambaroides japonicus)

They are species of crayfish indigenous to Japan. They are listed on the *IUCN Red List of Threatened Species.

*International Union for Conservation of Nature (IUCN)

Red swamp crawfish
known as an American crayfish in Japan
(Procambarus clarkii)

They were introduced from North America to Japan.

Illustration: Kazunori Maeda