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Science Window

Special Issue
for National Cherry Blossom Festival 2013

Is it true that we can run faster if we wear running shoes?

What is the proper fit for your running shoes?

Marathon races are becoming increasingly popular. They have even become a prominent event in the Olympics. The shoes that shine on the feet of the runners are an important item that influences how they run. If we wear these special shoes, can we run fast too?

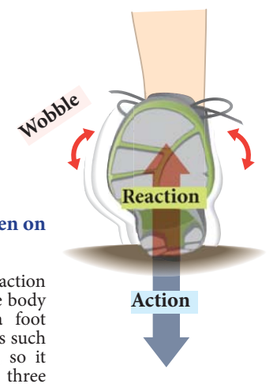
Sports Shoes Have Three Layers

"Most sports shoes have the same basic structure. They are made up of three layers, the sole and outsole at the bottom of the shoe, and the upper part that wraps around the foot. The sole, outsole, and upper are carefully constructed according to the movements and characteristics of bodies in sports," says Mr. Yutaka Tsubata of Achilles Corporation. Mr. Tsubata, a certified shoe fitter, has been involved in the development of shoes that are popular among elementary school students.

Running is an exercise in which you propel your body forward. When your feet hit the ground, approximately the same amount of force is received from the ground. Someone with a stride of one meter will hit the ground 10,000 times to travel 10 kilometers (6.2 miles), so the burden on the body is considerable.

Mr. Tsubata says, "In order to absorb impact from the ground, the sole uses material with good cushioning properties. One that is often used is a synthetic resin called ethylene-vinyl acetate, or EVA. It is flexible and resilient, and some shoemakers further increase cushion by adding air or gel to the sole."

Recently, new materials with outstanding shock absorption and pressure distribution have been used, so that when they surround an egg dropped from a height of one meter, the egg will not bounce or break. When I put insoles made of such a material into high-heel shoes and wore them, it felt like I was walking on hard clay. I did not tire easily and I felt comfortable. A variety of materials making use of cutting-edge science and technology are playing an active role in the sports world.



Running places a burden on the body

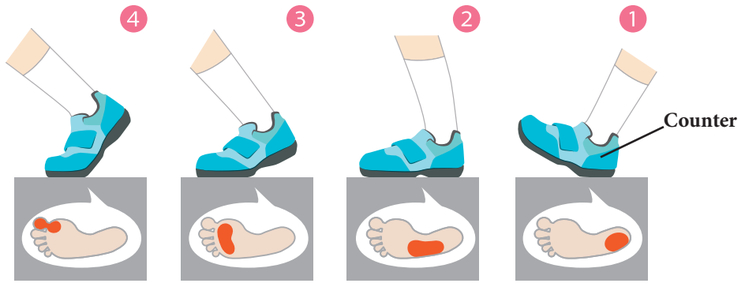
According to the law of action and reaction, the force the body receives when putting a foot down is a reaction. Factors such as momentum add to it, so it amounts to more than three times the runner's body weight. During a marathon, that burden is repeatedly applied over a long period of time.

The Function of Sports Shoes

When kicking off the ground while running, the upper is important. Firmly wrapping the foot with the upper decreases instability when hitting the ground while also making it easier to concentrate energy in the direction you drive your foot. The uppers of shoes for beginners are designed with many parts for wrapping the foot in order to provide even more stability.

The outsole, which transfers energy to the ground, uses the large amount of friction generated with the ground so feet don't slip when setting down, and it efficiently conveys the energy from the bottom of the foot to the ground. Achilles Corporation develops outsoles for many children's shoes depending on their intended application. (The next page, top photos)

Foot Movement While Running



The big toe area kicks off. **Contact transfers to behind the toes.** **Then the sole of the foot sets down.** **The outside of the heel hits the ground.**

Check the Fit with Your Heel and Toe

What kind of shoes should someone who wants to begin running choose?

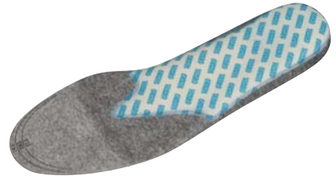
"High shoes with a thick sole and lots of cushion are good for beginners. A thicker sole is heavier, but at first, it is better to place importance on preventing pain to the foot. As you grow accustomed to running, seek lightness in your shoes for faster, longer running. A thin sole has less cushion, but if you acquire the basic actions of running and become able to keep running without placing an unnecessary burden on the body, light shoes for advanced runners will also be fine," answers Mr. Tsubata.

Some sports science specialists point out that thinner soles are better for changing the force from your feet hitting the ground into forward motion. The beginner should first fully break in shoes high in cushion properties and then try running shoes with varying sole thicknesses to find those that are best suited to the individual.

According to Mr. Tsubata, "When you buy your shoes, first put in your foot and then, while sitting, tap your heel against the floor to fit your heel in snugly. Then lace the shoes and firmly tie them. What you must check then are the hold on your heel and the size. In the heel portion, which receives a great amount of impact from striking the ground, there's a part called a counter, which is made of a hard material and designed to stop the foot from wobbling. This part is generally insufficient in cheap shoes, so be sure to check. As for size, it's good to have about one centimeter of space at the tip of your toes. You should be able to wiggle your toes freely and feel a firm hold on your heel. That is the ideal fit."

The width of shoes is also important. Shoe widths range from narrow sizes up through E, EE and EEE. Many children with narrow feet are wearing EEE. When the shoes are tied, if the left and right sides where the laces are threaded touch or are too far apart, it could lead to unsteadiness, resulting in energy loss when you kick against the ground.

▲ Above are the outsoles of sports shoes for elementary school students. They are designed according to purpose to generate friction with the ground effectively. The pair on the far left (A) is for soccer, the pair on the far right (F) is for jumping, and the others (B, C, D, E) are for running. The pairs in which the designs on the right and left outsoles are both oriented the same way rather than being like mirror images of each other are designed for maximizing friction while running counterclockwise around a track. The outsoles for soccer have been designed so the pivoting foot (left) will have increased grip when kicking the ball. (Photo credit: Achilles Corporation)



◀ **New materials absorb impact**
This is an insole using new materials with excellent shock absorption and pressure distribution. It converts impact energy from hitting the ground into molecular friction and absorbs it without rebounding.
(Photo credit: Sanshin Enterprises)

Children with No Arch

The number of children with undeveloped foot arches has been increasing. According to a report by Sekiso Harada, an honorary professor at the Hyogo University of Teacher Education who has surveyed the foot soles of over 200,000 people, 75% of children 5 years old had arches in 1980, but that had decreased to 46% by 2004.

According to professor Harada, "Using their toes increases development of the arches, but these days, more children's lifestyles don't involve using their toes, so arches don't form. One possible cause is that compared to the past, small children spend less time walking."

Also, children grow, so parents often buy them shoes that are too large. Their feet wobble around in the extra space, preventing them from applying proper strength and from using their toes. What is more, when walking time decreases and arches do not develop, the toes become bent, causing problems with walking and posture. Professor Harada stresses that wearing properly fitted shoes and walking, running and firmly planting your feet a lot are more important for foot development.

Science Door
Understand through photos and illustrations how to choose and wear shoes
http://mizunorunning.jp/contents/lesson/shoeserabi.html
Mizuno's site uses photographs and illustrations to explain the right way to choose and wear shoes.

To conclude, I will introduce four pointers for running fast that Mr. Tsubata taught me.

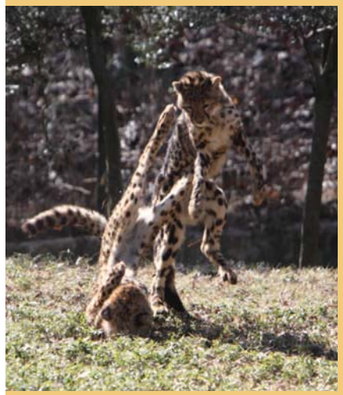
The first one is to wear shoes that fit so your feet do not wobble around inside them. The second one is to pronounce swinging of your arms. When you do that, the pace of your feet naturally speeds up. The third one is running along the innermost arc when turning corners so as to travel the shortest distance. The fourth one is to continually run the final stage of the marathon as if the finish is just a few meters ahead.

Find a pair of shoes that suits you and try it out!

Research and article: Chisato Hata
Illustrations: Tomoko Monobe
Research cooperation: Achilles Corporation, Sekiso Harada (Honorary Professor, Hyogo University of Teacher Education)

Science Window Summer Edition 2012

▲ Four cubs born together from the same mother. Nadeshiko (right) has a different pattern.



◀ Cheetahs have lithe bodies that can move like this.

▼ The king cheetah's spots are connected so they look like stripes.

Animal Secrets
Cheetah

Unexpectedly born with a rare pattern

In the morning, four cheetah cubs race out onto their exercise ground bursting with joy. They run around excitedly and play with each other. They look like domestic cats, but they have lither bodies than regular cats. When they leap atop a boulder, they seem to hang in the air and land softly.

Both the mother and her cubs have the characteristic speckled pattern of the cheetah, but—what is this? The one of four cubs has a pattern of long stripes on its back and a pattern of short lines on its belly. Is this a different species?

"No, they all have the same mother," says the zookeeper Mizuki Karasawa. "When they were born in June 2011, that one cub was darker than the others. I thought it was still wet, but it was black even after drying, which I thought was strange." However, Karasawa speculated about the explanation of the difference.

As suspected, that cub is a king cheetah, a cheetah with a distinct fur pattern. When first discovered in Africa in 1926, king cheetahs were once thought to constitute a separate subspecies. Globally, they are rare, and this is the first time one has been born in Japan. This cub is female and named Nadeshiko. The stripes are actually merged spots. The other cubs accept her as she is, so she scampers around happily with them.

Both her parents, her older brother and her sisters are all normal cheetahs, so why is Nadeshiko different?

"The king cheetah's unusual fur pattern is the result of a recessive gene. Both parents must have the king cheetah gene and those genes must then come together in the child. Due to the birth of Nadeshiko, we now know that both her parents have that gene. Other than her distinctive pattern, there are no differences among four cubs," Karasawa says.

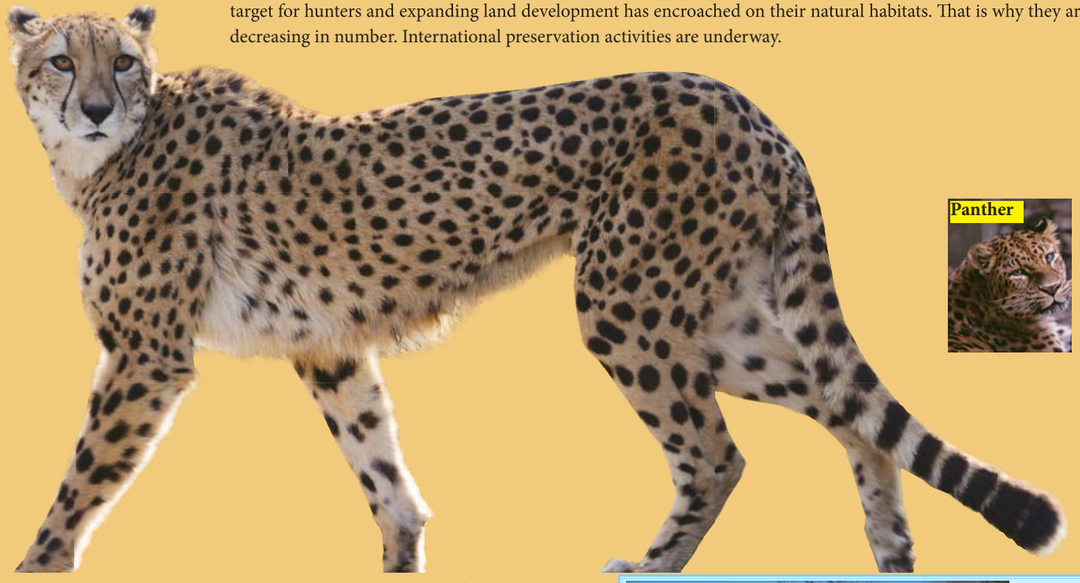
The probabilities of both parents giving recessive trait would be one fourth. As it happens, Nadeshiko is one of four. In the future, if her mate carries the king cheetah gene, there is a possibility that she will give birth to a king cheetah.

Cheetahs have small heads and flexible, spring-like bodies suited to running. You should go to see these beautiful animals at a zoo, regardless whether they are king cheetahs or not.

動物たちのないしょの話

The Cheetah

Cheetahs are carnivores that live in the savannahs and wildernesses from Africa to India. Reaching speeds of over 100 km/h (62 miles/h), they are the fastest mammal. However, they cannot run for long periods of time. They look like panthers, but the cheetah has a dark, thick stripe running from the inside corner of each eye down toward its chin. Also, cheetahs are not good at climbing trees the way panthers are. Their beautiful fur has made them a target for hunters and expanding land development has encroached on their natural habitats. That is why they are decreasing in number. International preservation activities are underway.



The cheetah is a large feline, but their claws do not retract fully. The claw tips are curved for achieving a better grip on the ground. When running, the cheetah's back legs dig into the ground more firmly, so these claws curl even more. ▼

▼ Two-month old cubs

Photos: Akira Sato

多摩動物公園

Tama Zoological Park

Opened in 1958, over 300 species are cared for on the park's spacious grounds, which cover 52.3 hectares (129.2 acres) and are divided up into four zones: Asia, Africa, Australia and Insectarium. Features include the Skywalk, where orangutans can be seen traveling from one tall tower to the next along a 150 meter (164 yard) rope; the Mole House, which recreates what a real mole tunnel is like; and the Lion Bus, which allows visitors to observe lions from a bus as in a safari park. In the koala hut, you can see the koala baby Papi, who just came out of her mother's tummy and into the world for the first time on January 1, 2012.

Address: 7-1-1 Hodokubo Hino city, Tokyo Prefecture
Phone: (Japan:81) 042-591-1611
Access: About 1 minute on foot from Tama Zoological Park Stateion on the Keio line or Tama Monorail
http://www.tokyo-zoo.net/xoo/tama/main.html

Water Absorption Experiment with vegetables close at hand

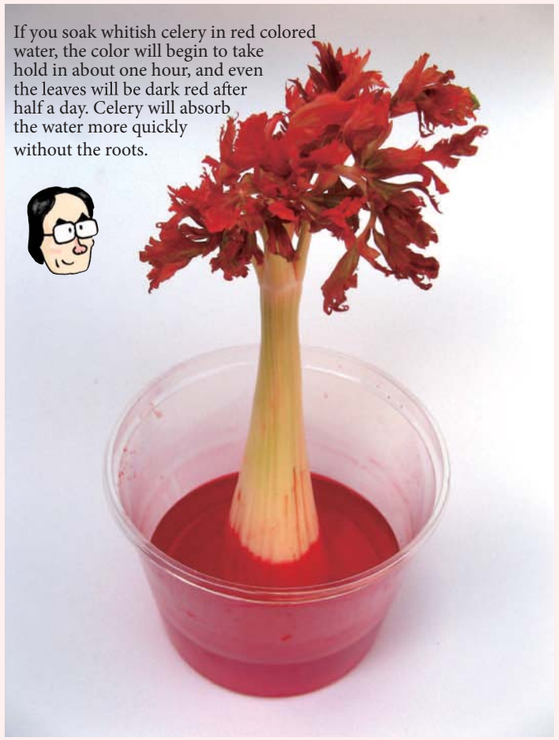
An experiment for observing the path water travels through plants was added to the Japanese government's new educational guidelines (for the sixth grade), but it is too soon to give up just because you cannot find the materials. Let us use materials close at hand to try it with Professor Ringoro.

Garden Balsam In No Problem But.....

Professor Ringoro ("R"below): Let's try an experiment using plants.

Ms. Nanako ("N"below): We are going to soak them in colored water to observe the path water travels in the roots, stem, and leaves. Garden balsam is often recommended for this type of experiment.

R: Garden balsam blossoms can be either red or white. This experiment is about how the plant absorbs water, so white blossoms will make our observations easier.



If you soak whitish celery in red colored water, the color will begin to take hold in about one hour, and even the leaves will be dark red after half a day. Celery will absorb the water more quickly without the roots.

N: Sure, but we can't get one in bloom at any time of the year. And aside from the color, it just doesn't feel right to use the flowers we've grown in the school flower bed for this experiment.

R: But garden balsam has a thick stem good for sucking up water, so it's perfect for this experiment. I do understand how you feel, though. (Laughs)

N: Aren't there any plants we could use in place of the garden balsam?

R: We could use something growing in a field or on empty land if the stem is thick and soft enough.

N: Will any type of plant work?

R: Well, not just any kind. Plants like Philadelphia fleabane with hollow stems are difficult to observe, but we could use annual fleabane or ragweed.

N: But those are hard to find when needed. Especially in the city.

R: Then shall we buy something at a flower shop? White chrysanthemums are coming into season.

N: I want to do the experiment, but flowers can be a little expensive.

R: I see… Then let's use vegetables. Even in the city, you can easily get those.

Professor Ringoro's Step-by-Step Instructions for Elementary School Teachers: Laboratory Procedure

What Vegetables Should You Use?

N: Now we're at the supermarket. We need vegetables with roots, a stem, and leaves. How about a daikon radish or a carrot?

R: Root vegetables have great roots, but they don't absorb colored water very well, so it would take too long to see the results of our experiment.

N: Oh, that's too bad. I'd rather not use a whole vegetable for an experiment, though.

R: Komatsuna (Japanese mustard spinach) or mitsuba (Japanese wild parsley) would be easy to use. For an experiment with leaves only, celery is recommended. Napa cabbage would also be good. They both quickly suck up water and are whitish in color, so the colored water will be clearly visible.

N: They do sell komatsuna and mitsuba with the roots, but is it okay even without the roots?

R: When the water comes in through the roots, it takes a full day for the color to reach the leaves. So make a sample beforehand with a plant like komatsuna that still has the roots and then have the children perform the experiment using plants without the roots. Even then, celery will take as much as an hour and komatsuna a few hours.

N: Also, you can see the overall path of the water on **Science Network*. *(*See the bottom of page 8)*

R: Of course, you must cover the whole path of the water, but even an experiment using only the leaves will be surprising and impressive.

N: Okay then, let's buy celery, komatsuna and radish. Other items we need include something like a plastic bottle that has been cut for use as a container. How about the colored water?

R: Something like art paint that is cloudy when they are dissolved in water. They will get stuck inside the water path, so it's best not to use anything like that. Fountain pen ink, craft dyes, or—in consideration of safety—food coloring would be the best. Food coloring is in the baking section in the supermarket.

◄ White chrysanthemum soaked in blue colored water for a whole day. Several blue streaks can be seen in the petals.

A purple radish soaked in green colored water for three days. It mostly only absorbs water through the thin part at the end. The colored water has passed through parts close to the outside and been carried to the stem and leaves. The round part of radishes and turnips isn't a root but a transformation of the hypocotyl, so it can't suck up water there. ►

Komatsuna root soaked in red colored water for half a day. The plant starts turning red at the root. ►

◄ Komatsuna leaves are radical leaves, so the shaft isn't a stem but part of the leaf. The xylem is stained red.

Part of a Komatsuna leaf soaked in red colored water for a whole day. It is easy to see how the xylem (in leaf veins) is stained red. This will take a few hours if you use only leaves for the experiment. ►

Observing the Water Path

R: Students study plant structure in detail in junior high school science, so it's good to attain a firm command of the fundamentals in elementary school.

N: Broadly speaking, the path of the water begins when moisture in the ground is taken in through the surface of the roots, passes through the stem, and is carried into the leaves.

R: The leaves use the energy from light to change the water and carbon dioxide from the air into the nutrient starch. This is photosynthesis, which students learn in the sixth grade. The Japanese government's new educational guidelines have added to the study of the water path.

N: The path of the water leads all the way to the leaves, and we can see that with the coloring.

R: Eventually, the water escapes into the air as water vapor through the many pores on the underside of the leaves. This is called transpiration. The moisture becomes a gas and enters the air, but the coloring remains in the leaves. That's why as time passes, the color gradually darkens.

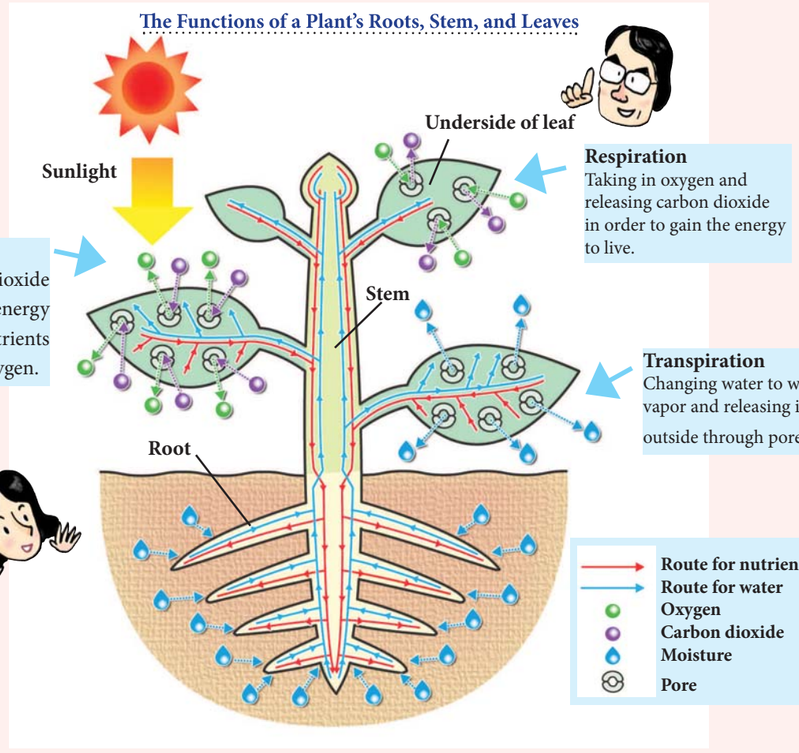
N: After all that work sucking up the water, why does the plant let it go?

R: That way it's easier to absorb new water through the roots.

N: Does that mean that fresh water tastes better to plants, too?

R: In a way, yes. One big goal of absorbing water through the roots is to take in small quantities of nutrients and fertilizer in the soil. Also, just as human beings sweat in order to adjust their body heat, the water helps prevent the leaves from growing too hot in strong sunlight.

N: Plants take in carbon dioxide for photosynthesis, they take in oxygen to breath, and they adjust their moisture… The way plants work is truly amazing!



Science Door
Understand the world of living things in 3-D on the Web
http://www.rikanet.jst.go.jp/contents/cp0110/start.html
This is part of the contents of ***Science Network,*** a digital collection of educational materials for JST science education. In "The Structure and Function of Plants," viewers can see realistic 3-D animation showing how water and nutrients are carried through the roots, stem and leaves.

Perfect! 200 Experiment Basics
http://www.rikanet.jst.go.jp/contents/cp0100a/start.html
This is also part of Science Network. The second area for junior high school, "How to Prepare a Plant Specimen," has videos introducing how to remove epidermis and use stains, and is useful when making observations with a microscope.

Guidance: Tokushige Matsumoto, Science Window committee member
Diagrams: Sachiyo Takiyama

Science Window 2009 Autumn Edition

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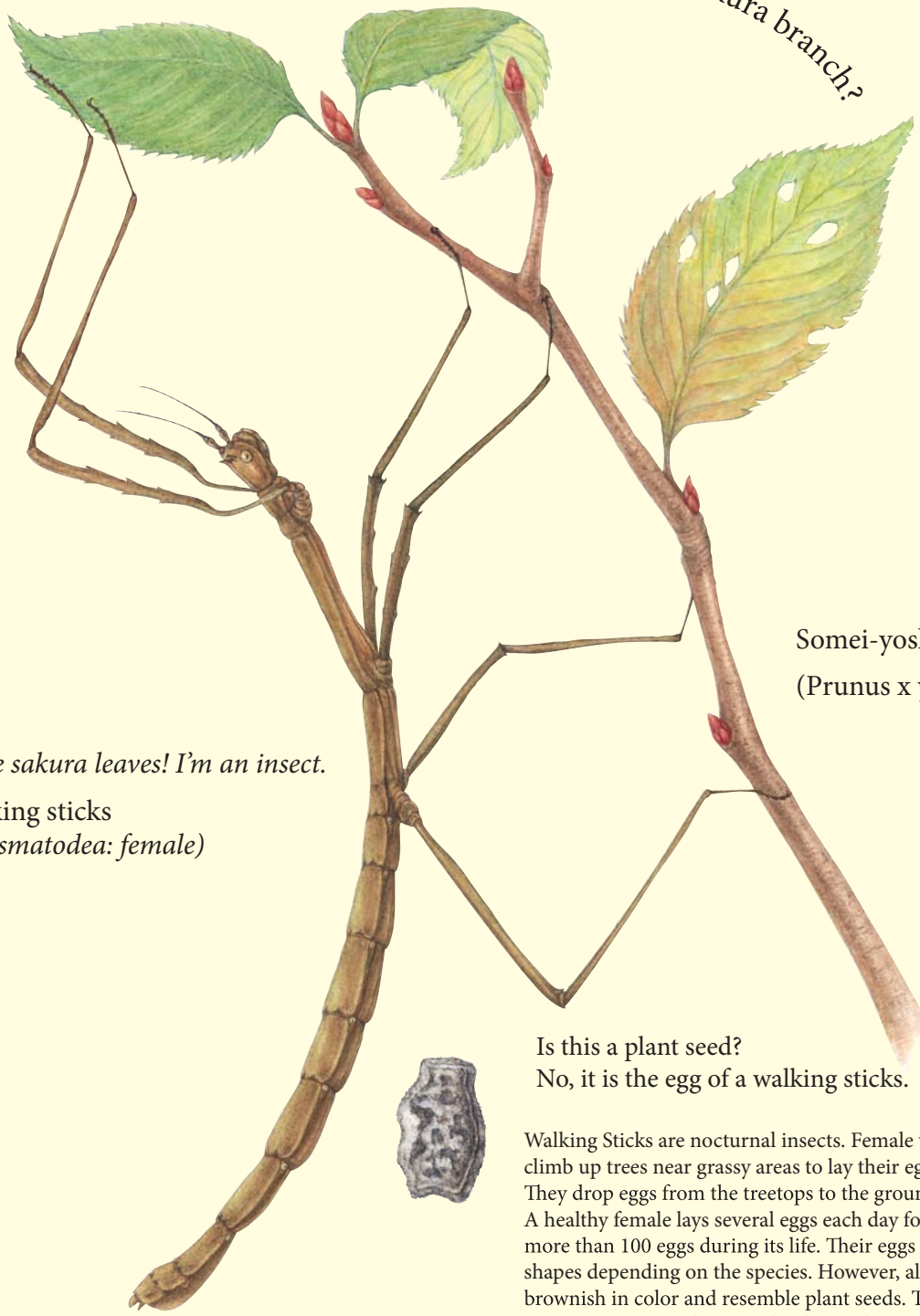
Biological mimicry



Walking Sticks are nocturnal insects. Female walking sticks climb up trees near grassy areas to lay their eggs at night. They drop eggs from the treetops to the ground one by one. A healthy female lays several eggs each day for a total of more than 100 eggs during its life. Their eggs have various shapes depending on the species. However, all eggs are brownish in color and resemble plant seeds. The adult insect is approximately 3.9 inches long. Their eggs are about 0.13 inches long, two-thirds of a grain of rice.

Illustration: Kazunori Maeda