# Recurrence Formula Including Squared and Cubic Terms

～The limit changes with the value of the first term～

Researchers: Nanami Sakaguchi / Akira Shimozaki / Takuya Miyagawa / Miki Miyasaka

In this study, we focused on the number of intersection points of the recurrence formula graph ①, and divided cases (y=x…①). We will explain the two characteristic cases this time.

I. When the recurrence formula including squared terms intersects with ①.
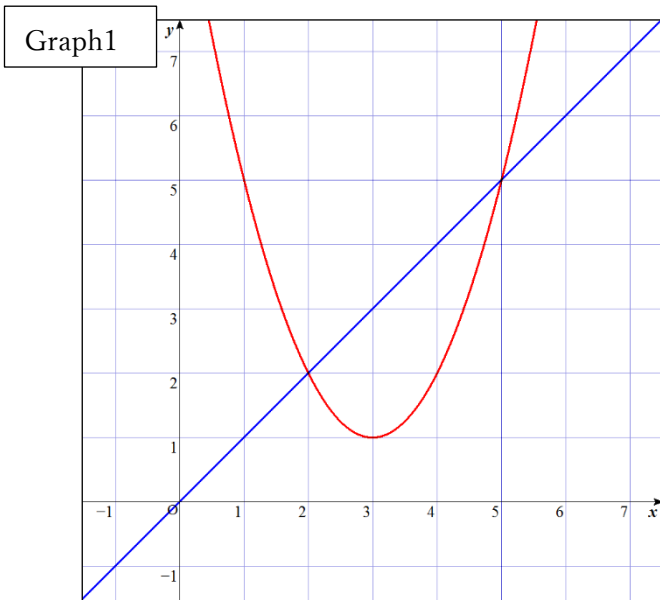
Graph1

We graphed this sequence by considering $a_{n+1} = a_n{}^2 - 6a_n + 10$ as $y = x^2 - 6x + 10$. (Graph1).

This graph intersects with ① at two points of (2, 2) and (5, 5).

Then we divide cases where we focus is on the first term,

$$\lim_{n \to \infty} a_n = \infty \, (a_1 < 1)$$

$$\lim_{n \to \infty} a_n = 5 \quad (a_1 = 1)$$
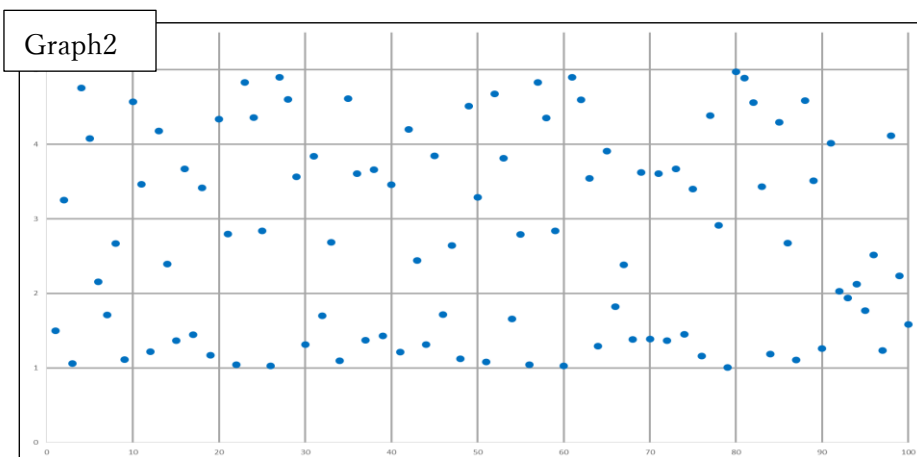
The limit is not fixed $(1 < a_1 < 2)$

$$\lim_{n \to \infty} a_n = 2 \quad (a_1 = 2)$$

The limit is not fixed $(2 < a_1 < 3)$

$$\lim_{n \to \infty} a_n = 5 \, (a_1 = 3)$$ 　The limit is not fixed $(3 < a_1 < 4)$

$$\lim_{n \to \infty} a_n = 2 \quad (a_1 = 4)$$ 　The limit is not fixed $(4 < a_1 < 5)$

$$\lim_{n \to \infty} a_n = 5 \quad (a_1 = 5)$$ 　　　$$\lim_{n \to \infty} a_n = \infty \quad (a_1 > 5)$$
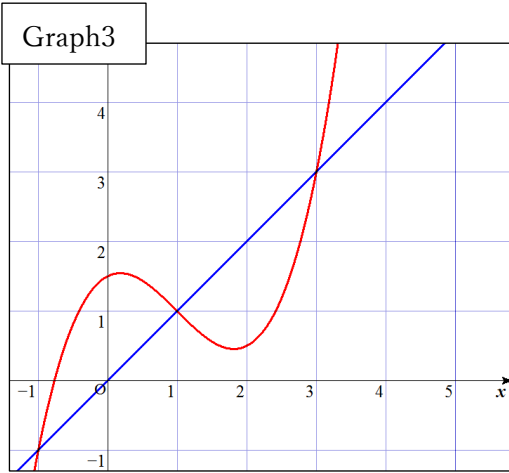
Graph2

Here, we considered the behavior of the value of the term when the limit value is not determined. When the limit value is not determined, $1 < a_1 < 5$ and $a_1 \notin \mathbb{Z}$ ($\mathbb{Z}$ is integer) Graph2 shows the values up to the 100th term when $a_1 = 1.5$. In this case, $1 < a_m < 5$ ($1 < m < 100$ and m is $\mathbb{Z}$) We supposed that when the recurrence formula,

including squared, terms intersects with ① and the value of the first term is the same as A or B, the limit value is determined. (A…the value of the point of intersection 　B…the value of the vertex) We supposed that when the recurrence formula including squared terms intersects with ① and the value of the first term is between the biggest A and

B, the limit value is not determined, but a_n is between A and B and is not the same value.　　We also experimented with other recurrence formulas. As a result, our assumptions are not inconsistent with each other.

II. When a recurrence formula including　cubic terms intersects with　① at three points.

Graph3

We graphed this sequence by considering

$$a_{n+1} = \frac{1}{2}a_n^{\ 3} - \frac{3}{2}a_n^{\ 2} + \frac{1}{2}a_n + \frac{3}{2} \quad \underset{\text{as}}{\quad} y = \frac{1}{2}x^3 - \frac{3}{2}x^2 + \frac{1}{2}x + \frac{3}{2}.$$

（Graph3）

This graph intersects with ①at three points of $(-1,-1)$、$(1,1)$ and $(3,3)$.　　Then we divide cases where we focus on the first term,
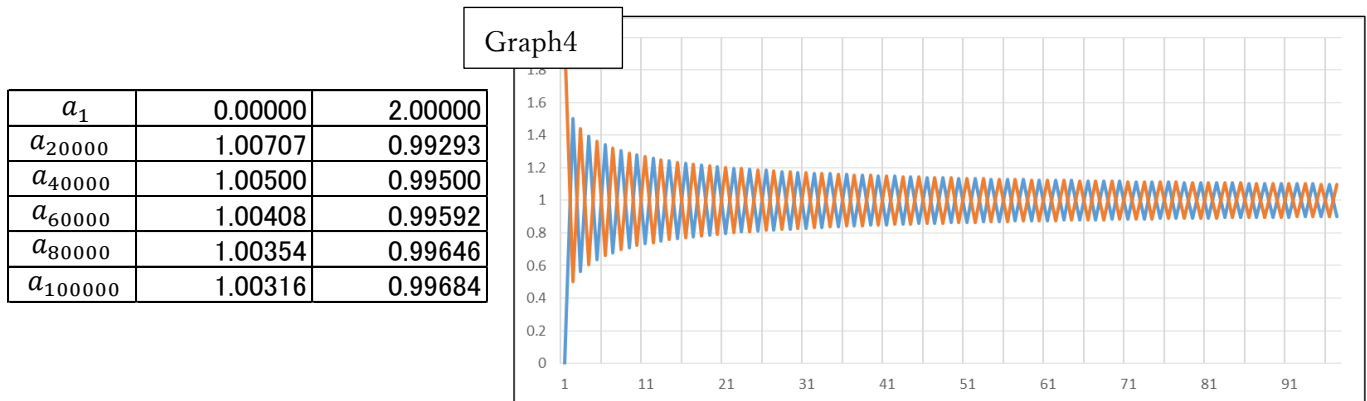
$$\lim_{n\to\infty} a_n = -\infty \, (a_1 < -1)$$

$$\lim_{n\to\infty} a_n = -1 \, (a_1 = -1)$$

The limit is not fixed　$(-1 < a_1 < 1)$　　　　$\lim_{n\to\infty} a_n = 1 \, (a_1 = 1)$

The limit is not fixed　$(1 < a_1 < 3)$　　　$\lim_{n\to\infty} a_n = 3 \, (a_1 = 3)$　　　$\lim_{n\to\infty} a_n = \infty \, (3 < a_1)$

　　Here, we considered the behavior of the value of the term when the limit value is not determined. When the limit value is not determined,$-1 < a_1 < 3$. Graph 4 shows the values up to the 100th term when $a_1 = 0,2$. In this case, a_m approach 1.　We supposed that when $a_1 = 0, 2$, a_n gradually approaches 1.　The list shows a_n gradually approaches 1.　We supposed that when the recurrence formula including cubic terms intersects with　① if the value of the first term is same as A, limit value is determined, if it is between the smallest A and the biggest A, the limit value is not determined, but a_n gradually approaches middle A. When $a_1 = 0, 2$, how to approach to a middle term is similar. We supposed that how to approach to a middle term of two terms, when the distance is equal from a central term, is similar.　We also experimented with other recurrence formulas.　As a result, our assumptions are not inconsistent with each other.

a_1	0.00000	2.00000
a_{20000}	1.00707	0.99293
a_{40000}	1.00500	0.99500
a_{60000}	1.00408	0.99592
a_{80000}	1.00354	0.99646
a_{100000}	1.00316	0.99684

Graph4

The Way to Know the Graph Outline by Differentiating

~Easy ways to get the graph outline~

Researchers: Miyami Iijima / Riko Kazama / Aduki Shimizu

1. Research Outline and Objectives

We learned differentiation to draw the graph. But it was hard to calculate a function.   Then we thought that we can find the way to know the graph outline with a little calculation.   And we researched the way to solve the extreme easily and to omit the calculation by drawing many kinds of functions.

2. Research Content and Method

Ⅰ. Researching the way to get the extreme easily and to cut the calculation by drawing the graph of fractional function, multiplicational function and composite function.

(1) Fractional function

　　Guess the formality in which we are able to calculate the number of the x of extreme.

(2)　Multiplicational function

　　Guess the formality by using the result of (1).

(3)　Composite function

　　Guess the formality by using the result of (1),(2).

　　Examine whether the result of (1),(2) and (3) are correct.

Ⅱ. Research the way to get the graph outline.

　　【The concept of curve asymptote】

　　It is easier to think about an asymptote which has low degree functions than to think primitive function.

　　In order to know the graph outline easily, we created the concept of curve asymptote multiplicating graph by graph.

　　Taking care of plotting the intersection point on x axis and plus and minus and guess the graph outline without differentiation.

3. Result

Ⅰ.【Fractional function1】~Create an increase/decrease table and find the extreme value.

We think about the rule from function: $y = x - 1 + \dfrac{1}{x-6}$

First we differentiate the function to create an increase/decrease table (Table1) and create a graph.(Graph1)
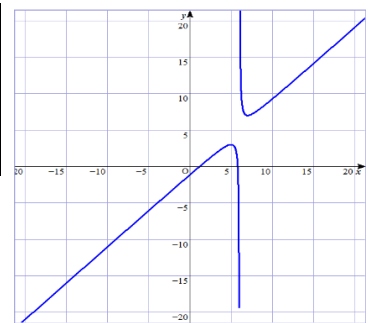
$$y = x - 1 + \frac{1}{x-6} = \frac{x^2 - 7x + 7}{x-6}$$

$$y' = 1 - \frac{1}{(x-6)^2} = \frac{x^2 - 12x + 35}{(x-6)^2}$$

When y'=0

$x = 5$, $x = 7$

x		5		6		7	
y'	+	0	−	/	−	0	+
y	↗	3	↘	/	↘	7	↗

(Table1)

From (Table1), (Graph1), it takes the maximum

Value 3 when x＝5, the minimum value 7,when $x = 7$

(Graph1)

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【Fractional function2】~Easily investigate the formula to find extreme value.

We divide function $y = x - 1 + \dfrac{1}{x - 6}$ into a function of a numerator

$f(x)$ and a function of a denominator $g(x)$.

We thought that there is something related to the slope of the tangent line at

$x = 5$, $x = 7$ of $f(x)$, $g(x)$.

$f'(x) = 2x - 7$, $g'(x) = 1$ when $x = 5$、 $\dfrac{f'(5)}{g'(5)} = 3$, when $x = 7$ $\dfrac{f'(7)}{g'(7)} = 7$

The value agreed with the maximal value and the minimum value found in 【Fractional function 1】.

Therefore, the following hypothesis can be made. $\dfrac{f(x)}{g(x)} = \dfrac{f'(x)}{g'(x)}$

We found this function $\left\{ \dfrac{f(x)}{g(x)} \right\}' = \dfrac{f'(x)g(x) - f(x)g'(x)}{\{g(x)\}^2} = 0$.

Using this method, we examined the synthetic function of the composite function and the product, and such a hypothesis was made.

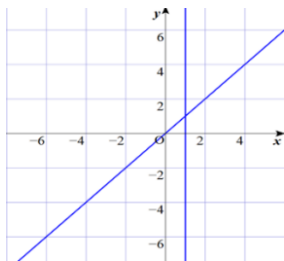$\{f(x)g(x)\}' = f'(x)g(x) + f(x)g'(x)$ $\rightarrow$ $\dfrac{f(x)}{g(x)} = -\dfrac{f'(x)}{g'(x)}$

$\{f(g(x))\}' = f'(g(x))g'(x)$ $\rightarrow$ when $\{f(g(x))\}' = 0$ $f'(g(x)) = 0$ or $g(x)' = 0$

Ⅱ （1） The concept of asymptotes

The asymptotes are a straight line that the distance between the curve and the line approaches zero infinitely and it doesn't match the graph you want to obtain.
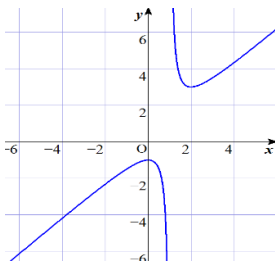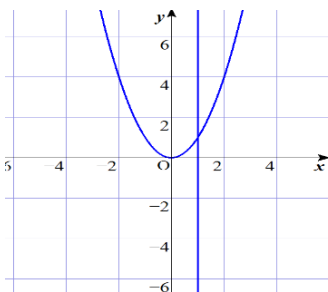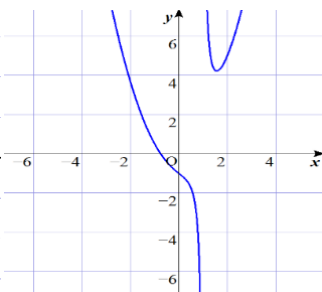

(Graph2)   (Graph3)

From the two graphs, you can see that the outline of a graph you want to obtain is shaped along the asymptotes. We thought that asymptotes which are not straight are useful for finding the graph. Here, we call them "asymptote curve." We investigated the asymptote curves ①～③.

【asymptote curve ①】 The asymptotes are a quadratic function and a straight line.
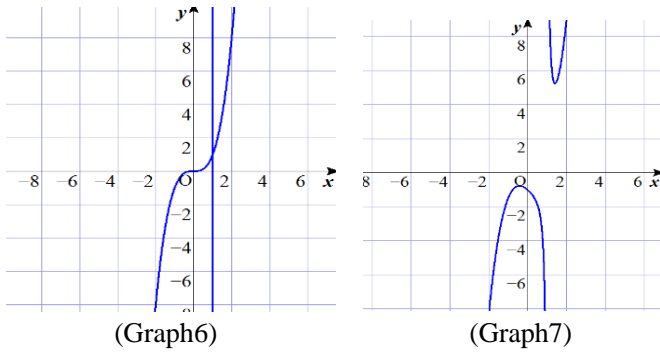

(Graph4)   (Graph5)

$$y = \frac{x^3 - x^2 + 1}{x - 1} = x^2 + \frac{1}{x - 1} \quad \rightarrow$$

Asymptote curve $y = x^2$, $x = 1$ (Graph4)

The asymptotes of Graph5 are those of Graph4.

【asymptote curve ②】

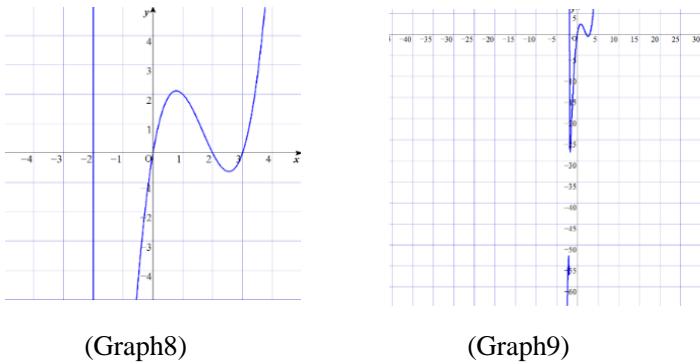The asymptotes are a cubic function without an extreme value and a straight line.

(Graph6)

(Graph7)

$$y = \frac{x^4 - x^3 + 1}{x - 1} = x^3 + \frac{1}{x - 1} \ \rightarrow$$

Asymptotes curve $\quad y = x^3, \quad x = 1$ (Graph6)

The asymptotes of Graph 7 are those of Graph 6

【asymptote curve ③】

The asymptotes are a cubic function with an extreme value and a straight line.

(Graph8)

(Graph9)

$$y = \frac{x^4 - 3x^3 - 4x^2 + 12x + 1}{x + 2}$$

$$= x^3 - 5x^2 + 6x + \frac{1}{x + 2}$$

➔ asymptote curve

$y = x^3 - 5x^2 + 6x$, x=-2 (Graph 8)

Asymptotes of Graph 9 are Graph 8.

(2) Graph of multiplication

We investigated the multiplication graph separately for f(x) and g(x).
For example, y=xsinx ➔ f(x)=x, g(x)=sinx (Graph 10)
You can write the outline of the graph you want to obtain from
the intersection of the x axis and the range of sinx. (Graph 11)
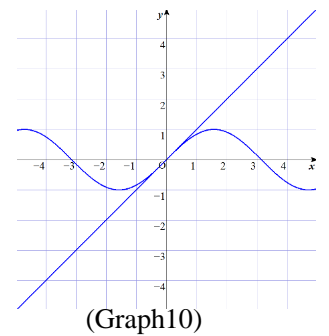
(Graph10)

4 Conclusion

Ⅰ. We found the formality to get the extreme.

It is effective in checking calculations.

Ⅱ. We got the results that we could know the graph outline.
It is sometimes effective, but conventional calculations are
sometimes easier than our method, so we want to research more.

(Graph11)

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Let's Go Deep into the Math World!!!

~Using knowledge of daily math classes~
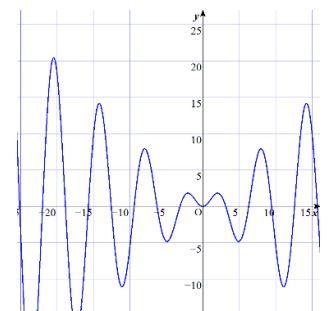
Researchers: Shii Suzuki / Takashi Nishizawa / Satoru Koizumi / Yuta Ito / Riku Sato

\<Background and Motive of this research\>

When we were searching for the theme of research during studying high school math, we came to want to consider generalizing the "Sigma Deployment Formula", which has no formula corresponding to any power, and setting about "Collatz Problem," which has been the problem not solved ever.

A. Sigma Formula

1. Definition of words and letters

We call Sigma expansion formula, that is, the expression $\sum_{k=1}^{n} k^a$ (Here in after, let $\sum_{k=1}^{n} k^a$ be $\sum k^a$) of the sum of each power series "Sigma Formula." (Example; $\sum k^2 = \frac{1}{6}n(n+1)(2n+1)$, $\sum k^3 = \{\frac{1}{2}n(n+1)\}^2$)

Expand $\sum k^a$ and set it as "first term, second term, …, b th term" in descending order of degree on n. (Example; $\sum k^2 = \frac{1}{6}n(n+1)(2n+1) = \frac{1}{3}n^3 + \frac{1}{2}n^2 + \frac{1}{6}n$), which are the first term, the second term, and the third term, respectively.

  *Expression after expansion of Sigma Formula is assumed to be arranged in descending order of degree of $'n'$.

  If a=1, 2, 3, ..., 7 is changed and aligned, Table 1 can be obtained.

2. Process and Result of the research

(1) The Basic laws which we found

- $[\frac{a}{2}]+2$ expresses term numbers by using "Gauss symbol [ ]"

- There is no constant when you expand the "Sigma Formula".

- The first three terms is all positive, which is followed by negative, positive, negative, positive, ..., and it continues like that. =①

- The way degrees of $'n'$ of each term appear is that the $'a'$ appears, then a degree opposite to the even number, odd number appear from $(a+1)$ power to smallest natural number power. (Example; When $'a'$ is 8, "9,8,7,5,3,1" appear as the degree) =②

(2) Result of the research

Considering ①② of (1), we found that the way signs (positive or negative) and degrees appear is different between "first term to third term" and "after fourth term", and we thought dividing like this would be better to consider, so we divided in that way.

Ⅰ. "First term to third term"

- "First term" is represented by $\frac{1}{a+1}$.

- "Second term" is all $\frac{1}{2}$.

- "Third term" is represented by $\frac{a}{12}$.

Ⅱ. "after fourth term"

It is easier to consider with dividing coefficient of each terms into denominator and numerator, so we did the dividing. And, <Table 2> is made by looking at <Table 1> vertically, and forming the numbers which is reduced to the lowest common denominator by each terms and divided into denominator and numerator.

(i) the numerator

We defined the vertical line involved in the numerator of <Table 2> as "4th term, 5th term, 6th term, ..., $'x'$th term". We watch this line as some sequence and considered. When we took progression of differences of "$'a'$th term" and took it again, we got the sequence of "$(x-1)$'th term". Also, because the progression of differences of "4th term" was {(First term) $+\sum_{k=1}^{x-1}k$}, basing on it, we found the general terms of "4th term" sequence {x=4}, the sequence above "4th term" (It is the progression of differences of "5th term") {between x=4 and x=5}, and "5th term" sequence {x=5}.

{x=4}　　　　　{between x=4 and x=5}　　　　　{x=5}

$$\frac{a(a-1)(a-2)}{6} \qquad \frac{a(a-1)(a-2)(a-3)}{24} \qquad \frac{a(a-1)(a-2)(a-3)(a-4)}{120}$$

Then, when we multiplied {x=4} by $\frac{a-3}{4}$, {between x=4 and x=5} appeared, and, when we multiplied it by $\frac{a-4}{5}$, {x=5} appeared.

Therefore, the general term of numerator of "$'x'$th term" is, we have created, as follows;

$$\boxed{\frac{a(a-1)(a-2)\dots(a-m+2)}{(m-1)!}}$$

$\left\{\begin{array}{l} \text{About } 'm', \ m=2b-4 \\ \text{(This } 'b' \text{ means "}'b'\text{th term", and } \ 'b'≧4) \\ \text{*We have not proven this yet.} \end{array}\right.$

(ii) the denominator

We lined up the denominator in <Table 2> to "10th term" and made <Table 3>, but we could not find out its regularity.

From the above, the coefficient of "$'b'$th term" which expanded the "Sigma Formula" of $'k'$'s $'a'$ power is as follows;

$$\boxed{\frac{1}{d} \cdot \frac{a(a-1)(a-2)\dots(a-m+2)}{(m-1)!}}$$

Saying about {d}, you should substitute the figure in <Figure 3> which is corresponded.

3. Future Prospects

We want to prove this formula, and make the formula of denominators as the future research.

B. Collatz problem

Collatz problem is what will happen when we take an arbitrary natural number N and perform the following manipulation .

Manipulation : (1)when "N" is an even number・・・n/2

(2)when "N" is an odd number・・・3n+1

To Collatz problem, conjecture as that "even if we take any initial number and do manipulation above here, the number will eventually reach "1" within the limited manipulation. (and enters a loop that) "1→4→2→1→・・・" is called Collatz conjecture.

<ex> if we take initial number N =3

"3→(3×3+1=)10→(10/2=)5→(5×3+1=)16→8→4→2→1(→4→2→1→・・・)" the loop "4→2→1→・・・" is repeated infinitely.

We decided to call from now the arrangement, when we perform the manipulation repeatedly, "Collatz sequence".

In this instance, like the normal sequence, we decided to write the initial number "N"=C_1=3 and note the number which appear K_{th} C_k.

According to the previous research, there are two counterexamples.

These are as follows.

❶Occasion that Collatz sequences diverge infinitely.

❷Occasion that loops (except 1→4→2→1→・・・) appear .

Therefore, we should show that two counterexamples don't appear.

[The achievement of Collatz conjecture]

We decided to prove Collatz conjecture indirectly by considering a paraphrase of Collatz conjecture and proving it.

A paraphrase proposal plan is as follows.

[When we define any arbitrary positive integer "N"(N≠1) as first term of the Collatz sequence , even if this sequence brings any N, M that becomes M<N surely appears.

*We decided to call this paraphrase proposal "C conjecture."

It is already proved that "C conjecture become paraphrase of Collatz conjecture."

And, about one of the advantage of C conjecture, among the two counterexamples of Collatz conjecture, there are points that we need not consider "Occasion that loops (except 1→4→2→1→・・・) appear," which is already proved.

Next, about the proof of C conjecture, proof when C_1= (by dividing by 4, three more number) has not proved yet. However, if this remaining proof is completed, the C prediction is fully proved.

<< The tables >>

	1st term	2nd term	3rd term	4th term	5th term
$\sum k$	$\frac{1}{2}$	$\frac{1}{2}$			
$\sum k^2$	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{1}{6}$		
$\sum k^3$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$		
$\sum k^4$	$\frac{1}{5}$	$\frac{1}{2}$	$\frac{1}{3}$	$-\frac{1}{30}$	
$\sum k^5$	$\frac{1}{6}$	$\frac{1}{2}$	$\frac{5}{12}$	$-\frac{1}{12}$	
$\sum k^6$	$\frac{1}{7}$	$\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{6}$	$\frac{1}{42}$
$\sum k^7$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{7}{12}$	$-\frac{7}{24}$	$\frac{1}{12}$

<Table 1>

numerator	4th term	5th term	6th term
$\sum k^4$	4		
$\sum k^5$	10		
$\sum k^6$	20	6	
$\sum k^7$	35	21	
$\sum k^8$	56	56	8
$\sum k^9$	84	126	36
denominator	-120	252	-240

<Table 2>

b	denominator
4	-120
5	252
6	-240
7	132
8	$-\frac{32760}{691}$
9	12
10	$-\frac{8160}{3617}$

<Table 3>

Wind Power Generation by Savonius – Type Wind Turbine

Researchers: Masakazu Ishikawa / Ryota Uchida / Kenta Sone / Issei Toida / Ryoya Wakabayashi

1 Research Outline and Objectives:

In recent years wind power generation has received attention as a way to generate electricity without producing carbon dioxide emissions. We studied the Savonius wind turbines' impact on the environment and its efficiency in low wind velocity. We constructed a small, desk-sized turbine and measured the amount of power generated at different wind velocities. The result was that the amount of power generated increased as the wind velocity became faster.

2 Contents:

In this age, energy problems are paramount. As a result, hydroelectric and wind power generation are drawing a lot of attention since they do not emit carbon dioxide.

At this time, Savonius wind turbines can be used in natural wind conditions – especially at low wind velocities – and have less of a burden on the environment. We believe this design can be applied to our schools and homes, so we decided to look further into this matter.

3 Method:

In preparation for the experiment, a 5mm polycarbonate plate was used with a wind tunnel produced with the dimensions of 450mm width by 1820mm length. A grid was made with the same material at both ends of the tunnel and adjusted accordingly. The wind turbine was also made with a 5mm polycarbonate plate.

For the part of the generator, we used a copper coil wire with a diameter of 0.2mm wound 1000 times and a neodymium magnet with a diameter of 1.3cm.

Experiments:

Wind Tunnel Experiment:

Using a large fan at one end of the wind tunnel, we measured the wind velocity. The wind velocity was then measured section by section using a lattice. Then, we confirmed the variations of wind velocity at each section and whether the lattice was used or not.

<u>Savonius Wind Turbine Experiment:</u>

Placing the Savonius turbine in the middle of the tunnel we measured the power generating capacity at different wind velocities. We changed the velocity between 0.5m/s to 3.0m/s and measured the electric current and voltage at each velocity.

4 Result:

In the case of inserting the lattice, we confirmed that there was a direct effect from adjusting the tunnel. The power generation from the Savonius wind turbine can be seen in the following graph.

5 Considerations:

The Savonius wind turbine used in our experiment sometimes had low generating capacity. The reason behind this was the low amount of power generation at 2m/s wind velocity is because of the unstable axis. In comparison, the reason for the increase in power generation was a result of a stable spin. This was because of an increase in the number of revolutions on its axis.

5 Future Prospects:

We hope to find the most efficient blade design to generate electricity and then examine its capacity with natural wind.

Research in the Occurrence Factor of a Whirlwind

~ Analysis from differences between water and air ~

Researchers: Tomoya Ihara / Shota Shida / Kairi Tanaka / Aguru Nishibe

1. Purpose

A group of former students did research about the occurrence factor of an eddy by stirring –the relationship of the occurrence factor of an eddy and a whirlwind. We had doubts about using liquid in this experiment of a whirl. Hence, we decided to study about the occurrence factor of a whirlwind by using not water but air with a similar experimental apparatus.

2. Method

Since it is impossible to see the motion of air as it is, we observed the motion by blowing small pieces of paper.

<Experimental Process>

① Put small pieces of paper inside a "コ"- shaped wall.

② Cover this wall with an upside-down water tank.

③ Fan the air in the wall with a blower through a crack under the water tank.

3. Results and Consideration

In this way, however, most of pieces of paper flew out of the wall without whirling at one place and they U-turned. We changed some conditions such as the power of wind, and the place of the blower fan and its angle. However the air hardly whirled.

As a result of trial and error, we found holes on the right and left side walls and the triangular wall inside effective. In particular, the triangular wall corrected the U-turn motion of air and prevented pieces of paper from staying in the corner. In the water, past classmates could give a rise to using a simple "コ"- shaped wall. In the air, however, we could not. We thought the reason for this difference is that cohesion of air is weaker than that of water; therefore air is easy to easy to disperse when effected by power, and is difficult to move when combined into one body, so the power to turn around is weak.

4. Conclusion

According to the two experiments from former students and we did, it is thought that a whirlwind is easy to arise in the place surrounded by walls which has a narrow opening in one direction. However, we can also see whirlwinds in open spaces. Therefore, we would further like to research other factors that generate a whirlwind.

The Miniaturization of an Aluminum Cell
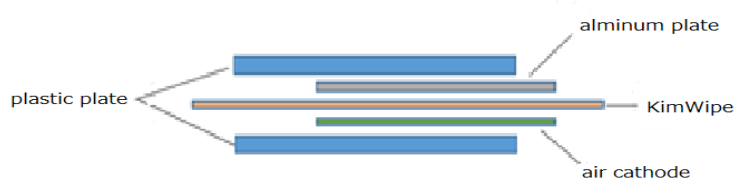
~A Research into its Practical Use~

Researcher: Tomoya Fujimori / Kaito Sato / Ryota Miura

1 An Abstract

Aluminum is a light metal and the third most buried substance of all.   It becomes a trivalent positive ion in aqueous solution and is expected to generate high voltage. We wanted to do research on an aluminum cell because we thought we can make a useful secondary cell with the nature of aluminum for modern people.   Therefore, we made a device and began to measure voltage and electric current under various conditions.

2 Experimentation Method

We made the device shown in the figure below.   We used a 100-mesh net of metal as an air-cathode and an aluminum plate as an anode.   In order to make a more practical cell we experimented many times, changing solvents and solutes.   A KimWipe is soaked into electrolyte in the device.

3 Results and Findings

We found that we could make a practical aluminum cell when we used a stainless steel net plated with platinum as an air-cathode and sodium hydroxide as electrolyte.   But there remained problems about something being produced to stick to an aluminum plate and water being electrolyzed. The aluminum ion conductor $Al_2(WO_4)_3$ is used by a company for making a secondary air-aluminum cell. By using it, we were able to prevent something sticking to the plate from being produced.   However, we were still not able to make a secondary cell because we did not know how to use tungsten acid aluminum to make one.

4 Future Prospects

We wanted to cover an aluminum plate with $Al_2(WO_4)_3$ but it was powder and difficult to use.   So, we are thinking of using a substance which is a dried mixture of polyvinyl alcohol and tungsten acid aluminum.

On Properties of Phenol

~ fixed quantities of Fe^{3+} using salicylic acid ~

Researchers: Reina Osada / Narumi Sakai / Hina Tsuyama / Honoka Nishizawa / Miu Hondo
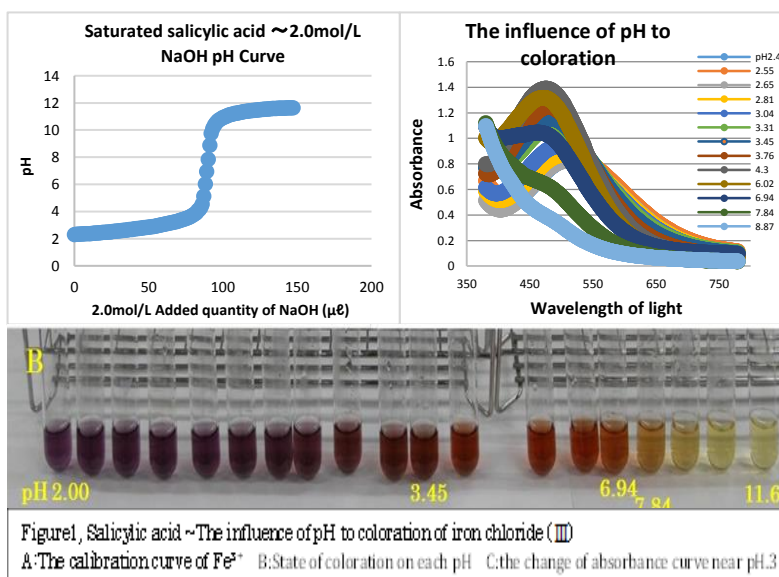
1, An outline of research findings

Iron chloride (Ⅲ) shows very unique colorations with phenols and the reaction depend on the pH of the solution. However, the reaction does not occur when the solution is from neutrality to base, because iron ion into the solution makes hydroxide. Especially, salicylic acid having weak acidity show great buffer action near pH.3 and stable colorations with iron chloride (Ⅲ). We found two salicylic acid ions put Fe^{3+} in order and occur colorations stably, and established the way of fixed quantities of Fe^{3+} using salicylic acid.

2, Motivation of research

Phenol has widely known that they change color into purple-blue by reacting with iron chloride (Ⅲ) liquor. However, our science teachers said the reaction cannot always be successful. So we wanted to know the reason. In addition, we had been interested in colorations for a long time. Therefore, we started to research it.

3, Method

We researched the influence of coloration that iron chloride (Ⅲ) react with phenols of phenol and salicylic acid by variation of pH. And we measured most absorbance accompanied by color changes using an absorbance instrument and tracked them. Also, the presence or absence of coloration was regularly confirmed using metal ion other than iron ion (Ⅲ) in order to confirm whether the color
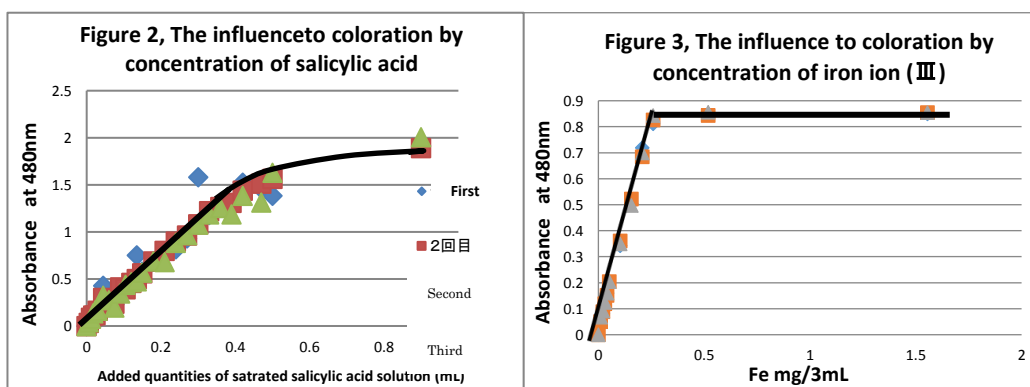

Figure1, Salicylic acid ~ The influence of pH to coloration of iron chloride (Ⅲ)
A: The calibration curve of Fe^{3+} B: State of coloration on each pH   C: the change of absorbance curve near pH.3

reaction of phenols are specific to only iron ion (Ⅲ). Finally, the influence of the concentration of salicylic acid on the coloration reaction under a constant iron chloride (Ⅲ) concentration and the influence on the color reaction of the concentration of iron chloride (Ⅲ) under constant salicylic acid solution concentration were examined by absorbance measurement at pH.3 480nm. It was based on the above a quantitative analysis method of iron ion (Ⅲ) was examined.

4, Results and Examination

The color reaction of phenols and iron chloride (Ⅲ) showed high specificity reaction which did not occur between other metal ions. Also, the color reaction has a large pH dependent and in particular, it was also found that from the neutral to basic region iron ions formed hydroxide and did not color (Figure 1). It was possible to establish a method of fixed quantities of Fe^{3+} using salicylic acid. This is because the coloration of salicylic acid is high in the acidic region compared to phenol and because the buffer action of salicylic acid can be utilized. We assumed that the quantity of total liquid of fixed quantity system is 3mL, added 0.50mL saturated salicylic acid and 2.5mL aqueous solution containing Fe^{3+}, stirred and measured the 280nm absorbance. When we used the data in Figure 3, the inclination was 3.24 [Abs at 280nm / (Fe mg / 3mL)]. Assuming that the absorbance measurement value is A, the weight of iron in 3mL is A/3.24mg. And it was found that reaction ratio without excess or deficiency between Fe^{3+} in Figure 2, 3 and salicylate ion was calculated and it was 1:2. Therefore, this complex is 6-coordinated iron, but salicylate ion was thought to be diametrically opposite to iron ion without steric hindrance.

Figure 2, The influenceto coloration by concentration of salicylic acid

Figure 3, The influence to coloration by concentration of iron ion (Ⅲ)

5, Assignment from now on

We would like to explore weak points of this quantitative method by conducting demonstration experiments of Fe^{3+} quantitative proposal, and we want to aim for further improvement.

Improving the Falling Time by Imitating Maple Seeds
～Focus on the area and mass of samara～

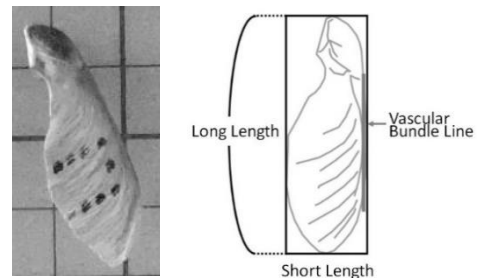Researchers : Tatsuya Miyamoto / Rintaro Takashi / Atsuki Kosakai

１． Purpose

We were interested in maple seeds, which have the structure called samara.When a seed falls down, it is distributed widely because of samara. We researched on the most effective factors of the flight using seeds in the natural environment. And we tried to make paper models to focus on the one factor.

２． Methods

We collected maple seeds and distinguished one by one. We timed more than one hundred seeds three times of each with no wind. We measured some factor of each seed and analyzed that data. The factors are the long and short length, mass, and area, which can be measured simply and objectively. Two of length are based on the line of vascular bundles (tube in plants).

(fig1) model image of measurement

We made paper model to find out factors which are difficult to experiment with real ones.
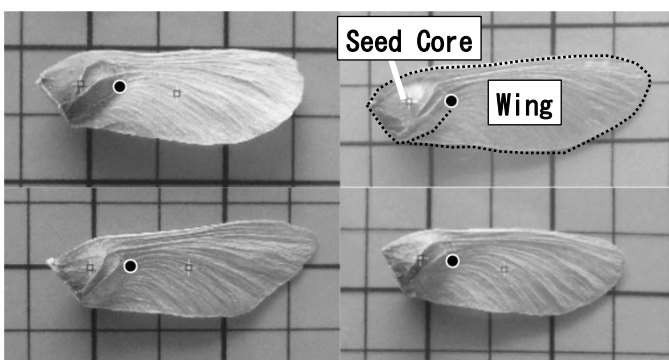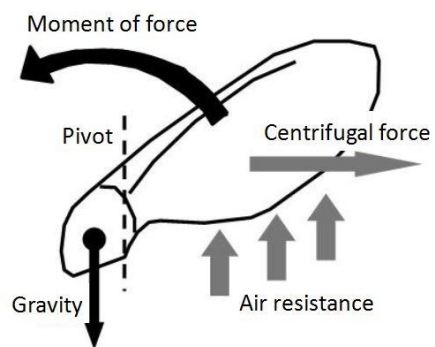

(fig1) model image of measurement

3. Result and Consideration

The seeds collected from trees have a large difference each other in the falling time , even if they are collected from the same tree. The average of time of a fall was 2.6 seconds, which contains over 3.0 seconds in the rate of 7%.

To know the mechanisms of spin, we estimated the center of gravity. It was estimated by using ImageJ soft that it is located in the middle of seed core and wing (fig2). (fig3) shows forces work on a seed. Seed core and wing might shows different behavior to spin.
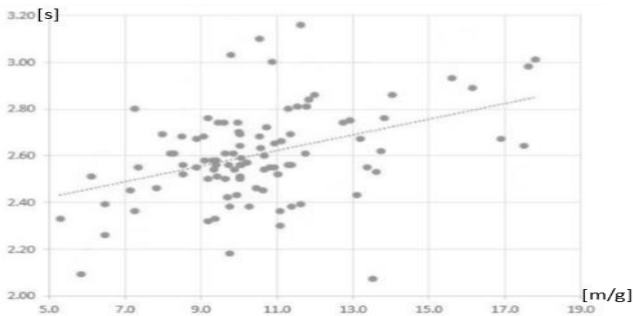

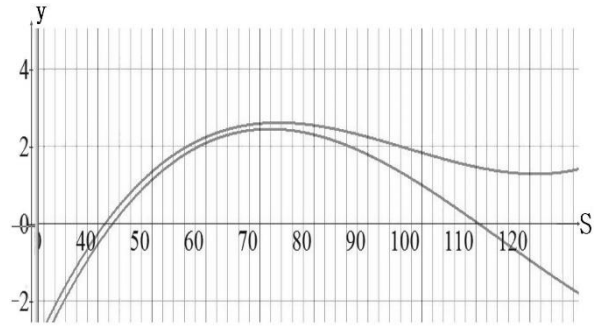(fig2) the center of gravity　(black point)

(fig3) forces work on a seed

We found correlations with some factors. For example, the long length divided by the mass has a correlation with the time (fig4).

(Falling time [s]) = 0.034(long length [cm]) / (mass [mg]) + 2.25

Like this, the area divided by the mass has a correlation. From this data, we got a graph which shows the best value of the area (fig5).

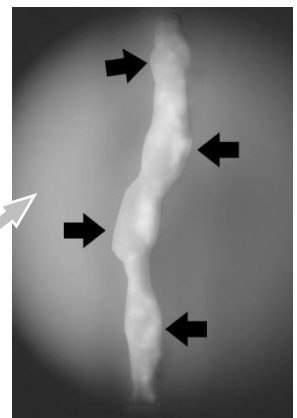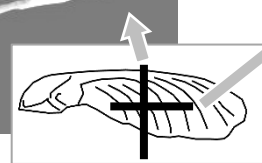(fig4) correlations with long length / mass

(fig5) area [mm^2] and time

We made paper models which copy the shape of seed. And paid attention to ratio of mass. Only to find they would not spin. We noticed that they spin when they have thick parts just like a vascular bundle (tube in plants). So, vascular bundles might play important roles to make seeds spin. Although vascular bundles on the natural seeds are tiny. (It is only 0.2mm of height.) It implies that you have to pay attention to the surface of seeds, which have great influence on spin when you make a model. Paper model spun when the center of gravity and vascular bundles line are considered.

(fig6) cross section
  Left: vertical direction to vascular bundles
  Right: parallel direction to vascular bundles

4．Conclusion

We got some candidate for the biggest factor, but there is no apparent one. So, it was difficult to predict time from the shape of seeds from now.

The factors which they have correlation
  ・Mass
  ・Area
  ・Length of samara in the two directions
  ・Area divide by mass
  ・Long length divided by mass
The factors which seems to have correlation, cannot measured yet
  ・The shape of seed bottom
  ・Surface of wing
It is certain that the factor which shows correlation affects air resistance or balance between gravity. The maple seeds seems to have enough area to fly with well balanced. We want to experiment with a paper model so that this data has large dispersion.

Suppression of Germination by Oats

--Different plant species have different susceptibility to allelopathy.--

Researcher: Hikari Ishida / Sato Kiyono / Miyako Kubota / Mio Sakakibara / Harumi Hanyu

1 Research Summary・Purpose

We took up a biological phenomenon called allelopathy in plants, for we are interested in pesticide-free agriculture. Some plants influence the physiology and ecology of other plants and animals around them by producing and giving off chemical substances, and this function is called allelopathy. It can suppress the growth of other plants in a case and attract or keep off animals and pathogenic bacteria in another. If we can take advantage of this, there is a good possibility of reducing the use of pesticides. However, there are still many things unknown concerning what specific substance has a certain effect and what mechanism the action is based on.

Oats have been known for having some effects of suppressing germination on other plants around them. Previous research at our school made it clear that they definitely influence radish germination.   In this study, we also focused on the oats' allelopathy and tried to examine some other plants which are easy to be influenced.

2 Research Content & Method

We used an incubator in which the internal temperature was kept at 20 degrees.   Sunlight entered inside through a scuttle.   And we used three kinds of seeds --oat seeds, scallion seeds and spinach seeds --on the market.   These seeds were shallowly planted on agar media which do not contain any nourishment.

<How to make agar media >

We put 10g of agar powder into 700cc of water, and melted it while heating.

After all the powder was melted, we poured the solution into a container and kept it cool until it hardened.   We made each medium 5cm deep.

We planted the seeds on crushed agar media early in the research, but thanks to the suggestion of our instructor that using crushed agar media could have an unfavorable influence on the experiments, we used not-crushed ones eventually.

<Control Experiment>

1   We planted 50 seeds of the scallion on one medium and spinach seeds on another in 10 straight lines.

2.   We examined the rate of germination 10 days after we planted them.

<Main Experiment>

1   We planted 10 seeds of the oats straight in the center of one agar medium.

2   10 days later, on one medium we planted 20 seeds of the scallion on either side of the oats in two lines

  2cm away from the oat seeds, and planted spinach seeds in the same way on another medium.

3   We examined each germination rate another 10 days later.

3   Results & Consideration
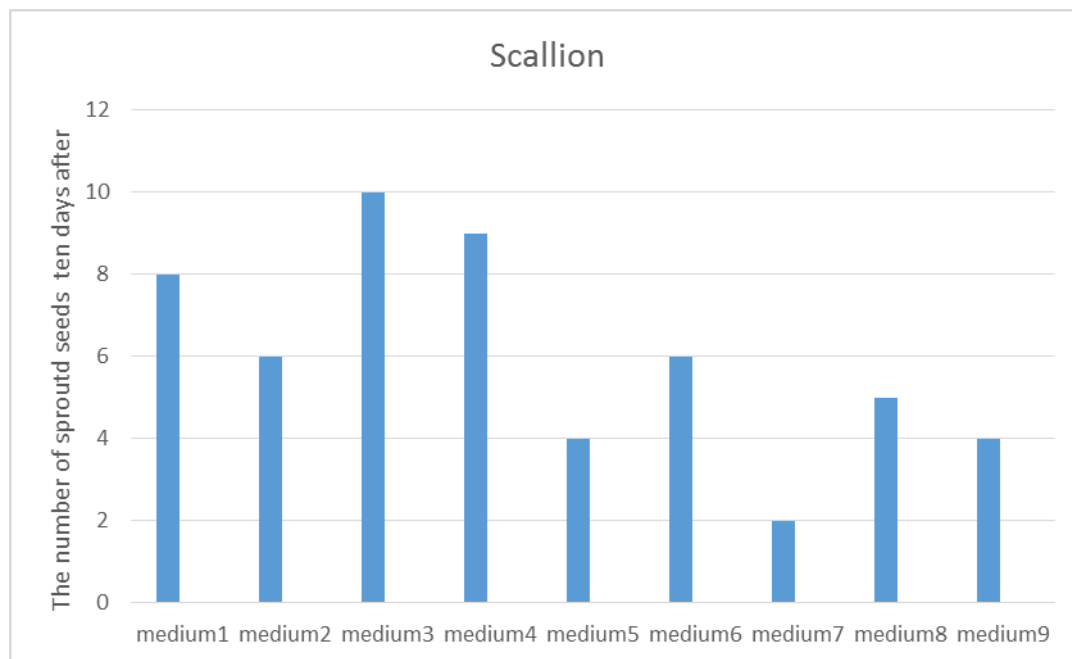
—Scallion—

【Results】

<Control experiment>

1st Experiment：21 out of 50 seeds sprouted.   The germination percentage was 42%.

2nd Experiment：37 out of 50 seeds sprouted.   The germination percentage was 74%.

The average percentage was 58%.

<Main experiment>

6 out of 20 seeds sprouted on average.   The average percentage of 9 times was 30%.

【Consideration】

When we compare the two kinds of experiments, it is clear that the germination percentage in the main experiments is smaller than that of the control experiments. The results show that oats have some allelopathic effects of suppressing germination on the scallion.

The germination percentage in the first control experiment was very low and in the main experiments the percentage was not steady, going up and down.   The reason may be the way to plant the seeds and how dry the medium has got.
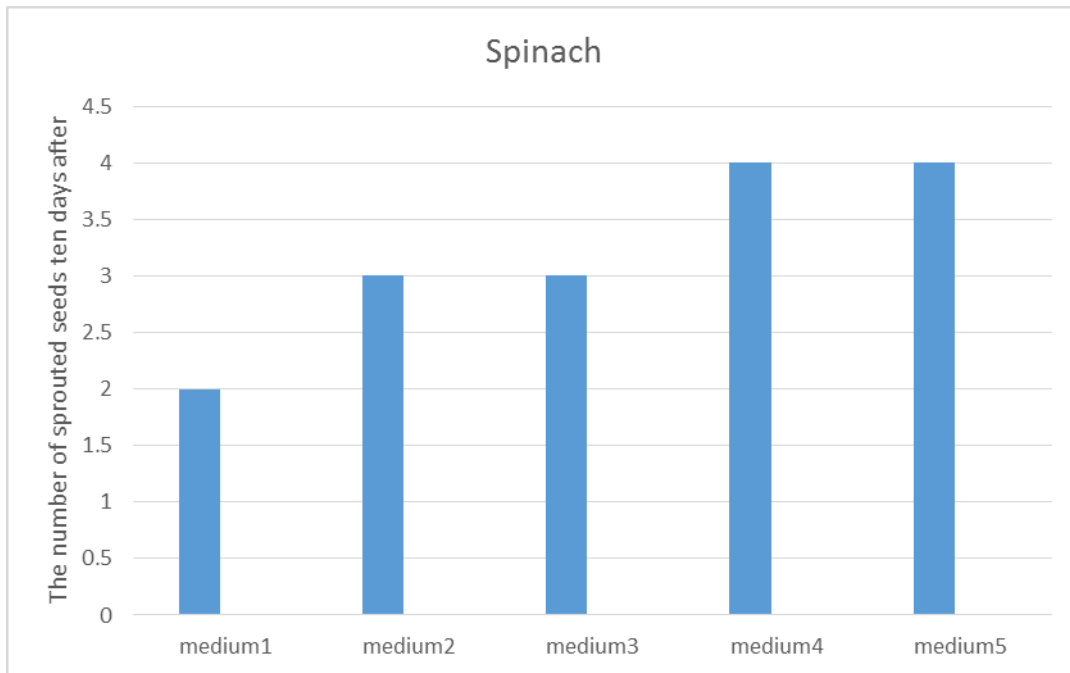
—Spinach—

【Results】

＜Control experiment＞

1st Experiment：38 out of 50 seeds sprouted.   The germination percentage was 76%.

2nd Experiment：47seeds out of 50 seeds sprouted.   The germination percentage was 94%.

The average percentage was 85%.

<Main Experiment>

3.2   out   of   20   seeds   sprouted   on   average.   The   average   percentage   of   5   times   was   16%.

Spinach — The number of sprouted seeds ten days after

【Consideration】

When we compare the two experiments, it is clear that the germination percentage in the main experiments is far smaller than that of the control experiments. The results show that oats have a great influence on the germination of the spinach as allelopathic plants.

4　Conclusion & Future Challenge

We've got a very interesting result from the experiments on the scallion and the spinach. The difference of germination rate between the control experiments and the main experiments is much bigger in the case of the spinach than in the case of the scallion. Therefore we consider that the spinach is much more susceptive to allelopathic effects of oats than the scallion.

We'd like to conduct some more experiments to improve the accuracy of the research.

The Process of Onion Weathering

Researchers: Koki Shibuya / Mizuki Iura / Maika Ota / Rintaro Ozaki

1. Study Purpose

Onion weathering can be compared to the skin of onion peeling off.   We found it when we went to the Shinakura area in Matsumoto City.   We began to question the formation of this process.   Therefore, we started this research in order to clear up the process.

2. Study Contents

(1) Field Survey:

We found an onion-weathering example, which is made of sand in our survey.   (Photo 1) In addition, we found stratums that were cracked.   (Photo 2) They seem that they are in the pre-stage of onion weathering.   Furthermore, we found mudstones that were finely grained down.   They seem that they are in the last stage of onion weathering.

(Photo 1)   (Photo 2)

(2) Digging of Onion Weathering

We dug out an onion-weathered rock, which we found in our survey. We found that the rock was progressing its onion weathering from the backside. (Photo 3)

(3) Model Experiment of Onion Weathering

We made a dried mud dumpling, put it in water and observed it. As a result, we could observe that a mud dumpling collapsed like onion weathering.

(Photo 3)

(4) A Measurement Experiment of Fe Ions

The color of the skin, which tends to come off, was different from the entire rock.   So we thought that a lot of Fe ions were included there and the difference of the amount of Fe ions related to the movement of water in the process of onion weathering.   Then we scraped away the rock from the parts of this photo ①～④ and the core of the rock of onion weathering, and we examined how many Fe ions were included in each part.   As a result, the amount of Fe ions were most at ④ (the inside skin), and they were least at ② (the outside skin).   The same amount of Fe ions were included at ① (the outside layer), ③ (the inside layer), and at the core of rock.

3. Consideration

Judging from these results, we feel that onion weathering occurs by "Chemical weathering" and "Physical weathering" and the process of onion weathering is as follows:

1. A square joint is made in the formation.   Then the water gets into the joint and the most outside skin of onion weathering is formed. (Figure1)

   (When we observed the formation in our field survey, there was a lot of onion weathering between the joint.)

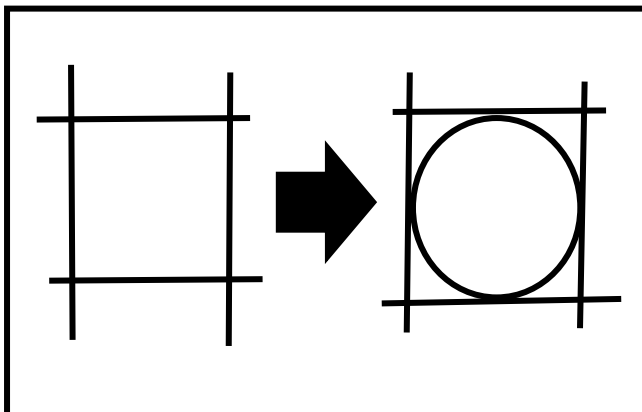2. The layer of onion weathering is formed from outside to inside.

   (When we did the model experiment, the mud dumpling with water collapsed from outside to inside.)

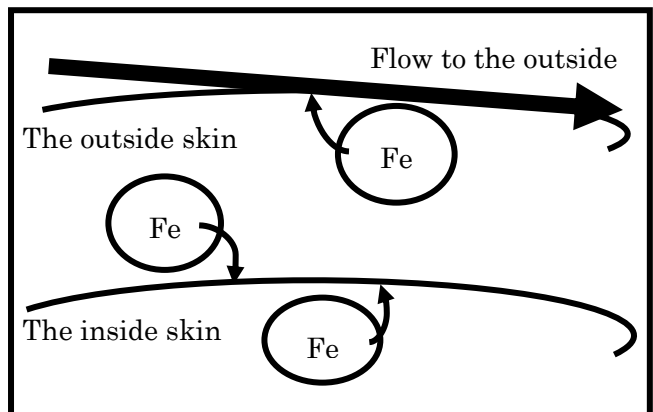3. At the same time as of #2, the Fe ions melt from in the rock to the water and gather to the skin of onion weathering. As much water flows from the old outside skin, the Fe ions flow to the outside of the skin. (Figure2) Also the Fe ions gather to the inside skin while forming.

   (When we did the measurement experiment of Fe ions, we received the result that much Fe ions were in the inside skin and little Fe ions were in the outside skin.)

4. Repeating #2 and #3, onion weathering forms to inside of rock.

(Figure 1)   (Figure 2)