How do spiders grasp a web?

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There are many kinds of spiders and they often use thread to live. Most of them can walk very fast on the web. We are interested in this point and we decided to research how they grasp a thread.We use “Nephila clavata” in our experiment.We took a video in which they climb a thread with a smartphone.We checked the video and observed their movement. From the video we found that they have three steps that “swing their legs” “their legs touch a thread” “move their leg to grasp the thread” when they grasp a thread. As a result we could expect that “Spiders may set lateral tarsal claws toward the spider's body when they grasp a thread”. However, we don’t have enough evidence to explain how spiders use their claws.Therefore, we have to do more research with spiders.

1. Introduction

Some species of spiders build their webs and live there, and others walk on the ground without building their web. We researched spiders.

Have you ever seen spiders walk on their web? They can walk very fast on the narrow web. So we believe spiders have the best way of walking on the web.

According to past research, we found that spiders use claws to catch the web. They find the web by tapping with their legs. And they have eight eyes so they have a wide field of view, however their eyesight is bad. From these things, we thought spiders should have an efficient method of finding their thread without using eyes, and efficient method of using claws to grasp.

However, no one researches how they grab the thread with their claws. Therefore, we conducted research on how spiders grasp the thread from the perspective of how the claws are used.

Spiders which make a nest have a claw like a hook in the middle and pair claws like a comb on both sides of the middle claw. We call these claws middle claws, and lateral tarsal claws, respectively. Bristles are growing around the claws on the sides of the leg, and in front of the middle claw and lateral tarsal claws, bristles which have multiple protrusions are growing.(fig.1)Only spiders which make nests have the middle claw. Spiders are classified into three-claw kind and two-claw kind depending on the presence or absence of the middle claw.

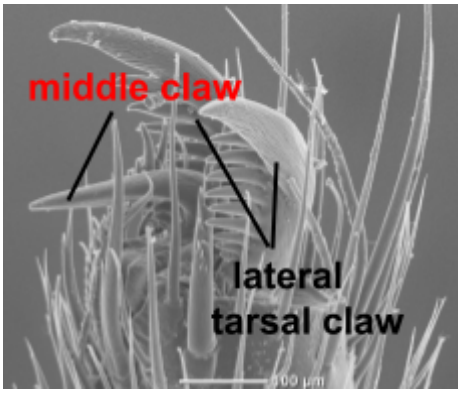

fig.1 spider claw

We make three hypotheses about using claws from the structure of spider claws.

1, Spiders may set the middle claw toward the spider's body when they grasp a thread.

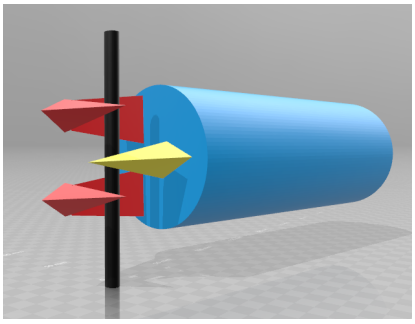

fig.2

2, Spiders may catch their thread only by lateral tarsal claws .

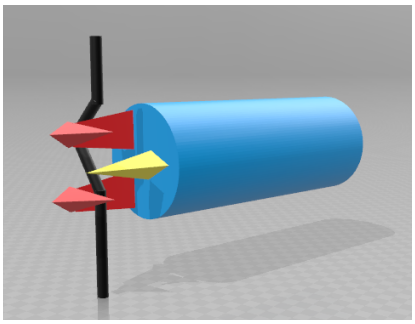

fig.3

3, Spiders may set lateral tarsal claws toward the spider's body when they grasp a thread.

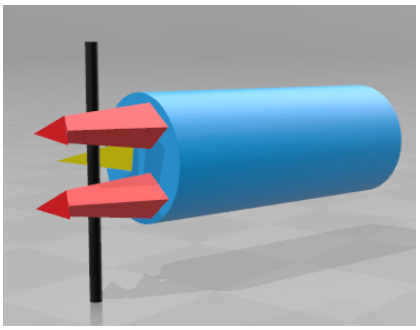

fig.4

We make another way "Spiders catch the thread using only the middle claw"

However, we exclude this way because spiders can't keep holding their balance in this way.

2. Method

We take action to decide the best way for spiders walking on the web.

Nephila clavata to be an experimented creature.

(1) We make a device to take pictures of the spider moving. We stretched the thread with a glass rod as a weight. (fig.5)

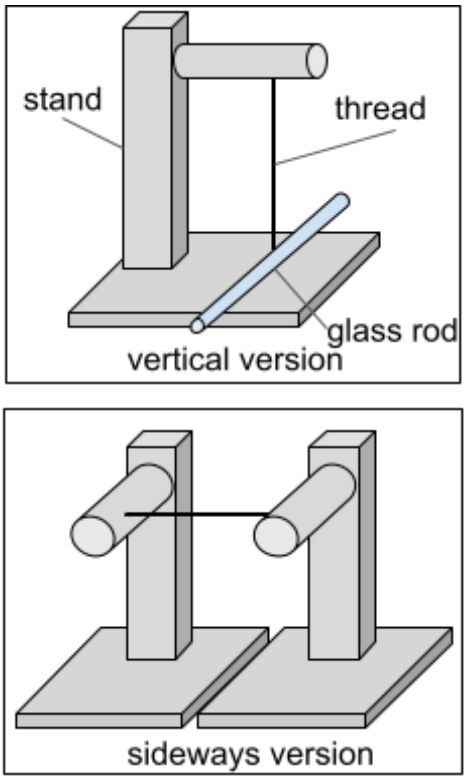

fig.5

(2) We put the spider on the thread.

Run the spider along the thread and we were taking video moves as its movement.

We changed the size of the spider and experimented six times.

We tried a sideways version , but the result is similar to the previous result.

In addition to climbing the thread in the vertical direction, we also attached a tow thread between the two stands and moved it horizontally and diagonally for observation.

3. Result and Explanation

From the footage of the Nephila clavata catching the thread, it was found that the Nephila clavata does not catch directly to grab the thread.we found spiders have some steps to catch the thread.

First,please look at pictures from NO.1 and No.2 in fig 6. Spider swings their forelegs to the thread,but spiders don't catch the thread directly.Spider foreleg passes by the thread.

Next, look at picture No.3 .Spider's leg hits the thread .Then, Spider moves their leg toward their body in pictures No.4,and No.5.

Finally, spider catches the thread in No.6.

In other words, Spiders have steps swing , hit , move, catch to grab the thread.(fig.6)

The three spiders which differ in size have the same movement. In case of changing direction into askew and sideways. The same movement is performed by the second forelimb. Their body is supported by grabbing the thread with the right foot of the first forelimb and the left foot of the second forelimb, or the left foot of the first forelimb and the right limb of the second forelimb. Moreover,the hind legs are just sliding on the thread like a ropeway.(fig.7)

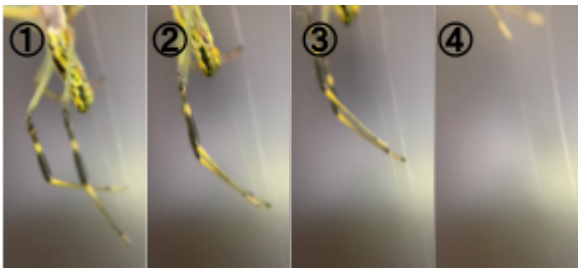

fig.7 Hind legs

From the result, in the case of Hypothesis 2 and Hypothesis 3, the rear part of the claw hits when pulling the limb toward the body, and it is necessary to move the limb to the left and right in order to grasp the thread. Therefore, we figure Hypothesis 1 to be the reasonable movement.

While the average thread thickness of a spider is 3 to 5 μm, the width between the protrusions of the lateral claw is 6 to 7 μm, so we consider that it is possible to use the lateral claw to hold the hook thread on the protrusion. In addition,The side of the spider's limbs have many sensory hairs.It works to grasp the position of the thread. It seems that they are doing it.(fig.8)

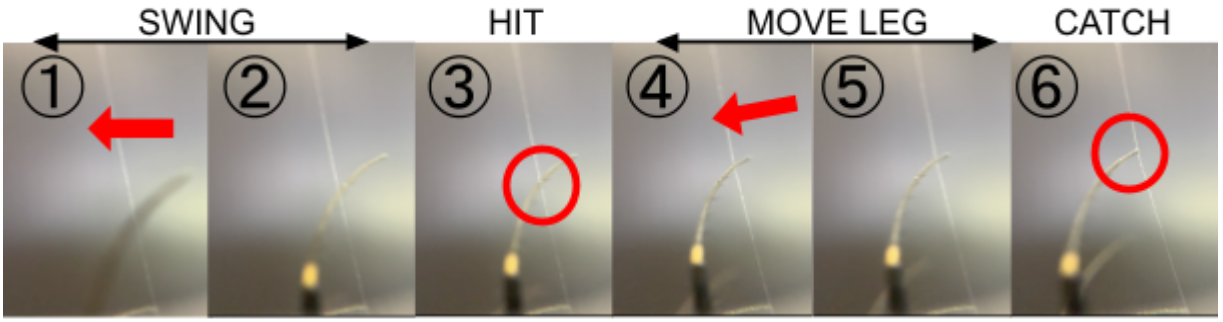

fig.6 foreleg from right side when spider catch the thread

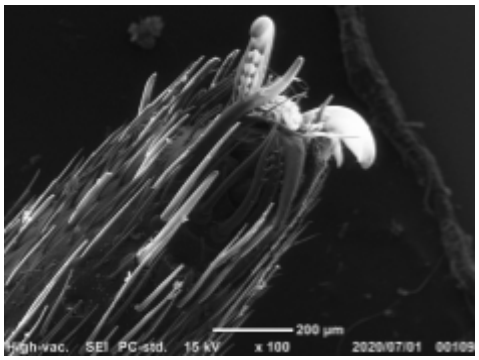

fig.8 Bristle

4 future work

From the result of the experiment, we concluded that spiders may set middle claws toward their body.However, That is not enough to identify how spiders walked on narrow threads.So, as future research, we would research joints of their claws or which part of the claw is used,to increase validity of our hypothesis. Actually we got rid of the bristle around claws to observe claws joint with glass rods which were stretched by heat. We took pictures by electronic microscope to watch spider's leg joints, but we couldn't watch the joints clearly because the joints are in tissue. (fig.9)

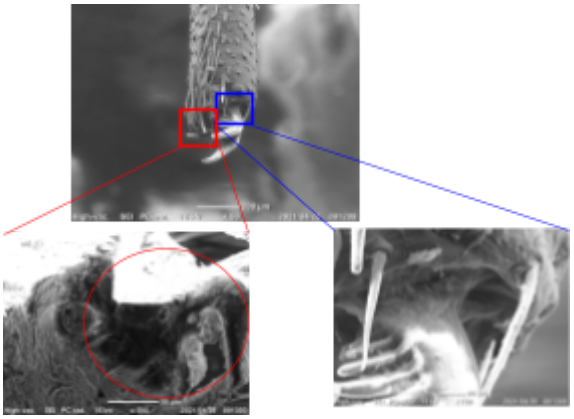

fig.9 Nephila clavata's limbs without bristles

Therefore, we have a plan to research which part of claws spiders use.First,we'll put paint material on spider thread,and have spiders walk on the thread.After that,we'll take pictures by electronic microscope.

Moreover,we should experiment with other species to prove all species of spiders set middle claws toward their body, because we only researched *Nephila clavata.*

Finally, We need evidence to explain our hypothesis so we want to take a picture of claws that spiders grasp a thread clearly. However, it is difficult to get such evidence because their claws are too small. We have to make a resolution for this problem to prove our hypothesis is true.

【Literature cited】

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