A Research into Mint's Effect which Protects Plants from Insects

Researchers: Ou Suien, Kitamura Moeka, and Kusama Ayumi
Supervisor: Horiuchi Saeko

1. Purpose of Research

From the point of view of biodiversity, it is desirable not to use pesticide. However, to evade pests is very hard for pesticide-free agriculture.

There are some plants which release volatile substances which pests dislike, that is, smells. The typical example is menthol, which mint includes. And according to the research by Arimura Genichirou and Nishihara Masahiro at the Faculty of Engineering, Tokyo University of Science, ingredients of smells of candymint and peppermint have an ability to promote soy beans to emit DNA which protects themselves from pests. We researched on how much protecting effect some sorts of mint have. And even when mint is proved to have a protecting effect, it is difficult to make it practical if it has allelopathy, which inhibits plants from growing or sprouting. So, we also researched on the effect on other plants.

2. Materials and Methods

-materials-

Experiment 1

・spearmint −a member of the mint family, *Mentha spicate,*

・soybean−*Glycine max*

Experiment 2

・spearmint

・peppermint−a member of the mint family, *Mentha x piperita*

・English mint−a member of the mint family, *Mentha x piperita vulgaris*

・broccoli −a member of the brassica family, *Brassica oleracea italica*

・lettuce−a member of the brassica family, *Lactuca sativa*

・potherb mustard−a member of the brassica family, *Brassica rapa var.laciniifolia*

・50 ml solution of vegetable gelatin in water (15g/L)

Methods

Experiment 1

① to plant a soybean and spearmint in a pot

② to set pots as in Figure 1

③ to observe how large the area of leaves eaten is

Figure 1

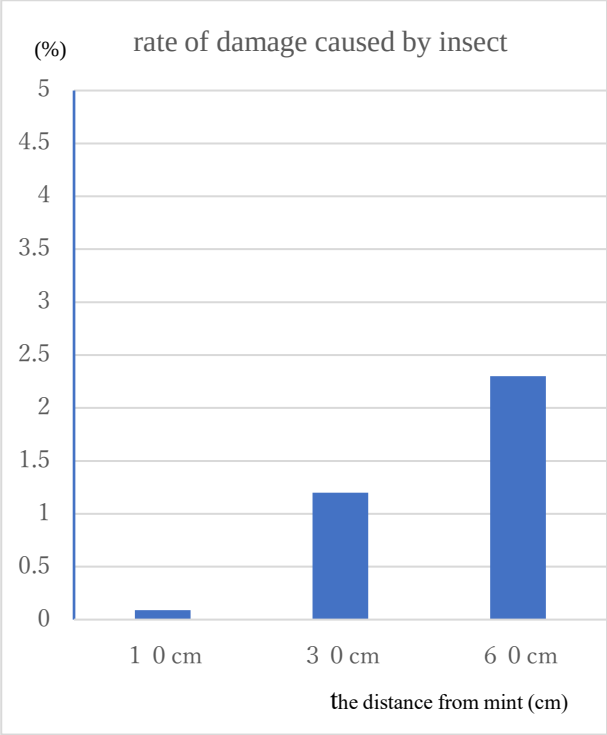
Experiment 2

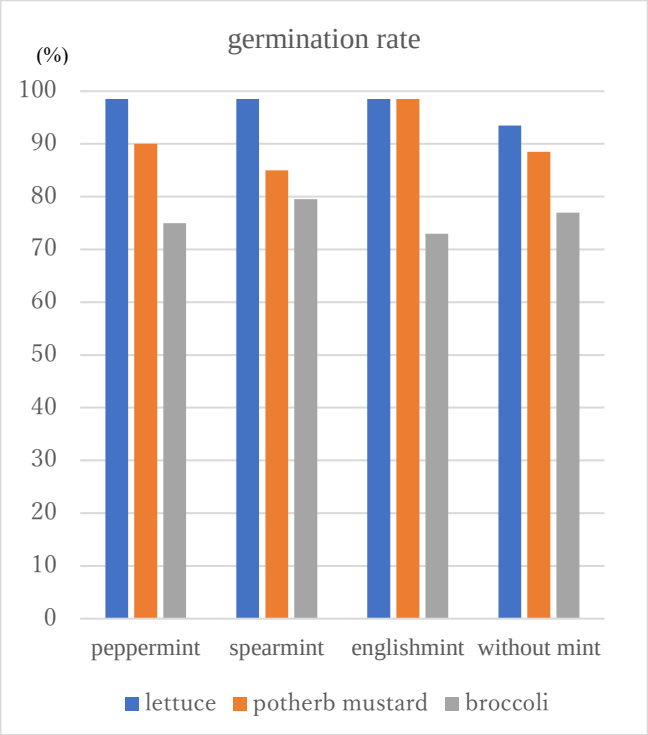
① to fix mint in a laboratory dish

② to put solution of vegetable gelatin into it and make an agar culture medium

③ to sow seeds of broccoli and potherb mustard on it and observe how many of them sprout

3. Results





Experiment 1

The nearer mint was to the plant, the less serious damage was, because mint has an insect-repellant effect.

Experiment 2

1) There was not a big difference in plants between with mint nearby and without it.

2) Lettuce's germination rate was the best of the three.

3) Spearmint's experimental group has the best germination rate among the mints.

4) Broccoli's germination rate was bad. It has no relationship with the existence of mint or the kind of mint.

4. Discussion

Experiment 1

1) Mint has effect that protects other plants from insects.

2) The nearer it is to the plant, the stronger the effect is.

Experiment 2

Mint has no effect on other plant's growth and sprouting. So, it is effective in pesticide-free agriculture. But even if we place mint near the plants, damage by insects cannot be eliminated perfectly. Therefore, another countermeasure and customers' understanding are necessary.

6.References

Yoshiharu Fujii, *Shokubutsutachino Shizukana Tatakai - Kagakubusshitsuga Ayatsuru Seizonkyousou* (Kagakudojin Shuppan,2016,)

Genichirou Arimura & Masahiro Nishihara, *Shokubutsuno Takurami - Kaorito Irono Shokubutsugaku* (Bere Shuppan,2018,)

About the Zygote of Microalgae

~ Exploring the durability of a zygote ~

Researchers: Katagiri Tomoya, Ishii Kei, Takahashi Kengo, and Horiuti Shungo
Instructor: Todoroki Kazuhisa

1. Purpose of research

The microalga is a generic name of the algae which require the microscope to observe. We became interested in the zygote that some species of microalgae made and began to study. The outline of the research is as follows:

1) To explore the conditions under which microalgae become zygotes.
2) To experiment to see how severe the environment the zygote can withstand is.
3) To explore the conditions under which the zygote returns to its original state.

[Figure.1] *Volvox*

2. Research methods and results

〈Methods〉

The concrete procedures of the research are as follows:

(1) To obtain microalgae and aim to cultivate them stably.
(2) To make microalgae form zygotes and put them in various environments such as heated, frozen, and dry ones.
(3) To put the zygotes back in the cultured environment and observe whether they can geminate and return to the original state. When they did not germinate, we changed the conditions and experimented again.
(4) To consider the data obtained from the experiment.

〈Results〉

(1) In the experiment, we used *volvox*(*species*) **[Fig.1]** which had been cultivated at school. During the culturing process, it was found that 0.01% liquid fertilizer was the most suitable for the culture medium among natural water, tap water, and 0.01% liquid fertilizer, so it was decided to be used in the later cultivation.
(2) In the process of searching for zygotes, we found something like green moss, which had accumulated at the bottom of the test tube where the *volvox* were gone. **[Fig.2]** It seemed to be zygotes of the *volvox*.
(3) Only this green object was taken out, and we divided it into four specimens. One was heated to 50° C., another heated to

[Figure.2] A green object was identified

60 ° C., still another frozen in a freezer, and the last one dried on a slide glass. They were immersed in the culture medium in test tube and observed to return from the zygote state to the original state. After a few days, there was less moss-like substance accumulated at the bottom of test tubes heated to 60 ° C than that heated and 60 ° C. Although the difference is 10° C, it seemed to have a large effect on plants.

(4) Usually, the zygotes germinate and return to the original state in about one month, *volvox* could not be confirmed in any of the test tube after one month. The possible causes are:

1. The water temperature was not suitable for the germination of *volvox*.
2. The water quality was not suitable.
3. Too few hours of sunlight.
4. The moss-like substance inhibited the germination of the *volvox*.

The water temperature was about 13° C. This is the lowest water temperature for rice paddies in early summer. The temperature was not suitable for the germination of *volvox*, but it is difficult to conclude the water temperature as the decisive factor. In addition, it is difficult to verify the other causes, and the main cause has not been identified even now.

3. Consideration and Future Prospects

The results we attained are:

(1) That we were able to find the most suitable Culture fluid for microalgae.

(2) That we were able to find a zygote of the volvox and carry out an experiment to see its endurance.

These are small results, and there some that still need to be clarified. They are:

(1) The exact condition under which the zygote is formed.

(2) The cause for the zygote not to germinate.

Finally, we would like to thank Mr. Todoroki, our advisor, and the staff of the Biology Laboratory who helped us with our experiments. Still, the remaining errors should be mine.

4. References

- 1Yuki Tuchikane (2015) Diversity of bonding styles in the genus *Closterium* - Japanese Algae Society-
- 1Yuki Tsuchikane (2017) Sexual reproduction, reproductive isolation and reproductive style of the japanese spider - Japanese Botanical Society-
- 1*Volvox* : Free Encyclopedia Wikipedia

Artificial Photosynthesis Using Metals

~Activation of Photo Catalysis by Altering Terms~

Researchers: Kobayasi Atsushi, Takara Koki, Nishinoiri Kosuke

Supervisor: Tezuka

1. Purpose of Research:

Today, it is urgent that we reduce carbon emissions to slow the progress of Global Warming. Besides this, the depletion of natural resources is also a concern. We began with the study of artificial photosynthesis to find solutions to these problems from a scientific perspective. We considered whether to activate photocatalysis by changing used metals or the way to assemble the device from preceding studies and come up with a new idea.

2. Materials & Methods:

Experiment-1: Construction an Experimental Device to Verify Photo Catalysis

① We saturated a sodium sulfate solution <Na_2SO_4> with nitrogen dioxide <CO_2>.

② We made an electrode device in ① with two metal plates of tantalum oxide <Ta/Ta_2O_5> and silver lines <Ag >.

③ We irradiated ultraviolet radiation with a black light and wrote down variation of the voltage and current.

Experiment-2: The Magnitude of Voltage and Current when Altering Heating Time of Tantalum

We heated tantalum <Ta> at 600℃ (about 1112℉) for 3min, 5min, 10min, 15min, and 20min. We recorded the variations of voltage and current as before.

Experiment-3: The Magnitude of Voltage and Current when Altering Metals

We prepared the following electrodes and assembled a device as before.

(ⅰ) Tantalum | Tantalum Oxide <Ta> (ⅱ) Aluminum | Aluminum Oxide <Al>

(ⅲ) Stainless | Heated Stainless (ⅳ) Copper | Copper Oxide <Cu>

(ⅴ) Molybdenum | Molybdenum Oxide <Mo> (ⅵ) Titanium | Titanium Oxide<Ti>

(ⅶ) Tungsten | Tungsten Oxide <W>

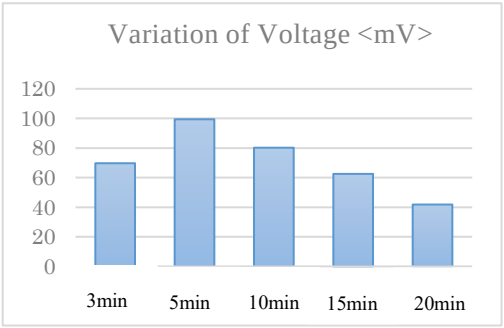
We recorded the variations of voltage and current as before.

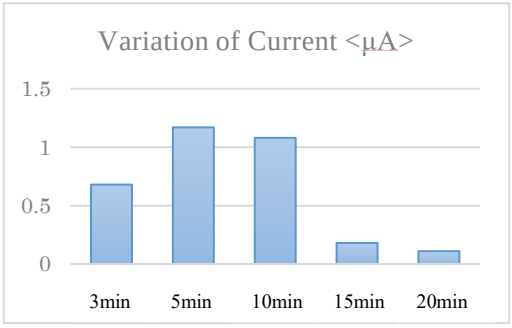
3. Result:

Ex1: Ta and TaO5 device

Ex2: Ta heated for 5min was best. Over 5min, I and V decreased.

Ex3: (ⅰ) Indicated the best current and voltage. (ⅱ)(ⅲ)(ⅴ)(ⅶ) had no reaction. (ⅳ)(ⅵ) Indicated a slight reaction.





		(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Voltage V <mV>	Before	26.6	23.6	24.2	10.5	100.2	62.9	105.9
	After	114.0	23.6	24.2	13.9	100.2	46.6	105.9
	⊿V	**87.4**	**0**	**0**	**3.4**	**0**	**16.3**	**0**
Current A <μA>	Before	0.03	0.44	0.21	0.74	6.84	0.87	4.29
	After	1.17	0.44	0.21	1.10	6.84	0.69	4.29
	⊿A	**1.14**	**0**	**0**	**0.36**	**0**	**0.18**	**0**

4. Summary:

Ex1: The device indicated a photo catalysis reaction.

Ex2: Ta heated for an ineffectual time, so oxidation is was lacking. Thus, it do not produce sufficient photo catalysis. Ta heated for a longer time altered the metal to a white colour. It is possible that the oxide film had changed.

Ex3: Results of UV rays. It is more appropriate to choose metal from the viewpoint of compatibility between metals and light. We expect that metal, which is nearer to Ta, would indicate a photo catalysis reaction, but it was not correct. We found that photo catalysis reaction was unique to the metal. Ta heated for 5min was the best result.

5. Outlook:

There were some metals that responded to UV light. We would like to know how the differences from this experiment when using light with different wavelengths. Also, we would like to investigate more kinds of metals and find metals that have a lager current and voltage than tantalum<Ta>.

We would like to find an aqueous solution that shows a stronger photo catalytic reaction than an aqueous solution of sodium sulfate<Na_2So_4>.

We feel that it was necessary to request cooperation from the research institute and analyze it by using liquid chromatography to confirm what kind of organic compound was produced from carbon dioxide <CO_2>.

6. References:

1) 12th High School Science Grand Contest “Research on artificial photosynthesis: “Generation of hydrogen and oxygen from water using photocatalysis”

2) 13th High School science Grand Contest “Research on artificial photosynthesis: “Generation of formic acid from carbon dioxide and Visible light response using tantalum plate”

3) Book “What is the true energy of dreams artificial photosynthesis” edited by photochemical society

Digitization Project of Seismometer Records

—Digitize records with a soft named DigitSeis—

Researchers：Taguchi Akira, Chihara Eishi, Miyazawa Katsuaki,
Yashiro Masaki, Yamada Asumi
Teacher：Oishi Koeru

1. Purpose

In April 1889, Ernst von Rebeur-Paschwiz, a seismologist who was working for a seismological observatory in Potsdam, Germany, discovered that an undulation was recorded on the seismometer. Later, it was confirmed that the cause of the undulation was a seismic wave caused by an earthquake that happened in Japan. We defined that it is the first earthquake that is recorded on seismometers, which means that the history of seismic records on seismometers is over 100 years. Most of the records were analog and were recorded on paper.

It was not until the 1990s that the seismometer became digital. For these reasons, there are great number of seismograph records that we have to digitize. (Fig.1)

An image file of the seismometer records that Ms. Ishii and her colleagues scanned over five years is stored on the computer. They use digital time series in research, so the analogy is useless.

The purpose of this project is to digitize seismometer records from the past and create a database that researchers around the world can use.

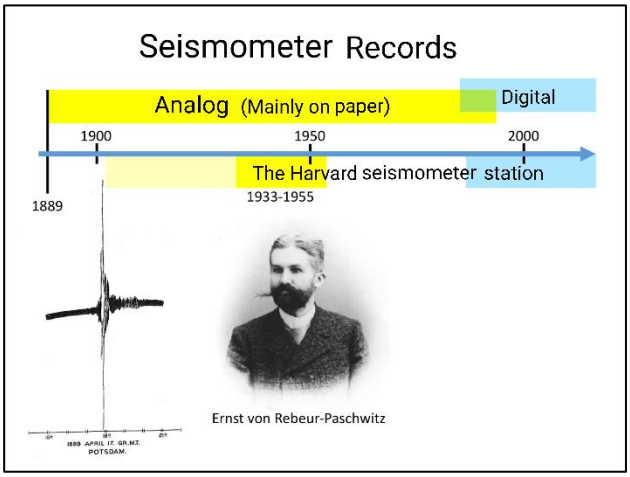


Fig.1

It is data collected at the Harvard Earthquake Observatory that we are digitizing.

2. Method

Do all the work with DigitSeis.

① Classification

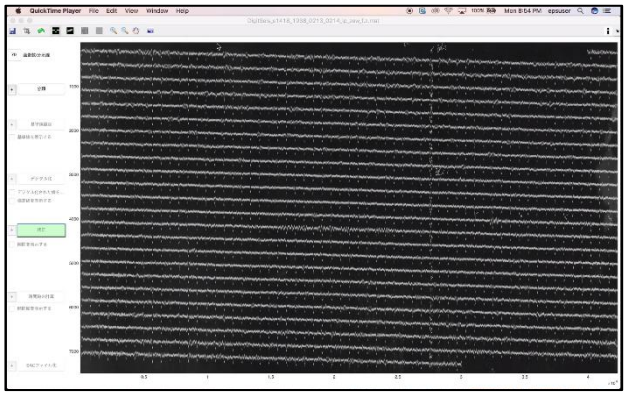


Fig. 2

When you press the "Classify" button on the basic screen (Fig. 2), calculation starts and the screen switches (Fig. 3). It is very similar to the screen of the seismograph record shown on the basic screen, but it is colored. White represents the main line, light blue represents the division line or hour line, and red represents neither the division line nor the main line.

However, it is not always calculated perfectly, and handwritten notes are sometimes classified as the main line or the main line is classified as useless information.

Correcting it precisely is what we have to do in this step.

This classification step is necessary to draw the data recorded by the seismometer. Not only is it an important

step, but it is also the most time-consuming step in the DigitSeis analysis.

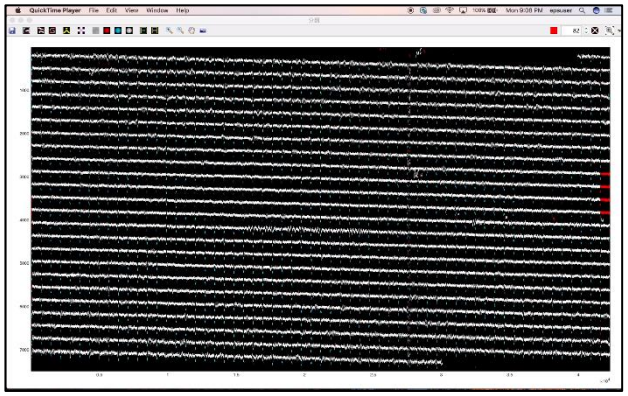


Fig. 3

② Setting of base line and digitize

After we finish the classification step, we set up a base line. It starts calculating and displays a broken line by pressing a button of “setting of base line” on a basic display. When we see the broken line almost overlaps the main line, we press the “digitize button” and it starts calculating.

After it finishes calculating, the main line is displayed in blue.

③ Revising digitized line

When a space is found on the main line due to a mistake in the digitization step, it has to be revised by hand.

④ Setting the time line

When we press "Calculate time line" on the basic screen, the calculation begins, and a yellow line is displayed every minute. Check if this is the branch line and correct it by hand if it is off.

Then look for handwritten notes about time. For example, if we find out "Feb.13.15", we input "February 13 15:00". Then, when we press the "Calculate time line" button again, the time is shown in yellow letters every 15 minutes. （Fig. 4）

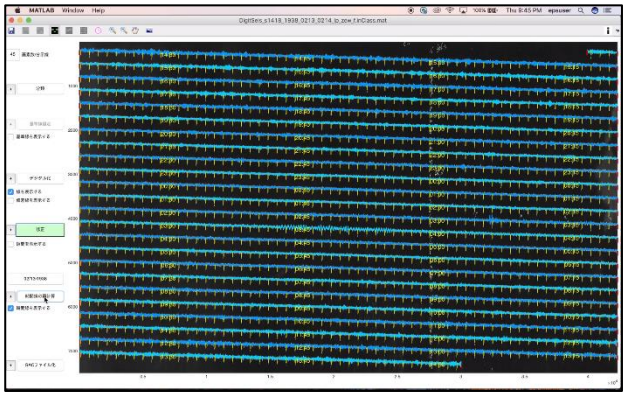


Fig. 4

This is the end of all our work.

3. Future Outlook

This project is going to be carried over to the astronomical club and the project is supposed to continue.

4. References

Fig.1 http://seismology.harvard.edu/research/DigitSeisJapan/restricted/180902analogHRV.mp4
Fig.2 http://seismology.harvard.edu/research/DigitSeisJapan/intro/180827ImageTrim.mp4
Fig.3 http://seismology.harvard.edu/research/DigitSeisJapan/intro/180827initial.mp4
Fig.4 http://seismology.harvard.edu/research/DigitSeisJapan/intro/180831time.mp4

Investigating the occurrence factor of whirlwind

~The relationship between whirlwinds and the convection of air~

Researcher: Abe Rina, Ota Shun, Shimizu Tatsuya,
Tanaka Rinha, Nishimura Hikaru, Matsumoto Mayu
Supervisor: Kurata Ryousuke

1.Purpose

If a whirlwind has a big scale, it may cause serious damage to a person and a building. Therefore, we wanted to investigate the place where the whirlwind was easy to arise by clarifying the cause to reduce sudden damage by the whirlwind.

2. Materials & Methods

There are two kinds of whirlwind. For one thing, it swirls temporarily on the surface of the earth. For another thing, it swirls continuously and rises to a constant height. We studied the latter this time.

① Check and analysis of previous studies

Previous studies1） We lit snake fireworks in the playground and in the corner of the school buildings.

→No swirl of smoke arose when lit in the playground, but it arose when lit in the corner of the school building.

Previous studies 2) We span a stirrer in water.

→A swirl like whirlwind arose when there were walls, but it didn't arise when without walls.

Previous studies 3) We put dry ice in a box and created updraft and crosswind.

→We created upward whirlwinds.

・Hypothesis based on the previous studies

Updraft and crosswind are required to raise whirlwinds, but when whirlwinds arise naturally, not only upwind but also vertical convection which replaces walls can be required.

② Experiments to prove our hypothesis

We assumed that the convection could be created in the space surrounded by 4 incandescent bulbs.

Experiment-1) Experiment with 4 incandescent bulbs

We put 4 incandescent bulbs on a flat table. We gave off smoke there and observed whether a whirlwind occured or not. Also, we changed the distance between the incandescent bulbs.

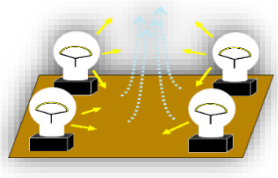


Figure1 Arrangement of incandescent bulbs and conceivable convection

Experiment-2) Experiment with 1 incandescent bulb.

We put only 1 incandescent bulb and observed whether a whirlwind arose or not.

Experiment-3) Experiment by changing the source of heat

We put 4 magnetic stirrers instead of incandescent bulbs. We observed whether a whirlwind arose or not.

3. Result

Experiment-1) Table 1 A relationship of distance between incandescent bulbs, and the occurrence of a whirlwind

Distance between incandescent bulbs (cm)	15	25	35	45	55
Occurrence of whirlwind	×	○	○	○	×

・When the distance between the light bulbs was too close or too far, whirlwinds didn't arise.

・We found that the distance between the light bulbs is related to the generation of convection.

Experiment-2) Whirlwinds didn't arise when there was an incandescent bulb.

Experiment-3) We placed the magnetic stirrers in the same way we placed the light bulbs, but whirlwinds didn't arise.

What can be considered from these results,

① Even if we produce crosswind after warming a part of the floor surface and creating updraft, smoke would only spread instead of becoming a whirlwind because there is no stable vertical convection.

② Because the whole area is warm, the air mass would expand, swirl and a stable vertical convection would appear near the ground surface.

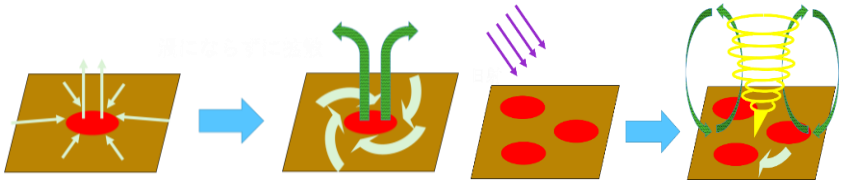


Figure2 Image of ①

Figure3 Image of ②

③ The actual whirlwind continues to move. If a part of the ground is warmed up and an updraft arises, the whirlwind should stay in the same place. On the other hand, if the whirlwind doesn't disappear due to convection, the air mass continues to move, due to the convection which explains the phenomenon of whirlwind movement.

④ Whirlwinds often arise in the playground and so on. We can think that the entire schoolyard is heated and convection arises in the vertical direction, rather than that a part of the playground is heated and an upward flow arises. When crosswind is added, we can see whirlwinds.

4. Discussion

・The occurrence of whirlwinds needs ascending air currents and crosswinds. We hypothesized that not only the updraft but also vertical convection instead of walls are needed for whirlwinds to arise in nature. In our experiments, when we produced convection where there was no wall, whirlwind arose. Therefore, our hypothesis seems to be correct.

・If there is an updraft and a crosswind, a whirlwind will occur where there is a wall.

・If the crosswind is too strong where there is no wall, convection will collapse and a whirlwind will not occur.

5. Future Direction of Research

・We want to examine the temperature distribution of the air on the ground when a whirlwind arises.

・We want to examine what will happen when the number of incandescent bulbs and the arrangement of them is changed from square to circle.

・We want to examine the conditions where convection is likely to arise in nature.

6, References

・“Conditions for arising whirlwind.”
Information drive control laboratory, department of robotics and mechatronics, faculty of future science, Tokyo Denki University.

・In 2013, Yashiro high school assignment research report,
“Investigate the cause of arising whirlwind : Considering the environment in which whirlwind easily occurs from the reproduction experiment.”

・In 2015, Yashiro high school assignment research report,
“The factor that causes of vortex flow in stirring: Relationship between vortex flow and whirlwind arising factors.”

・http://www.jma.go.jp/jma/index.html

・https://www.mri-jma.go.jp/index_en.html?/

Making a wingless wind generator

～Development of new energy by using familiar items～

Researcher：Ikeda Sota, Omuro Yuto, Kawajiri Nodoka, Denda Hinaka

Supervisor：Fukushima Tetsuo

1. Purpose of research

The wind turbines that are in use today have some problems. First, they are expensive to maintain. Second, it is very dangerous if birds hit them. A wingless wind generator is a way to solve these problems.

2. Materials & Methods

Using what is close to us, we created a wingless generator, exposed it to a fan wind, and measured the amount of power generated by the wind. By making a wingless wind generator with things around us, we will be able to produce electricity that can actually be used.

1）Mechanism of power generation

By referring to a company that makes wingless wind generators, we developed one. When wind hits a cylindrical object, vibration occurs perpendicular to the wind direction. We attached the magnets in the direction of vibration, and the wingless wind generator generates electricity through electromagnetic induction. Please see Figure 1.

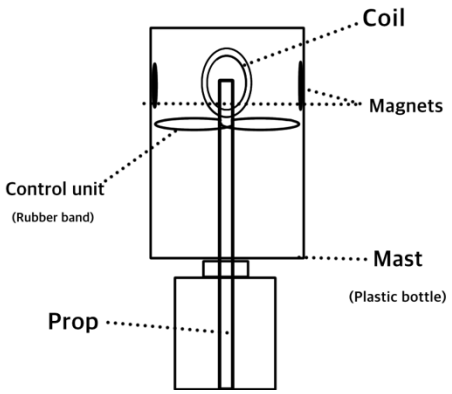


Figure 1

2） About the control unit

We used rubber bands as a control unit. The vibration of generator is kept constant by connecting the prop to the plastic bottle mast with rubber bands. If the plastic bottle mast moves, it cannot return to its original position without the control unit. The plastic bottle which moves to one side is pushed back to the other side by the power of the rubber bands.

3） Outline of experiment

①The shape of plastic bottles（500ml tea bottle, 500ml soda bottle, 2L soda bottle）

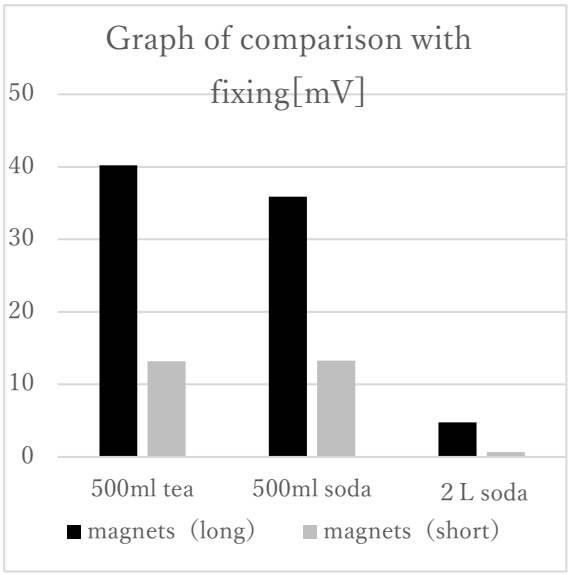
②The distance between coil and magnet

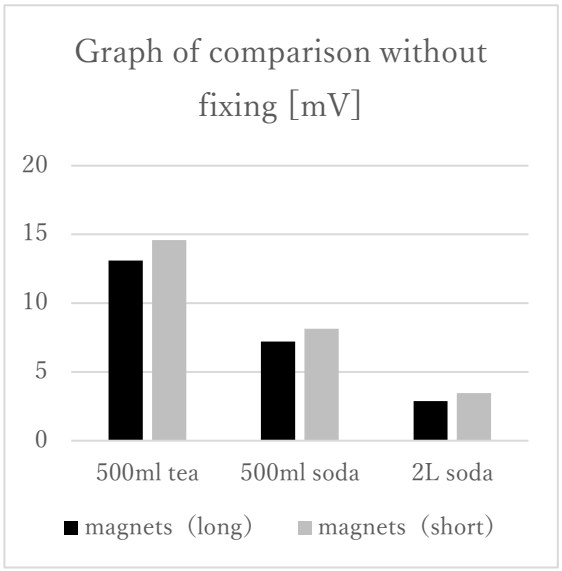
③With or without foundation fixing

We changed three points mentioned above to do the experiments.

3. Results

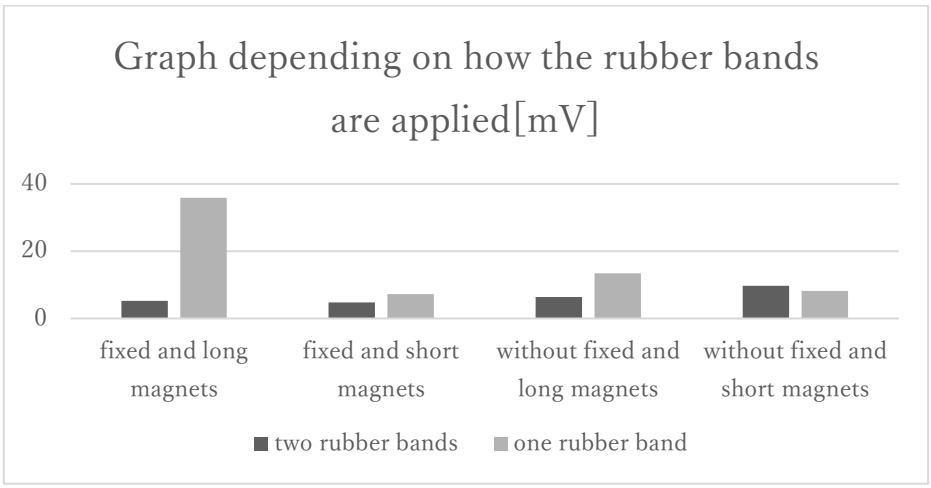
We experimented about the three points, and made a graph.





We experimented with two rubber bands so that the generator would move even if the wind blows from all directions.

We used the 500ml soda plastic bottle.　The results are as follows.



4. Discussion

The voltage of the 2L plastic bottle was low, but this is probably because the magnet was attached to the wall surface of the plastic bottle, so the distance from the coil to the magnet became large and the magnetic field change was small. If we design the generator so that the distance between the coil and the magnets is small, we think it can change the magnetic field significantly.

5. Future Direction of Research

We attempted to cope with the wind blowing from all directions by increasing the number of rubber bands. But plastic bottle didn't vibrate and the amount of electricity was small because the tension of vibration was too strong. If we use different materials for the mast and the control unit, and create a mechanism to increase the amplitude of the generator, we would be one step closer to commercialization.

6. References

https://vortexbladeless.com/

Oxidation Capacity of Ozone and the Effects Therein

~Making Dirt Clean with Ozone ~

Researchers: Komiyama Reika, Sakaguchi Kokoa, Nakazima Haruna, Nakatani Saki

Supervisor: Miyahara Kimio

1. Purpose of Research:

Knowing that ozone has a deodorant effect, and sterilization, we started experiments in order to make use of such effects in everyday life.

2. Methods of Research:

~Experiment I~ "The Transformation of Muddy Water Caused by Ozone"

・Knowing that ozone has a strong capacity of oxidation, and the effects of purification and decolorant from literature, we generated ozone and checked these effects.

~Experiment II~ "The Change of Conditions with Experiment I"

・It was confirmed that the dirt in the muddy water was decomposed.

To check if this was due to ozone: ①do nothing, ②add ozone, ③add oxygen, ④add air

↳Observe in the control experiment

~Experiment III~"Addition of Ozone to Indian Ink and Water-Based Ink (i.*)"

・Experiment I and II confirmed that the ozone decomposes the muddy water, so we used an Indian ink and a water-based ink in Experiment I. *The water-based ink in I: contained protective colloid.

~Experiment IV~ "Add ozone to the water-based ink in Experiment II*"

・We didn't see decolorizing action with water-based ink Experiment I and India ink in Experiment III, so we checked the reaction of other water-based ink in Experiment II.

*The water-based ink in Experiment II: did not contain protective colloid.

~Experiment V~ "Produce Ozone Water"

・We attempted to make ozone water by adding ozone in water.

~Experiment VI~ "Confirmation of the Effect of Purchased Ozone Water in Experiment I"

・We conducted the experiment to confirm the effect of ozone water which we bought using the water-based ink pen which we used in Experiment IV.

~Experiment VII~ "Confirmation of the Effect of Purchased Ozone Water in Experiment 2"

・We carried-out this experiment to confirm the effect of ozone water which we bought using clothes in order to apply the effect to washing.

3. Results:

~Experiment I~

・Mud: add ozone for 35 minutes and the solution became clear.

~Experiment II~ Table l: “24min. Results”

Experiment	State	Color
Nothing	Precipitation of mud	Clear gray
Ozone	Precipitation of mud	Colorless clear
Oxygen	Precipitation of mud	Clear gray
Air	Precipitation of mud	Clear gray

~Experiment III~

・Indian Ink: add ozone for 1hour → no change /・Water-based pen I…add ozone for 44 minutes → no change

~Experiment IV~

・Water-based II: add ozone for 14 minutes → colorless (clear)

～Experiment V～

・We had added ozone to water for 30 minutes, but the potassium iodide paper of starch didn’t change

～Experiment VI～

・We had added ozone to water-based ink II and as a result the aqueous solution become clear

～Experiment VII～ Table 2: “Full Day Result” —: no change ○: adhesion of substance

Substance used	Before experiment	After (distilled water)	After (ozone water)
① ketchup	○	—	little thin
② soy sauce	○	disappeared	disappeared
③ leaves	○	—	little thin
④ acetocarmine	○	—	thin
⑤ mud	○	—	—
⑥ water-based ink i	○	—	thin

4. Discussion:

・According to experiments I and II, ozone is capable of decomposing dirt.

・Ozone is incapable of decomposing dirt including protective colloid.

・We have to conduct the experiment of making ozone water under special conditions.

・Ozone is capable of decomposing dirt and removing color.

5, Future Vision:

・We want to think about making ozone water in collaboration with the research institutions.

・We want to establish a method of checking ozone water with high school knowledge.

・The effect of ozone water was poorly identified, so it is necessary to think about the application to real life.

・As an experiment to decompose dirt with ozone, we want to investigate the effect of acidic and basic solutions on the oxidizing capacity of ozone.

6. References:

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・https://www.jstage.jst.go.jp/article/jswe1978/13/12/13_12_792/_pdf

・https://www.mitsubisielectric.co.jp/society/ozonizer/technology/index.htm

The Potential of Dye-sensitized Solar Cells

~Aiming for practical understanding~

Researcher: Miryu Miyamoto, Toya Kobayashi, Ryusei Miyazawa
Supervisor: Yanagisawa Katsuhiro

1. Purpose of Research:

Dye-sensitized Solar Cells were examined for the next generation of solar batteries. We wanted to study about the basic outside factor of dye-sensitized solar cells, which haven't clarified yet. We also wanted to examine a connection between dye-sensitized solar cells and the basic outside factor. We did an experiment that we thought could relate to something aimed at a practical understanding from the result.

2. Method of Study:

We made simple dye-sensitized solar cells, and they were illuminated by the light of the projector in a dark place based on preceding studies. (Graph 1)

We divided the experiment into three cases.

【Ⅰ】Normal temperature (about 30℃)

【Ⅱ】High temperature (about 50℃)

【Ⅲ】Low temperature (about 10℃)

We measured these temperatures with a radiation thermos meter and an electromotive force with a digital multi-meter. In addition to the measurement, these results were compared.

Experiment-1: A Comparison of Electromotive Force for Each Temperature

Experimental Process

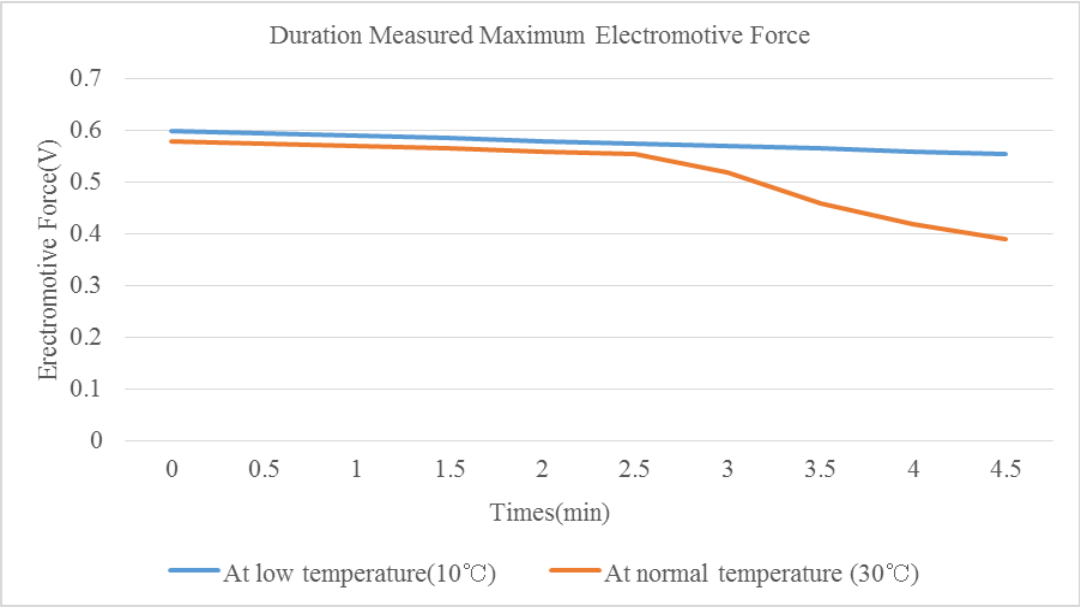
- We made simple dye-sensitized solar cells.
- We kept the distance between the solar cell and light source to 7cm.
- We irradiated a yellow-green light to the solar cell.
- We recorded the change in the electromotive force when the temperature was changed

.

Result-1

- When the temperature is high (battery ambient temperature is about 50℃), clearly the electromotive force had dropped.
- No clear difference was seen between room temperature and the low temperature.

Thus, we experimented a second time to find the duration of the constant electromotive force for these two cases.



Experiment-2: Battery Duration from Maximum Electromotive Force

- We placed a projector , which is the light source, in a styrofoam box suitable for heat retention to prevent the heat of the projector from affecting the battery.
- We irradiated the battery with light in the dark.

Result-2:

- From the graph, at room temperature, the electromotive force dropped significantly after 3 minutes.
- At low temperature, the electromotive force did not change much after 4 or 5 minutes.

3. Consideration・Summary:

We put the projector in styrofoam to intercept the heat emitted from it (experiment②). As a result, the maximum voltage was higher and the battery duration was longer at low temperature. It is considered that this is because the low surface temperature of the battery allowed the deterioration of the function of the semiconductor to be delayed as compared with that at room temperature.

From this result, it was found that the temperature influences the semiconductor of the dye-sensitized solar cell, and it lasts longer when the temperature is lower than room temperature. For that reason, when power is generated using the dye-sensitized solar cell, the surface temperature rises due to the irradiation light, and the function of the semiconductor deteriorates. Therefore, it is recommended to use it at a low temperature such as with a frozen mixture. In the future, we would like to study what kind of changes will occur if the temperature is further lowered.

4. References:

・2013　Yashiro High School,　Dye-sensitized Solar Cell Research Team,　Leading Research
・Mechanism of dye-sensitized solar cell ／Peccell Technologies
・Dye-sensitized solar cell ／SHARP

Toward the utilization of electricity generating bacteria

-Development of a simple generation confirmation method-

Researchers：Miyajima Ryota,Takeda Hiroka, Takeuchi Kaiki

Teacher：Nagayama Koki

1. Purpose

We focused on the bacteria (electricity generating bacteria) that live in rice fields and have the ability to generate electricity. It is known that these bacteria discharge an electron when decomposing organic matter, thanks to some research at Tokyo Pharmaceutical University.

From this research, we also learned that it was necessary to use a complicated device to confirm the power generation capacity of this bacteria. So we decided to find a way to make confirm this information easily. If successful, it can be used as a method to search for new useful power-producing bacteria in soil. We proceeded with our research, thinking that it might lead to the production of a simple microbial battery.

2. Material & Methods

First, we tried to determine whether or not the power generation capacity of these electricity generating bacteria that inhabit soil could be easily measured with a digital multimeter. However, we found that this method made it impossible to determine whether the obtained voltage was due to microorganisms or other substances such as metal ions, so we abandoned the experiment using soil.

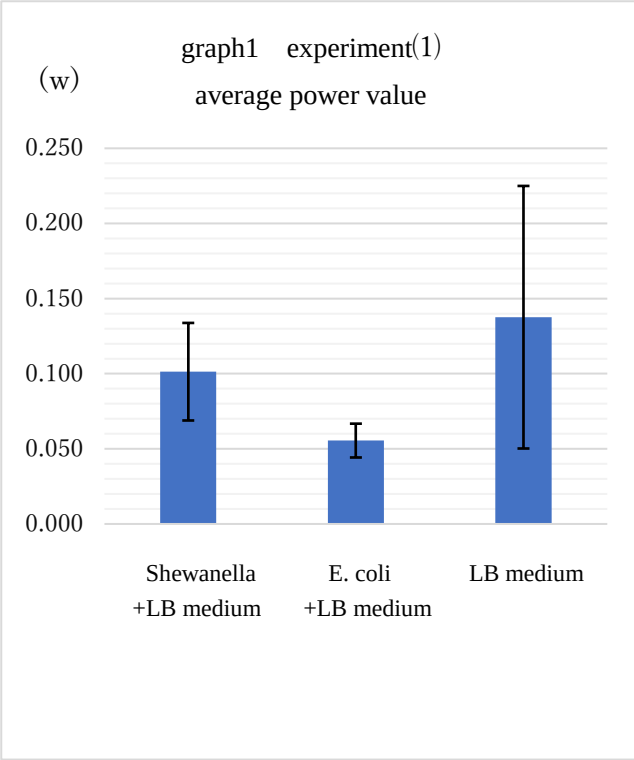
Next, we shifted our experiment in which the electrodes of the voltmeter were inserted into LB medium in which Shewanella was incubated in the laboratory. As a negative control, we compared just the LB medium and culture fluid of E. coli with Shewanella. In some cases, the culture fluid of Shewanella sometimes showed higher numerical values than others. But the value changed greatly each time, and the sample containing only the medium often had the highest value. It was found that this method was greatly affected by the subtle distance between the two electrodes and other uncertain factors.

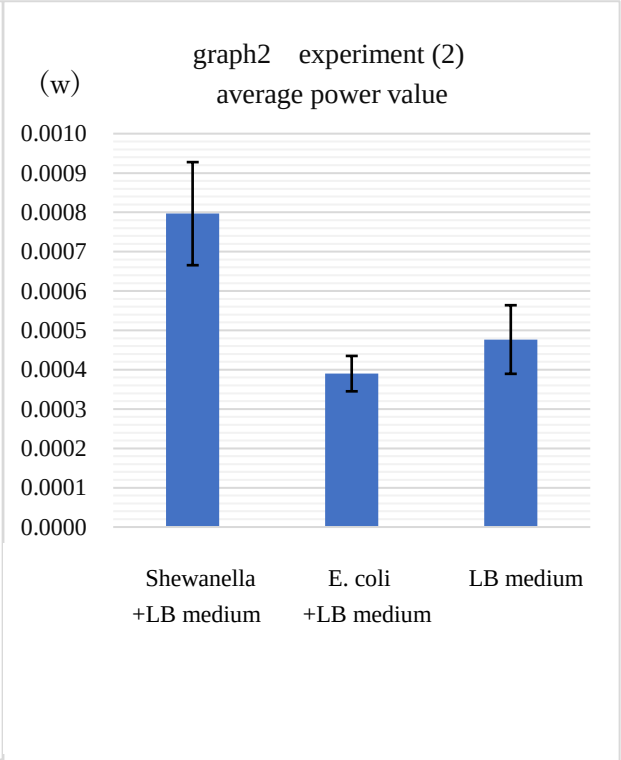
Based on the results of these two preliminary experiments, we thought that the method of inserting an electrode in a liquid medium would cause cells to float and a stable numerical value could not be obtained. Therefore, as a simple battery experiment, we decided to make a model of the famous 1-yen and 10-yen coin batteries. Since the electricity generating bacteria emit electrons, we used it as a negative electrode instead of the one-yen coin. In fact, we decided to serve it as both an electrolyte containing bacteria and a negative electrode and electrolyte. We thought that this could make the distance of Shewanella in the medium from the electrode plate constant.

Experiment (1) Place a 10-yen coin on aluminum foil, and put a medium containing bacteria or a paper towel soaked with only the medium on it. One electrode was pressed against a ten-yen coin and the other was pressed against the paper towel, and the current and voltage were measured.

Experiment (2) Use a well-polished flat copper plate instead of the 10-yen coin without using aluminum foil for the experiment. As for other conditions, the current and voltage were measured in the same way, and the power was calculated based on the formula of current × voltage = power.

３． Results





In experiment (1) graph 1 shows that Shewanella has greater power than E. coli. But, we found that the error is particularly large for samples containing only the medium. We thought unevenness and rust on the ten-yen coin might cause error. So in experiment (2), we prepared a copper plate with a flat surface, we used it and polished it well after each experiment. The results are as follows. Graph 2 shows that standard error has decreased. And, we could show Shewanella has grater electric power than the others.

Graphs 1 and 2 show the average value and standard error (error bar) of the three experiments. In Graph 2, there is margin of error between the medium alone and E. coli but Shewanella has greater electric power than the others.

4. Consideration

There was a big difference in power value because microbes are living things. We thought that temperature might have an influence on numerical value. Shewanella is Anaerobic bacteria but we had it generate electricity in an aerobic environment so that we can use it easily.

5. Outlook

We would like to consider a measurement method with higher reproducibility by controlling the conditions such as changing metal.

Why do the Japanese live so long?

～From the viewpoint of statistics, compared with other countries～

Researchers Tsubata Akari, Harayama Yumeka
Ikeda Chiharu, Maruyama Yuzuki
Instruction teachers Katsuyama Tadahito
Miyazawa Yuta

１． Outline and purposes of the research.

We had an interested in Japan’s average lifespan, which is the longest in the world. So, we wondered what matters affect it. First, we researched the relationship between the average lifespan of some other countries and the BMI of each of them.

The result shows that Japan is different in the general tendency. The general tendency is that a country which has high percentage of obesity has a long average lifespan.

However, Japan is different. Japan has low percentage of obesity, but the average lifespan is long. So, we started a research on the relationship between Japan’s average lifespan and things in addition to BMl.

2. Research content・Research method

We looked into connections between Japan’s average lifespan and various things.

1)The connection between the average lifespan and obesity

2)The connection between the average lifespan and the number of doctors per 1,000 people

3)The connection between the average lifespan and average annual working hours

4)The connection between the average lifespan and nutrient intake

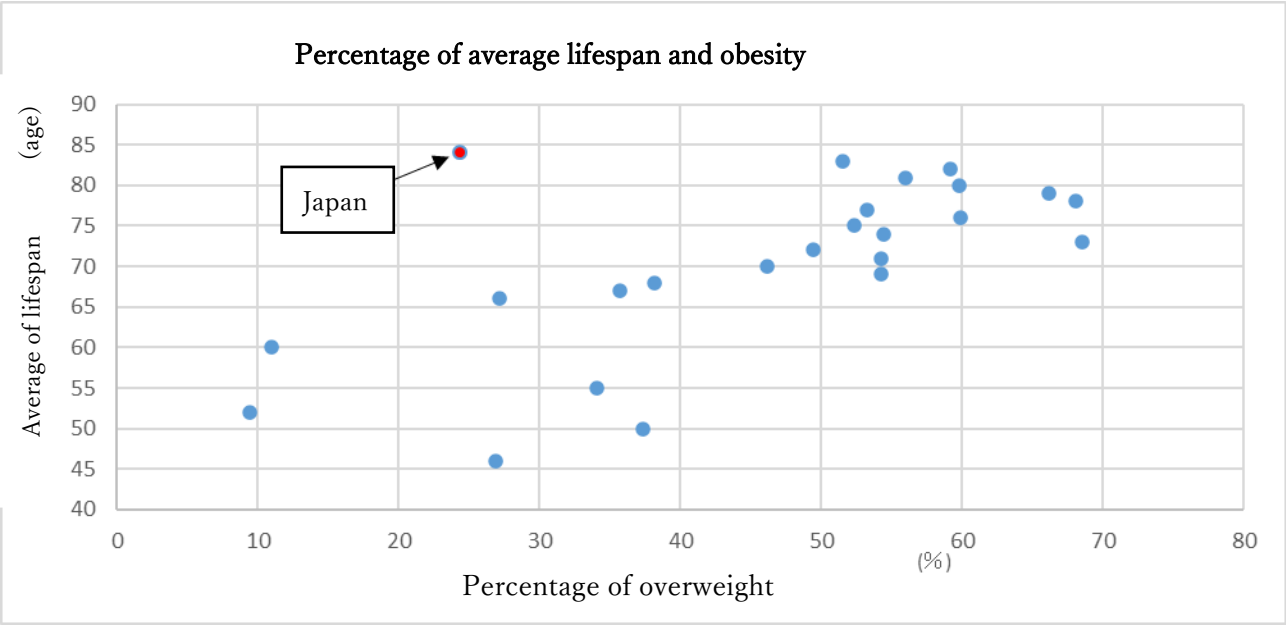
5)The connection between the average lifespan and total medical expenses per person

3. Findings ・Consideration

１） the connection between the average lifespan and obesity

Obesity is the condition where overly fat is stuck to adipocyte and Body mass index is

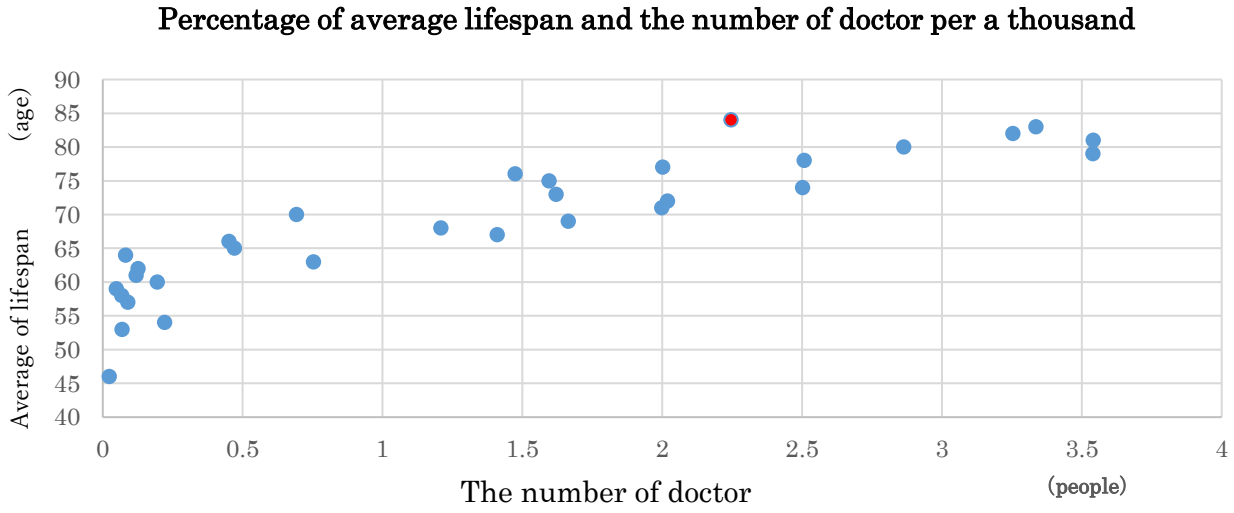
(BMI=weight〔kg〕/ height^2〔m〕≧25)



This graph shows that the country which has the percentage of obesity is high lifespan is long.

→However, Japanese average lifespan is long despite the low percentage of obesity.

2） the connection between the average lifespan and the number of doctors per 1,000 people.

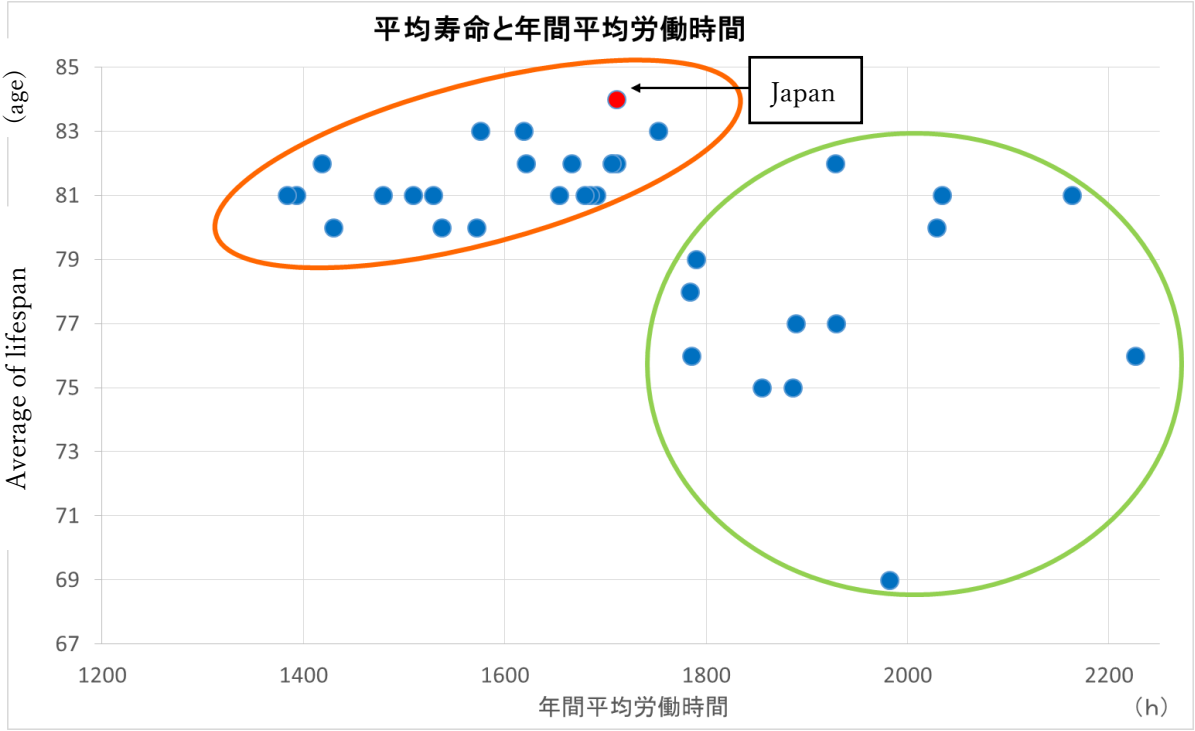


On the whole, this graph shows that the country which has a lot of doctor has comparatively long average lifespan.

→Japan has also many doctors, so the average of lifespan is long:

3） the connection between the average lifespan and average annual working hours.

Average lifespan and an average of working hours annually



※Average annual working hours do　Average of working hours annually

・①･･･Short average annual working hours, long average lifespan

・②･･･Long average annual working hours, short average lifespan

・Japan belongs to ① → Japan's average lifespan is long inspite of long average annual working hours.

4. Summary

	Ratio of obesity	The number of the doctors	Hours worked per year	Ratio of nutrients	Total medical expenses
The comparison of Japan with other countries	**Different tendency →Japan has low ratio of obese people, but the average life expectancy is long.**	**Similar tendency →a country with more number of the doctors has a long average life expectancy.**	**Similar tendency →If an average life expectancy is long, working hours are short.**	**Similar tendency →The relations between the ratio of nutrients and the average life expectancy are not seen.**	**Among the countries whose average lifespan is close to Japan's life expectancy there seems to be no particular similarity in total medical expenses. So we can say life expectancy is not related to total medical expenses.**

※We omitted the publication of the graph of 4) 5) of study contents.

5. References

・Life expectancy (2012)

http://top10.sakura.ne.jp/WHO-WHOSIS-000002R.html

http://top10.sakura.ne.jp/WHO-WHOSIS-000010R.html

・An average of working hours(2012)

http://top10.sakura.ne.jp/OECD-HOURSWKD-T1.html

・Ratio of nutrients (Japan 2005, others 2003)

http://www.maff.go.jp/j/wpaper/w_maff/h18_h/trend/1/t1_1_3_01.html

・Total medical expenses (2012)

http://top10.sakura.ne.jp/WHO-WHS7-156.html

・The number of doctor per a thousand.(2010)

http://top10.sakura.ne.jp/IBRD-SH-MED-PHYS-ZS.html