

NATURAL SCIENCE STORIES

STORIES FROM PHYSICS

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STORIES FROM BOTANY

by Leo Tolstoy

Translated from the Original Russian and edited by Leo Wiener
Assistant Professor of Slavic Languages at Harvard University

1869- 1872

STORIES FROM PHYSICS

THE MAGNET

I.

In olden days there was a shepherd whose name was Magnes. Magnes lost a sheep. He went to the mountains to find it. He came to a place where there were barren rocks. He walked over these rocks, and felt that his boots were sticking to them. He touched them with his hand, but they were dry and did not stick to his hand. He started to walk again, and again his boots stuck to the rocks. He sat down, took off one of his boots, took it into his hand, and touched the rocks with it.

Whenever he touched them with his skin, or with the sole of his boot, they did not stick; but when he touched them with the nails, they did stick.

Magnes had a cane with an iron point.

He touched a rock with the wood; it did not stick; he touched it with the iron end, and it stuck so that he could not pull it off.

Magnes looked at the stone, and he saw that it looked like iron, and he took pieces of that stone home with him. Since then that rock has been known, and has been called Magnet.

II.

Magnet is found in the earth with iron ore. Where there is magnet in the ore, the iron is of the best quality. The magnet resembles iron.

If you put a piece of iron on a magnet, the iron itself begins to attract other iron. And if you put a steel needle on a magnet, and hold it thus for awhile, the needle will become a magnet, and will attract iron. If two magnets are brought together at their ends, one side will turn away from the other, while the other sides will be attracted.

If a magnetic rod is broken in two, each half will attract at one end, and will turn away at the other end. Cut it again, and the same will happen ; cut it again, as often as you please, and still the same will happen: equal ends will turn away from each other, while opposite ends will be attracted, as though the magnet were pushing away at one end, and pulling in at the other. No matter how you may break it, it will be as though there were a bump at one end, and a saucer at the other. Whichever way you put them together, – a bump and a saucer will meet, but a bump and a bump, or a saucer and a saucer will not.

III.

If you magnetize a needle (holding it for awhile over a magnet), and attach it in the middle to a pivot in such a way that it can move freely around, and let it loose, it will turn with one end toward midday (south), and with the other toward midnight (north).

When the magnet was not known, people did not sail far out to sea. When they went out far into the sea, so that land was not to be seen, they could tell only by the stars and the sun where they had to sail. But when it was dark, and the sun or stars could not be seen, they did not know which way to sail. And a ship was borne by the winds and carried on rocks and wrecked.

So long as the magnet was not known, they did not sail far from the shore; but when the magnet was discovered, they made a magnetic needle on a pivot, so that it should move around freely. By this needle they could tell in which direction to sail. With the magnetic needle they began to sail farther away from the shores, and since then they have discovered many new seas.

On ships there is always a magnetic needle (compass), and there is a measuring-rope with knots at the stem of a ship. This rope is fixed in such a way that when it unrolls, they can tell how far the ship has travelled. And thus, in sailing in a boat, they always know in what spot it is, whether far from the shore, and in what direction it is sailing.

MOISTURE i.

Why does a spider sometimes make a close cobweb, and sit in the very middle of its nest, and at other times leave its nest and start a new spider-web ?

The spider makes its cobweb according to the weather, both the present and the future weather. Looking at a spider, you can tell

what kind of weather it is going to be: if it sits tightly in the middle of the cobweb and does not come out, it means that it is going to rain. If it leaves the nest and makes new cobwebs, it is going to clear off.

How can the spider know in advance what weather it is going to be ?

The spider's senses are so fine that as soon as the moisture begins to gather in the air, – though we do not yet feel it, and for us the weather is clear, – for the spider it is already raining.

Just as a naked man will feel the moisture, when a man in his clothes does not, so it is already raining for a spider, while for us it is only getting ready to rain.

n.

Why do the doors swell in the winter and close badly, while in the summer they shrink and close well ?

Because in the fall and winter the wood is saturated with water, like a sponge, and spreads out, while in the summer the water comes out as a vapour, and the wood shrinks.

Why does soft wood, like aspen, swell more, and oak less ?

Because in the hard wood, in the oak, the empty places are smaller, and the water cannot gather there, while in the soft wood in the aspen, there are larger empty places, and the water can gather there. In rotten wood these empty places are still larger, and so rotten wood swells most and shrinks most.

Beehives are made out of the softest and rottenest wood; the very best are made from rotten willow wood. Why ? Because the air passes through the rotten wood, and in such a hive the bees feel better.

Why do boards warp ?

Because they dry unevenly. If you place a damp board with one side toward the stove, the water will leave it, and the board will contract on that side and will pull the other side along ; but the damp side cannot contract, because it is full of water, and so the whole board will be bent.

To keep the floors from warping, the dry boards are cut into small pieces, and these pieces are boiled in water. When all the water is boiled out of them, they are glued together, and then they never warp (parquetry).

THE DIFFERENT CONNECTION OF PARTICLES

CRYSTALS

Why are cart bolsters cut and wheel naves turned not from oak, but from birch ? Bolsters and naves have to be strong, and oak is not more expensive than birch.

Because oak splits lengthwise, and birch does not split, but ravel out.

Because, though oak is more firmly connected than birch, it is connected in such a way that it splits lengthwise, while birch does not.

Why are wheels and runners bent from oak and elm, and not from birch and linden ?

Because, when oak and elm are steamed in a bath, they bend and do not break, while birch and linden ravel in every direction.

This is again for the same reason, that is, that the particles of the wood in the oak and in the birch are differently connected.

If you pour salt into water and stir it, the salt will begin to melt and will entirely disappear; but if you pour more and still more salt into it, the salt will in the end not dissolve, and no matter how much you may stir after that, the salt will remain as a white powder. The water is saturated with the salt and cannot receive any more. But heat the water and it will receive more; and the salt which did not dissolve in the cold water, will melt in hot water. But pour in more salt, even the hot water will not receive it. And if you heat the water still more, the water will pass away in steam, and more of the salt will be left.

Thus, for everything which dissolves in the water there is a measure after which the water will not dissolve any more. Of anything, more will be dissolved in hot than in cold water, and in each case, when it is saturated, it will not receive any more. The thing will be left, but the water will go away in steam.

If the water is saturated with saltpetre powder, and then more saltpetre is added, and all is heated and is allowed to cool off without being stirred, the superfluous saltpetre will not settle as a powder at the bottom of the water, but will all gather in little six-edged columns, and will settle at the bottom and at the sides, one column near another. If the water is saturated with saltpetre powder and is put in a warm place, the water will go away in vapours, and the superfluous saltpetre will again gather in six-edged columns.

If water is saturated with simple salt and heated, and is allowed to pass away in vapour, the superfluous salt will not settle as powder, but as little cubes. If the water is saturated both with salt and saltpetre, the superfluous salt and saltpetre will not mix, but will settle each in its own way: the saltpetre in columns, and the salt in cubes.

If water is saturated with lime, or with some other salt, and anything else, each thing will settle in its own way, when the water passes away in vapour: one in three-edged columns, another in eight-edged columns, a third in bricks, a fourth in little stars, – each in its own way. These figures are different in each solid thing. At times these forms are as large as a hand, – such stones are found in the ground. At times these forms are so small that they cannot be made out with the naked eye; but in each thing there is its own form.

If, when the water is saturated with saltpetre, and little figures are forming in it, a corner be broken off one of these little figures with a needle, new pieces of saltpetre will come up and will fix the broken end as it ought to be, – into a six-edged column. The same will happen to salt and to any other thing. All the tiny particles turn around and attach themselves with the right side to each other.

When ice freezes, the same takes place.

A snowflake flies, and no figure is seen in it; but the moment it settles on anything dark and cold, on cloth, on fur, – you can make out its figure; you will see a little star, or a six-cornered little board. On the windows the steam does not freeze in any form whatever, but always as a star.

What is ice? It is cold, solid water. When liquid water becomes solid, it forms itself into figures and the heat leaves it. The same takes place with saltpetre: when it changes from a liquid into solid figures, the heat leaves it. The same is true of salt, of melted cast-iron, when it changes from a liquid into a solid. Whenever a thing changes from a liquid into a solid, heat leaves it, and it forms figures. And when it changes from a solid to a liquid it takes up heat, and the cold leaves it, and its figures are dissolved.

Bring in melted iron and let it cool off; bring in hot dough and let it cool off; bring in slacked lime and let it cool off, – and it will be warm. Bring in ice and let it melt, – and it will grow cold. Bring in saltpetre, salt, or any other thing that dissolves in the water, and melt it in the water, and it will grow cold. In order to freeze ice-cream, they put salt in the water.

INJURIOUS AIR

In the village of Nikolskoe, the people went on a holiday to mass. In the manor yard were left the cow-tender, the elder, and the groom. The cow-tender went to the well for water. The well was in the yard itself. She pulled out the bucket, but could not hold it. The bucket pulled away from her, struck the side of the well, and tore the rope. The cow-tender returned to the hut and said to the elder:

" Aleksandr! Climb down into the well, – I have dropped the bucket

into it."

Aleksandr said:

" You have dropped it, so climb down yourself."

The cow-tender said that she did not mind fetching it herself, if he would let her down.

The elder laughed at her, and said:

"Well, let us go! You have an empty stomach now, so I shall be able to hold you up, for after dinner I could not do it."

The elder tied a stick to a rope, and the woman sat astride it, took hold of the rope, and began to climb down into the well, while the elder turned the well-wheel. The well was about twenty feet deep, and there was less than three feet of water in it. The elder let her down slowly, and kept asking:

" A little more ?"

And the cow-tender cried from below:

" Just a little more !"

Suddenly the elder felt the rope give way: he called the cow-tender, but she did not answer. The elder looked into the well, and saw the cow-tender lying with her head in the water, and with her feet in the air. The elder called for help, but there was nobody near by; only the groom came. The elder told him to hold the wheel, and he himself pulled out the rope, sat down on the stick, and went down into the well.

The moment the groom let the elder down to the water, the same thing happened to the elder. He let go of the rope and fell head foremost upon the woman. The groom began to cry, and ran to church to call the people. Mass was over, and people were walking home. All the men and women rushed to the well. They gathered around it, and everybody holloaed, but nobody knew what to do. The young carpenter Ivan made his way through the crowd, took hold of the rope, sat down on the stick, and told them to let him down. Ivdn tied himself to the rope •with his belt. Two men let him down, and the rest looked into the well, to see what would become of Ivryn. Just as he was getting near the water, he dropped his hands from the rope, and would have fallen down head foremost, if the belt had not held him. All shouted, " Pull him out!" and Ivan was pulled out.

He hung like dead down from the belt, and his head was drooping and beating against the sides of the well. His face was livid. They took him off the rope and put him down on the ground. They thought that he was dead; but he suddenly drew a deep breath, began to rattle, and soon revived.

Others wanted to climb down, but an old peasant said that they could not go down because there was bad air in the well, and that that bad air killed people. Then the peasants ran for hooks and began to pull out the elder and the woman. The elder's mother and wife cried at the well, and others tried to quiet them; in the meantime the peasants put down the hooks and tried to get out the dead people. Twice they got the elder half-way up by his clothes; but he was heavy, and his clothes tore and he fell down. Finally they stuck two hooks into him and pulled him out. Then they pulled out the cow-tender. Both were dead and did not revive.

Then, when they examined the well, they found that indeed there was bad air down in the well.

This air is so heavy that neither man nor any animal can live in it. They let down a cat into the well, and the moment she reached the place where the bad air was, she died. Not only can no animal live there, even no candle will burn in it. They let down a candle, and the moment it reached that spot, it went out.

There are places underground where that air gathers, and when a person gets into one of those places, he dies at once. For this purpose they have lamps in the mines, and before a man goes down to such a place, they let down the lamp. If it goes out, no man can go there; then they let down fresh air until the lamp will burn.

Near the city of Naples there is one such cave. There is always about three feet of bad air in it on the ground, but above it the air is good. A man can walk through the cave, and nothing will happen to him, but a dog will die the moment it enters.

Where does this bad air come from? It is made of the same good air that we breathe. If you gather a lot of people in one place, and close all the doors and windows, so that no fresh air can get in, you will get the same kind of an air as in the well, and people will die.

One hundred years ago, during a war, the Hindoos captured 146 Englishmen and shut them up in a cave underground, where the air could not get in.

After the captured Englishmen had been there a few hours they began to die, and toward the end of the night 123 had died, and the rest came out more dead than alive, and ailing. At first the air had been good in the cave; but when the captives had inhaled all the good air, and no fresh air came in, it became bad, just like what was in the well, and they died.

Why does the good air become bad when many people come together?

Because, when people breathe, they take in good air and breathe out bad air.

HOW BALLOONS ARE MADE

If you take a blown-up bladder under water and let go of it, it will fly up to the surface of the water and will swim on it. Just so, when water is boiled in a pot, it becomes light at the bottom, over the fire, – it is turned into a gas; and when a little of that water-gas is collected it goes up as a bubble. First comes up one bubble, then another, and when the whole water is heated, the bubbles come up without stopping. Then the water boils.

Just as the bubbles leap to the surface, full of vapoury water, because they are lighter than water, just so will a bladder which is filled with hydrogen, or with hot air, rise, because hot air is lighter than cold air, and hydrogen is lighter than any other gases.

Balloons are made with hydrogen or with hot air. With hydrogen they are made as follows: They make a large bladder, attach it by ropes to posts, and fill it with hydrogen. The moment the ropes are untied, the balloon flies up in the air, and keeps flying up until it gets beyond the air which is heavier than hydrogen. When it gets up into the light air, it begins to swim in it like a bladder on the surface of the water.

With hot air balloons are made like this: They make a large empty ball, with a neck below, like an upturned pitcher, and to the mouth of it they attach a bunch of cotton, and that cotton is soaked with spirits, and lighted. The fire heats the air in the balloon, and makes it lighter than the cold air, and the balloon is drawn upward, like the bladder in the water. And the balloon will fly up until it comes to the air which is lighter than the hot air in the balloon.

Nearly one hundred years ago two Frenchmen, the brothers Montgolfier, invented the air balloons. They made a balloon of canvas and paper and filled it with hot air, – the balloon flew. Then they made another, a larger balloon, and tied under the balloon a sheep, a cock, and a duck, and let it off. The balloon rose and came down safely. Then they attached a little basket under the balloon, and a man seated himself in it. The balloon flew so high that it disappeared from view; it flew away, and came down safely. Then they thought of filling a balloon with hydrogen, and began to fly higher and faster.

In order to fly with a balloon, they attach a basket under the balloon, and in this basket two, three, and even eight persons are seated, and they take with them food and drink.

In order to rise and come down as one pleases, there is a valve in the balloon, and the man who is flying with it can pull a rope and open or close the valve. If the balloon rises too high, and the man who is flying wants to come down, he opens the valve, – the gas escapes, the balloon is compressed, and begins to come down. Then there are always bags with sand in the balloon. When a bag with sand is thrown out, the balloon gets lighter, and it flies up. If the one who is flying wants to get down, but sees that it is not what he wants below him, – either a river or a forest, – he throws out the

sand from the bags, and the balloon grows lighter and rises again.

GALVANISM

There was once a learned Italian, Galvani. He had an electric machine, and he showed his students what electricity was. He rubbed the glass hard with silk with something smeared over it, and then he approached to the glass a brass knob which was attached to the glass, and a spark flew across from the glass to the brass knob. He explained to them that the same kind of a spark came from sealing-wax and amber. He showed them that feathers and bits of paper were now attracted, and now repelled, by electricity, and explained to them the reason of it. He did all kinds of experiments with electricity, and showed them all to his students.

Once his wife grew ill. He called a doctor and asked him how to cure her. The doctor told him to prepare a frog soup for her. Galvani gave order to have edible frogs caught. They caught them for him, killed them, and left them on his table.

Before the cook came after the frogs, Galvani kept on showing the electric machine to his students, and sending sparks through it.

Suddenly he saw the dead frogs jerk their legs on the table. He watched them, and saw that every time when he sent a spark through the machine, the frogs jerked their legs. Galvani collected more frogs, and began to experiment with them. And every time he sent a spark through the machine, the dead frogs moved their legs as though they were alive.

It occurred to Galvani that live frogs moved their legs because electricity passed through them. Galvani knew that there was electricity in the air; that it was more noticeable in the amber and glass, but that it was also in the air, and that thunder and lightning came from the electricity in the air.

So he tried to discover whether the dead frogs would not move their legs from the electricity in the air. For this purpose he took the frogs, skinned them, chopped off their heads, and hung them on brass hooks on the roof, beneath an iron gutter. He thought that as soon as there should be a storm, and the air should be filled with electricity, it would pass by the brass rod to the frogs, and they would begin to move.

But the storm passed several times, and the frogs did not move. Galvani was just taking them down, and as he did so a frog's leg touched the iron gutter, and it jerked. Galvani took down the frogs and made the following experiment: he tied to the brass hook an iron wire, and touched the leg with the wire, and it jerked.

So Galvani decided that the animals lived because there was electricity in them, and that the electricity jumped from the brain to the flesh, and that made the animals move. Nobody had at that time tried this matter and they did not know any better, and so they

all believed Galvani. But at that time another learned man, Volta, experimented in his own way, and proved to everybody that Galvani was mistaken. He tried touching the frog differently from what Galvani had done, not with a copper hook with an iron wire, but either with a copper hook and a copper wire, or an iron hook and an iron wire, – and the frogs did not move. The frogs moved only when Volta touched them with an iron wire that was connected with a copper wire.

Volta thought that the electricity was not in the dead frog but in the iron and copper. He experimented and found it to be so: whenever he brought together the iron and the copper, there was electricity; and this electricity made the dead frogs jerk their legs. Volta tried to produce electricity differently from what it had been produced before. Before that they used to get electricity by rubbing glass or sealing-wax. But Volta got electricity by uniting iron and copper. He tried to connect iron and copper and other metals, and by the mere combination of metals, silver, platinum, zinc, lead, iron, he produced electric sparks.

After Volta they tried to increase electricity by pouring all kinds of liquids – water and acids – between the metals. These liquids made the electricity more powerful, so that it was no longer necessary, as before, to rub in order to produce it; it is enough to put pieces of several metals in a bowl and fill it with a liquid, and there will be electricity in that bowl, and the sparks will come from the wires.

When this kind of electricity was discovered, people began to apply it: they invented a way of gold and silver plating by means of electricity, and electric light, and a way to transmit signs from place to place over a long distance by means of electricity.

For this purpose pieces of different metals are placed in jars, and liquids are poured into them. Electricity is collected in these jars, and is transferred by means of wires to the place where it is wanted, and from that place the wire is put into the ground. The electricity runs through the ground back to the jars, and rises from the earth by means of the other wire; thus the electricity keeps going around and around, as in a ring, – from the wire into the ground, and along the ground, and up the wire, and again through the earth. Electricity can travel in either direction, just as one wants to send it: it can first go along the wire and return through the earth, or first go through the earth, and then return through the wire. Above the wire, in the place where the signs are given, there is attached a magnetic hand, and that hand turns in one direction, when the electricity is allowed to pass through the wire and back through the earth, and in another direction, when the electricity is sent through the earth and back through the wire. Along this hand there are certain signs, and by means of these signs they write from one place to another on the telegraph.

THE SUN'S HEAT

Go out in the winter on a calm, frosty day into the field, or into the woods, and look about you and listen: all around you is snow, the rivers are frozen, dry grass blades stick out of the grass, the trees are bare, – nothing is moving.

Look in the summer: the rivers are running and rippling, in every puddle the frogs croak and plunge in; the birds fly from place to place, and whistle, and sing; the flies and the gnats whirl around and buzz; the trees and the grass grow and wave to and fro.

Freeze a pot with water, and it will become as hard as a rock. Put the frozen pot on the fire: the ice will begin to break, and melt, and move; the water will begin to stir, and bubbles will rise; then, when it begins to boil, it whirls about and makes a noise. The same happens in the world from the heat. Without heat everything is dead; with the heat everything moves and lives. If there is little heat, there is little motion; with more heat, there is more motion; with much heat, there is much motion; with very much heat, there is also very much motion.

Where does the heat in the world come from? The heat comes from the sun.

In winter the sun travels low, to one side, and its beams do not fall straight upon the earth, and nothing moves. The sun begins to travel higher above our heads, and begins to shine straight down upon the earth, and everything is warmed up in the world, and begins to stir.

The snow settles down; the ice begins to melt on the rivers; the water comes down from the mountains; the vapours rise from the water to the clouds, and rain begins to fall. Who does it all ? – The sun. The seeds swell, and let out rootlets; the rootlets take hold of the ground; old roots send up new shoots, and the trees and the grass begin to grow. Who has done that ? – The sun.

The bears and moles get up; the flies and bees awaken ; the gnats are hatched, and the fish come out from their eggs, when it is warm. Who has done it all ? – The sun.

The air gets warmed up in one place, and rises, and in its place comes colder air, – and there is a wind. Who has done that ? – The sun.

The clouds rise and begin to gather and to scatter, – and the lightning flashes. Who has made that fire ? – The sun.

The grass, the grain, the fruits, the trees grow up; animals find their food, men eat their fill, and gather food and fuel for the winter; they build themselves houses, railways, cities. Who has prepared it all ? – The sun.

A man has built himself a house. What has he made it of ? Of timbers. The timbers were cut out of trees, but the trees are made

to grow by the sun.

The stove is heated with wood. Who has made the wood to grow ? – The sun.

Man eats bread, or potatoes. Who has made them grow? – The sun. Man eats meat. Who has made the animals, the birds to grow? – The grass. But the grass is made to grow by the sun.

A man builds himself a house from brick and lime. The bricks and the lime are burnt by wood. The wood has been prepared by the sun.

Everything that men need, that is for their use, – all that is prepared by the sun, and on all that goes much sun's heat. The reason that men need bread is because the sun has produced it, and because there is much sun's heat in it. Bread warms him who eats it.

The reason that wood and logs are needed is because there is much heat in them. He who buys wood for the winter, buys sun's heat; and in the winter he burns the wood whenever he wants it, and lets the sun's heat into his room.

When there is heat, there is motion. No matter what motion it may be, – it all comes from heat, either directly from the sun's heat, or from the heat which the sun has prepared in the coal, the wood, the bread, and the grass.

Horses and oxen pull, men work, – who moves them ?

– Heat. Where does the heat come from ? – From the food. And the food has been prepared by the sun.

Watermills and windmills turn around and grind. Who moves them ? – Wind and water. And who drives the wind ? – Heat. And who drives the water ? – Again heat. Heat raises the water in the shape of vapour, and without this the water would not be falling down. A machine works, – it is moved by steam. And who makes steam ?

– Wood. And in the wood is the sun's heat.

Heat makes motion, and motion makes heat. And both heat and motion are from the sun.

STORIES FROM ZOOLOGY

THE OWL AND THE HARE

It was dusk. The owls began to fly through the forest to find some prey.

A large hare leaped out on a clearing and began to smooth out his fur. An old owl looked at the hare, and seated himself on a branch ; but a young owl said to him :

" Why do you not catch the hare ?"

The old owl said:

" He is too much for me : if I get caught in him, he will drag me into the woods."

But the young owl said :

" I will stick one claw into his body, and with the other I will clutch a tree."

The young owl made for the hare, and stuck one claw into his back so that all his talons entered the flesh, and the other claw it got ready to push into the tree. The hare yanked the owl, while the owl held on to the tree, and thought, " He will not get away." The hare darted forward and tore the owl. One claw was left in the tree, and the other in the hare's back.

The next year a hunter killed that hare, and wondered how the owl's talons had grown into the hare's back.

HOW THE WOLVES TEACH THEIR WHELPS

I was walking along the road, and heard a shout behind me. It was the shepherd boy who was shouting. He was running through the field, and pointing to something.

I looked, and saw two wolves running through the field: one was full-grown, and the other a whelp. The whelp was carrying a dead lamb on his shoulders, and holding on to one of its legs with its teeth. The old wolf was running behind. When I saw the wolves, I ran after them with the shepherd, and we began to shout. In response to our cries came peasants with dogs.

The moment the old wolf saw the dogs and the people, he ran up to the whelp, took the lamb away from him, threw it over his back, and both wolves ran as fast as they could, and disappeared from view.

Then the boy told what had happened: the large wolf had leaped out from the ravine, had seized the lamb, killed it, and carried it off.

The whelp ran up to him and grasped the lamb. The old wolf let the whelp carry the lamb, while he himself ran slowly beside him.

Only when there was danger, did the old wolf stop his teaching and himself take the lamb.

HARES AND WOLVES

The hares feed at night on tree bark; the field hares eat the winter rye and the grass, and the threshing-floor hares eat the grain in the granary. Through the night the hares make a deep, visible track through the snow. The hares are hunted by men, and dogs, and wolves, and foxes, and ravens, and eagles. If a hare walked straight ahead, he would be easily caught in the morning by his tracks; but God has made a hare timid, and his timidity saves him.

A hare goes at night fearlessly through the forests and fields, making straight tracks; but as soon as morning comes and his enemies wake up, and he hears the bark of dogs, or the squeak of sleighs, or the voice of peasants, or the crashing of a wolf through the forest, he begins to toss from side to side in his fear. He jumps forward, gets frightened at something, and runs back on his track. He hears something again, and he leaps at full speed to one side and runs away from his old track. Again something makes a noise, and the hare turns back, and again leaps to one side. When it is daylight, he lies down.

In the morning the hunters try to follow the hare tracks, and they get mixed up on the double tracks and long leaps, and marvel at the hare's cunning. But the hare did not mean to be cunning. He is merely afraid of everything.

THE SCENT

Man sees with his eyes, hears with his ears, smells with his nose, tastes with his mouth, and feels with his fingers. One man's eyes see better, another man's see worse. One hears from a distance, and another is deaf. One has keen senses and smells a thing from a distance, while another smells at a rotten egg and does not perceive it. One can tell a thing by the touch, and another cannot tell by touch what is wood and what paper. One will take a substance in his mouth and will find it sweet, while another will swallow it without making out whether it is bitter or sweet.

Just so the different senses differ in strength in the animals. But with all the animals the sense of smell is stronger than in man.

When a man wants to recognize a thing, he looks at it, listens to the noise that it makes, now and then smells at it, or tastes it; but, above all, a man has to feel a thing, to recognize it.

But nearly all animals more than anything else need to smell a thing. A horse, a wolf, a dog, a cow, a bear do not know a thing

until they smell it.

When a horse is afraid of anything, it snorts, – it clears its nose so as to scent better, and does not stop being afraid until it has smelled the object well.

A dog frequently follows its master's track, but when it sees him, it does not recognize him and begins to bark, until it smells him and finds out that that which has looked so terrible is its master.

Oxen see other oxen stricken down, and hear them roar in the slaughter-house, but still do not understand what is going on. But an ox or a cow need only find a spot where there is ox blood, and smell it, and it will understand and will roar and strike with its feet, and cannot be driven off the spot.

An old man's wife had fallen ill; he went himself to milk the cow. The cow snorted, – she discovered that it was not her mistress, and would not give him any milk. The mistress told her husband to put on her fur coat and kerchief, – and the cow gave milk; but the old man threw open the coat, and the cow scented him, and stopped giving milk.

When hounds follow an animal's trail, they never run on the track itself, but to one side, about twenty paces from it. When an inexperienced hunter wants to show the dog the scent, and sticks its nose on the track, it will always jump to one side. The track itself smells so strong to the dog that it cannot make out on the track whether the animal has run ahead or backward. It runs to one side, and then only discovers in what direction the scent grows stronger, and so follows the animal. The dog does precisely what we do when somebody speaks very loud in our ears; we step a distance away, and only then do we make out what is being said. Or, if anything we are looking at is too close, we step back and only then make it out.

Dogs recognize each other and make signs to each other by means of their scent.

The scent is more delicate still in insects. A bee flies directly to the flower that it wants to reach; a worm crawls to its leaf; a bedbug, a flea, a mosquito scents a man a hundred thousand of its steps away.

If the particles which separate from a substance and enter our noses are small, how small must be those particles that reach the organ of smell of the insects!

TOUCH AND SIGHT

Twist the forefinger over the middle finger and touch a small ball with them, so that it may roll between the two fingers, and shut your eyes. You will think that there are two balls. Open your eyes, – and you will see that it is one ball. The fingers have deceived you, but the eyes correct you.

Look (best of all sidewise) at a good, clean mirror, – you will think that it is a window or a door, and that there is something behind it. Touch it with a finger, – and you will see that it is a mirror. The eyes have deceived you, but the fingers correct you.

THE SILKWORM

I had some old mulberry-trees in my garden. My grandfather had planted them. In the fall I was given a dram of silkworm eggs, and was advised to hatch them and raise silkworms. These eggs are dark gray and so small that in that dram I counted 5,835 of them. They are smaller than the tiniest pin-head. They are quite dead; only when you crush them do they crack.

The eggs had been lying around on my table, and I had almost forgotten about them.

One day, in the spring, I went into the orchard and noticed the buds swelling on the mulberry-trees, and where the sun beat down, the leaves were out. I thought of the silkworm eggs, and took them apart at home and gave them more room. The majority of the eggs were no longer dark gray, as before, but some were light gray, while others were lighter still, with a milky shade.

The next morning I looked at the eggs, and saw that some of the worms had hatched out, while other eggs were quite swollen. Evidently they felt in their shells that their food was ripening.

The worms were black and shaggy, and so small that it was hard to see them. I looked at them through a magnifying-glass, and saw that in the eggs they lay curled up in rings, and when they came out they straightened themselves out. I went to the garden for some mulberry leaves; I got about three handfuls of leaves, which I put on my table, and began to fix a place for the worms, as I had been taught to do.

While I was fixing the paper, the worms smelled

their food and started to crawl toward it. I pushed it away, and began to entice the worms to a leaf, and they made for it, as dogs make for a piece of meat, crawling after the leaf over the cloth of the table and across pencils, scissors, and papers. Then I cut off a piece of paper, stuck holes through it with a penknife, placed the leaf on top of it, and with the leaf put it down on the worms. The worms crawled through the holes, climbed on the leaf, and started to eat.

When the other worms hatched out, I again put a piece of paper with a leaf on them, and all crawled through the holes and began to eat.

The worms gathered on each leaf and nibbled at it from its edges. Then, when they had eaten everything, they crawled on the paper and looked for more food. Then I put on them new sheets of perforated paper with mulberry leaves upon them, and they crawled over to the new food.

They were lying on my shelf, and when there was no leaf, they climbed about the shelf, and came to its very edge, but they never fell down, though they are blind. The moment a worm comes to an edge, it lets out a web from its mouth before descending, and then it attaches itself to it and lets itself down; it hangs awhile in the air, and watches, and if it wants to get down farther, it does so, and if not, it pulls itself up by its web.

For days at a time the worms did nothing but eat. I had to give them more and more leaves. When a new leaf was brought, and they transferred themselves to it, they made a noise as though a rain were falling on leaves, – that was when they began to eat the new leaf.

Thus the older worms lived for five days. They had grown very large and began to eat ten times as much as ever. On the fifth day, I knew, they would fall asleep, and waited for that to happen. Toward evening, on the fifth day, one of the older worms stuck to the paper and stopped eating and stirring.

The whole next day I watched it for a long time. I knew that worms moulted several times, because they grew up and found it close in their old hide, and so put on a new one.

My friend and I watched it by turns. In the evening my friend called out:

" It has begun to undress itself, – come ! "

I went up to him, and saw that the worm had stuck with its old hide to the paper, had torn a hole at the mouth, thrust forth its head, and was writhing and working to get out, but the old shirt held it fast. I watched it for a long time as it writhed and could not get out, and I wanted to help it. I barely touched it with my nail, but soon saw that I had done something foolish. Under my nail there was something liquid, and the worm died. At first I thought that it was blood, but later I learned that the worm has a liquid mass under its skin, so that the shirt may come off easier. With my nail I no doubt disturbed the new shirt, for, though the worm crawled out, it soon died.

The other worms I did not touch. All of them came out of their shirts in the same manner ; only a few died, and nearly all came out safely, though they struggled hard for a long time.

After shedding their skins, the worms began to eat more voraciously, and more leaves were devoured. Four days later they again fell asleep, and again crawled out of their skins. A still larger

quantity of leaves was now consumed by them, and they were now a quarter of an inch in length. Six days later they fell asleep once more, and once more came out in new skins, and now were very large and fat, and we had barely time to get leaves ready for them.

On the ninth day the oldest worms quit eating entirely and climbed up the shelves and rods. I gathered them in and gave them fresh leaves, but they turned their heads away from them, and continued climbing. Then I remembered that when the worms get ready to roll up into larvae, they stop eating and climb upward.

I left them alone, and began to watch what they would do.

The eldest worms climbed to the ceiling, scattered about, crawled in all directions, and began to draw out single threads in various directions. I watched one of them. It went into a corner, put forth about six threads each two inches long, hung down from them, bent over in a horseshoe, and began to turn its head and let out a silk web which began to cover it all over. Toward evening it was covered by it as though in a mist; the worm could scarcely be seen. On the following morning the worm could no longer be seen; it was all wrapped in silk, and still it spun out more.

Three days later it finished spinning, and quieted down. Later I learned how much web it had spun in those three days. If the whole web were to be unravelled, it would be more than half a mile in length, seldom less. And if we figure out how many times the worm has to toss its head in these three days in order to let out all the web, it will appear that in these three days the worm tosses its head 300,000 times. Consequently, it makes one turn a second, without stopping. But after the work, when we took down a few cocoons and broke them open, we found inside the worms all dried up and white, looking like pieces of wax.

I knew that from these larvae with their white, waxen bodies would come butterflies; but as I looked at them, I could not believe it. None the less I went to look at them on the twentieth day, to see what had become of them.

On the twentieth day, I knew, there was to be a change. Nothing was to be seen, and I was beginning to think that something was wrong, when suddenly I noticed that the end of one of the cocoons grew dark and moist. I thought that it had probably spoiled, and wanted to throw it away. But then I thought that perhaps it began that way, and so I watched to see what would happen. And, indeed, something began to move at the wet end. For a long time I could not make out what it was. Later there appeared something like a head with whiskers. The whiskers moved. Then I noticed a leg sticking out through the hole, then another, and the legs scrambled to get out of the cocoon. It came out more and more, and I saw a wet butterfly. When all six legs scrambled out, the back jumped out, too, and the butterfly crawled out and stopped. When it dried it was white; it straightened its wings, flew away, circled around, and alighted on the window.

Two days later the butterfly on the window-sill laid eggs in a row, and stuck them fast. The eggs were yellow. Twenty-five butterflies laid eggs. I collected five thousand eggs. The following year I raised more worms, and had more silk spun.

STORIES FROM BOTANY

THE APPLE-TREE

I set out two hundred young apple-trees, and for three years I dug around them in the spring and the fall, and in winter wrapped them with straw against the hares. On the fourth year, when the snow melted, I went to take a look at my apple-trees. They had grown stouter during the winter: the bark was glossy and filled with sap; all the branches were sound, and at all the tips and axils there were pea-shaped flower-buds. Here and there the buds were bursting, and the purple edges of the flowerleaves could be seen. I knew that all the buds would be blossoms and fruit, and I was delighted as I looked at the apple-trees. But when I took off the wrapping from the first tree, I saw that down at the ground the bark was nibbled away, like a white ring, to the very wood. The mice had done that. I unwrapped a second tree, and the same had happened there. Of the two hundred trees not one was unharmed. I smeared pitch and wax on the nibbled spots; but when the trees were all in bloom, the blossoms at once fell off; there came out small leaves, and they, too, dropped off. The bark became wrinkled and black. Out of the two hundred apple-trees only nine were left. On these nine trees the bark had not been gnawed through all around, but strips of bark were left on the white ring. On the strips, where the bark held together, there grew out knots, and, although the trees suffered, they lived. All the rest were ruined; below the rings there came out shoots, but they were all wild.

The bark of the tree is like the arteries in man : through the arteries the blood goes to the whole body, and through the bark the sap goes along the tree and reaches the branches, leaves, and flowers. The whole inside of a tree may be taken out, as is often the case with old willows, and yet the tree will live so long as the bark is alive; but when the bark is ruined, the tree is gone. If a man's arteries are cut through, he will die, in the first place, because the blood will flow out, and in the second, because the blood will not be distributed through the body.

Even thus a birch dries up when the children bore a hole into it, in order to drink its sap, and all the sap flows out of it.

Just so the apple-trees were ruined because the mice gnawed the bark all around, and the sap could not rise from the roots to the

branches, leaves, and flowers.

THE OLD POPLAR

For five years our garden was neglected. I hired labourers with axes and shovels, and myself began to work with them in the garden. We cut out and chopped out all the dry branches and wild shoots, and the superfluous trees and bushes. The poplars and bird-cherries grew ranker than the rest and choked the other trees. A poplar grows out from the roots, and it cannot be dug out, but the roots have to be chopped out underground.

Beyond the pond there stood an enormous poplar, two men's embraces in circumference. About it there was a clearing, and this was all overgrown with poplar shoots. I ordered them to be cut out: I wanted the spot to look more cheerful, but, above all, I wanted to make it easier for the old poplar, because I thought that all those young trees came from its roots, and were draining it of its sap. When we cut out these young poplars, I felt sorry as I saw them chop out the sap-filled roots underground, and as all four of us pulled at the poplar that had been cut down, and could not pull it out. It held on with all its might, and did not wish to die. I thought that, no doubt, they had to live, since they clung so much to life. But it was necessary to cut them down, and so I did it. Only later, when nothing could be done, I learned that they ought not to have been cut down.

I thought that the shoots were taking the sap away from the old poplar, but it turned out quite differently. When I was cutting them down, the old poplar was already dying. When the leaves came out, I saw (it grew from two boughs) that one bough was bare; and that same summer it dried up completely. The tree had been dying for quite awhile, and the tree knew it, so it tried to give its life to the shoots.

That was the reason why they grew so fast. I wanted to make it easier for the tree, and only killed all its children.

THE BIRD-CHERRY

A bird - cherry grew out on a hazel bush path and choked the bushes. I deliberated for a long time whether I had better cut down the bird-cherry, or not. This birdcherry grew not as a bush, but as a tree, about six inches in diameter and thirty feet high, full of branches and bushy, and all besprinkled with bright, white, fragrant blossoms. You could smell it from a distance. I should not have cut it down, but one of the labourers (to whom I had before given the order to cut down the bird-cherry) had begun to chop it without me. When I came, he had already cut in about three inches, and the sap splashed under the axe whenever it struck the same cut. " It cannot be helped, - apparently such is its fate," I thought, and I picked up an axe myself and began to chop it with the peasant.

It is a pleasure to do any work, and it is a pleasure to chop. It is

a pleasure to let the axe enter deeply in a slanting line, and then to chop out the chip by a straight stroke, and to chop farther and farther into the tree.

I had entirely forgotten the bird-cherry, and was thinking only of felling it as quickly as possible. When I got tired, I put down my axe and with the peasant pressed against the tree and tried to make it fall. We bent it: the tree trembled with its leaves, and the dew showered down upon us, and the white, fragrant petals of the blossoms fell down.

At the same time something seemed to cry, – the middle of the tree creaked; we pressed against it, and it was as though something wept, there was a crash in the middle, and the tree tottered. It broke at the notch and, swaying, fell with its branches and blossoms into the grass. The twigs and blossoms trembled for awhile after the fall, and stopped.

“ It was a fine tree!” said the peasant. “ I am mightily sorry for it!”

I myself felt so sorry for it that I hurried away to the other labourers.

HOW TREES WALK

not exist under the linden, so it had stretched out, dropped a branch to the ground, made a root of that branch, and left the other root. Only then did I understand how the first bird-cherry had grown out on the road. It had evidently done the same, – only it had had time to give up the old root, and so I had not found it.

One day we were cleaning an overgrown path on a hillock near the pond. We cut down a lot of brier bushes, willows, and poplars, – then came the turn of a birdcherry. It was growing on the path, and it was so old and stout that it could not be less than ten years old. And yet I knew that five years ago the garden had been cleaned. I could not understand how such an old birdcherry could have grown out there. We cut it down and went farther. Farther away, in another thicket, there grew a similar bird-cherry, even stouter than the first. I looked at its root, and saw that it grew under an old linden. The linden with its branches choked it, and it had stretched out about twelve feet in a straight line, and only then came out to the light, raised its head, and began to blossom.

I cut it down at the root, and was surprised to find it so fresh, while the root was rotten. After we had cut it down, the peasants and I tried to pull it off; but no matter how much we jerked at it, we were unable to drag it away : it seemed to have stuck fast. I said: . “ Look whether it has not caught somewhere.”

A workman crawled under it, and called out:

" It has another root; it is out on the path!"

I walked over to him, and saw that it was so.

Not to be choked by the linden, the bird-cherry had gone away from underneath the linden out on the path, about eight feet from its former root. The root which I had cut down was rotten and dry, but the new one was fresh. The bird-cherry had evidently felt that it could