

The Adventure story of

MuEye Boy

Lost in the Crustacean world



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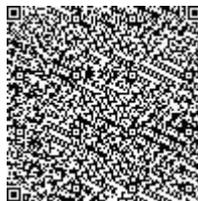
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National Electronics and Computer Technology Center

112 Thailand Sciences Park, Phahonyothin Rd.,

Khlong Nueng, Khlong Luang, Pathum Thani 12120

Tel 02 564 6900

Fax 02 564 6901-2



Story of MuEye Microscope

Optical microscope is a basic scientific instrument which is widely available in laboratories or schools. It magnifies small objects, invisible to our naked eyes, in fascinating details. Thus it is a powerful learning tool for everyone especially students in scientific program. Although microscope is important for learning, many schools cannot afford to have many microscopes. The equipment also comes with other relating costs (i.e. lens maintenance, temperature and humidity controlled room, and external camera for image capture).

In 2014, NSTDA's Researchers from Photonics Technology Laboratory (PTL), National Electronics and Computer Technology Center (NECTEC), successfully developed a flexible-polymer lens which can be easily attached onto camera of smartphone or tablet, and it converts the phone's camera into a personal microscope with large display. We named our lens is as MuEye (μ Eye) which means eyes for seeing micron-size objects.

In order to make full use of high-magnification MuEye lens, we designed and fabricated a sample stand which has build-in white LED light source, an adjustment knob and ability to use with both front and back camera of smartphone device. This conversion kit made MuEye a digital device that can replace conventional optical microscope with greater convenience. Being so light and small, MuEye microscope is ideal for personal use, indoor as well as outside classroom learning.

Data collecting of various samples can be done with camera snap shots which can be easily shared via internet such as email, or any social network platforms.

We really hope that MuEye microscope will be a learning tool that helps students to have fun with learning and be excel in sciences.

MuEye Team



Message from the President

One of my best childhood's memories is when I received a first microscope from my father as a present. Using this microscope, I have enjoyed observing things around me whenever I wanted to. This becomes my motivation to study further in a field of science and technology.

I found that having the ability to observe small organisms and things through a microscope help improving my observant skill and logical thinking. However, due to its price, not school can own a microscope.

I was very excited when Dr. Sarun reported that a research team from NECTEC, NSTDA has invented MuEye lens and the techniques to manufacturer this lens with high precision. MuEye lens can convert a smart phone or a tablet to a microscope.

With MuEye microscope, modern kids can own a personal microscope and can improve their observant skill by observing things around them using smart devices. After looking at stunning pictures that students took with MuEyes lens and reading this book, I am quite confident that everyone will have more enjoyable experience in learning science using this lens.

Many people asked me what is the big deal with adding lenses to smart phone, since many people are doing it. MuEye lens is different from other lenses. Our patented manufacturing process results in a better quality and clearer surface than ordinary lens in current market, due to better physics and precise magnification control. MuEye lens can be mass produced in Thailand at very competitive price. With our technology, and it is ready to challenge the world market.

I hope that this invention will increase motivation of Thai students to study in the field of science and technology. So, they can play an important role in making Thailand more competitive and innovative in the future.

Thaweesak Koanantakool, Ph.D.
President

National Science and Technology Development Agency

Message from the Director

MuEye lens is one of the best innovations from National Electronics and Computer Technology Center (NECTEC) that can unprecedentedly transform your mobile phone into a smart digital microscope. This invention opens a wide range of opportunities to those who are interested in observing tiny animals and small things by just using their mobile phones or tablets. The captured image or the recorded clip video can also be shared to others easily. Combination of MuEye lens and a camera of a mobile phone or a tablet with its built-in functions or new related application programs can leverage the learning process for students, teachers, and general public as well.

To demonstrate how a set of MuEye lenses can help us see tiny details of an object, the MuEye team of NECTEC has wholeheartedly put their effort and spent their valuable time in planning and preparing the materials for this book “The Adventure Story of MuEye Boy: Lost in the Crustacean world.”

I hope that this book with a set of MuEye lenses can motivate our young generations to love science and technology more as well as to develop their critical thinking skills. Eventually, their passion for creating new ideas and inventions are raised that benefit society and push Thailand competitiveness to the next level.

Sarun Sumriddetchkajorn, Ph.D.
Executive Director
National Electronics and Computer Technology Center



Introduction to Crustacean

Crustacean is a group of arthropod. Most of them are living in water. Many people think of crab and shrimp when speaking of crustacean. However, there are lots of tiny young and adult crustaceans float in water like planktons. These creatures play an important role in food chain. We can find crustacean almost everywhere from a small pond to the ocean.

Various types of artemia, barnacle, copepod, krill, nauplius of shrimp and crab are examples of small crustacean zooplankton. Each of them has different life cycle. Mostly, their life cycle begin with eggs and later transform into adults. This transformation process is called metamorphosis.

Let's follow MuEye boy to discover young crustacean world! Do not forget to bring the MuEye lens. A secret of crustacean is going to reveal!





Message from school

Ms. Warunya Ounnankard

Teacher from Banjongkam Provincial
Administration Organization School
Mae Hong Son Province, Thailand

School Background

Banjongkam provincial administration organization school is opportunity expansion school in a small rural town in Northern Thailand. Although school mainly supports primary education, students can extend to junior high school. Currently, there are 40 and 32 students in 1st and 2nd year junior high school. Integration curriculum is applied to motivate students to solve community problems with science, sociology and art. In the past three semesters, students have learned about sufficiency economy, food safety and “one tambon one culture one identity”. Asia education is currently taught in this 4th semester.

What does MuEye microscope help in teaching?

Before we received MuEye Lens from NECTEC, students had learned sufficiency economy via hand-on workshop. They grew rice in a demo field beginning from soil fertilizer mixing, seeding process, tillering observation, crown and nodal roots investigation. They used school microscope which is limited in number and mobility. After we got MuEye Lens, students have opportunity to use their own microscope. Therefore, they all have fun with learning, discussing and sharing knowledge, helping each others in sample collection and creating a piece of artwork from things they see though MuEye Lens.

Sample collection and preservation

Tools and Chemicals

- Silk screen nylon mesh or filter fabric
- Container for water collecting or water sampler
- Bottle for keeping sample
- Formalin or ethyl alcohol for preserving sample
- Dropper
- Slide, coverslip and petri dish



Sample collecting and preserving procedure

We sampling young crustacean by collecting large volume of water that filter it through silk screen nylon mesh or fine mesh filter fabrics. To preserve the sample, simply prepare formalin solution with the final concentration of 4% or ethyl alcohol at 40-70% in the bottle. The crustacean left on nylon mesh after filtration is finally added into the preservation bottle.



Sample preparation for microscope

On Slide - Use dropper to place a few drops of preserved sample onto glass slide. Cover a sample with coverslip. Beware of creating air bubbles. Use tissue paper to clean excess water. Then, sample slide is ready to observe with MuEye Microscope.

On Petri dish - Use dropper to place 0.5-1 ml of preserved sample in the petri dish. Then, sample slide is ready to observe with MuEye Microscope.

MuEye microscope Instructions

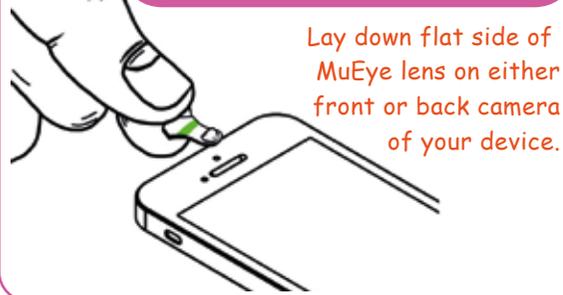


Choose magnification.



Green 25x Yellow 50x Red 100x

Stick MuEye lens on camera.



Lay down flat side of MuEye lens on either front or back camera of your device.

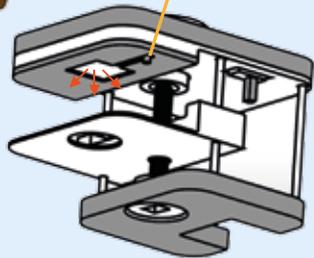
To use with MuEye stage, switch on light source.

**To open or close aperture, slide a patch to one end.

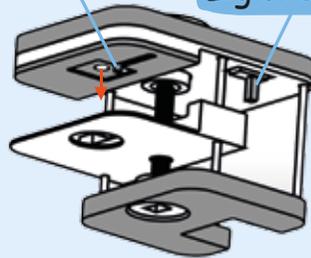
Open aperture

Close aperture

Light switch



For Lens 25x or 50x



For 50x or 100x

For using with front camera

- 1 Use double-sided tape to secure stage with the table
- 3 Slide a device with MuEye lens attached on the front camera into the position. Camera must be aligned with a stage opening

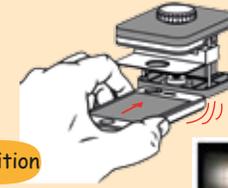


Double-sided tape

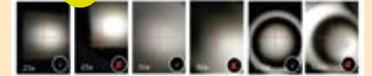


Knob

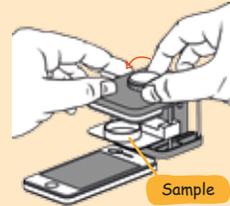
2 Put an adjustment knob in position



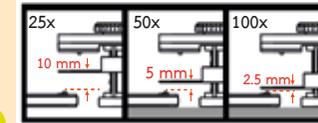
4 Start camera app and switch to front camera. Move either phone or MuEye lens, until light appears in the middle. (see the green check pictures)



- 5 Place your sample on stage. Turning a knob on top of the stage to adjust focus.



Sample



- 6 Bring sample close to lens especially for high magnification.



Sample

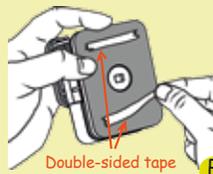
- 7 Gently move sample left or right to change positions. Do not move stage or phone.

Front-camera setup is suitable for wet samples, i.e. Slide without coverslip or petri dish.

For using with back camera

Turn the MuEye stage upside down.

- 1 Use double-sided tape to secure stage with the table.
- 3 Place a phone with MuEye lens attached on its back camera on a box. Use a packaging box, bottom one, to get a perfect height.



Double-sided tape



Knob

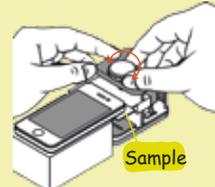
2 Put an adjustment knob in position.



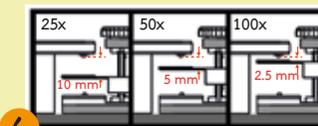
4 Start camera app and switch to front camera. Move either phone or MuEye lens, until light appears in the middle. (see the green check pictures)



- 5 Place your sample on stage. Turning a knob on top of the stage to adjust focus.

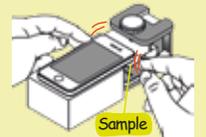


Sample



- 6 Bring sample close to lens especially for high magnification.

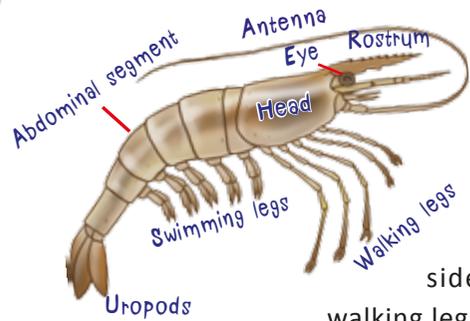
7 Gently move sample left or right to change positions. Do not move stage or phone.



Sample

Back-camera setup is suitable for thin samples, i.e. thickness is less than lens focal length.

Whiteleg Shrimp (Vannamei or Pacific white shrimp)



Whiteleg shrimps are marine species originally found in Pacific coast of South America. Their adult stage have 6 white abdominal segments, rostrum (8 teeth on the dorsal side and 2 teeth on the ventral side), 2 red antennas, red eyes, white

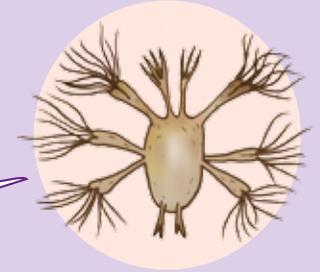
walking legs with red shoes, 5 pairs of swimming

legs, 4 uropods and 1 telson. Life cycle of whiteleg shrimps begins from fertilized eggs. Then, eggs will hatch in 12-14 hours to be nauplii. Nauplii do not need food in the beginning because they have yolk sac that provides nutrients. After that they will transform to protozoa which head and body can be clearly distinct. When shrimps develop swimming legs but their movement is still in a backward direction, we call them "Mysis". Then, post-larvae stage will be reached when walking legs are appeared. Shrimps will continue grow until they become adult.



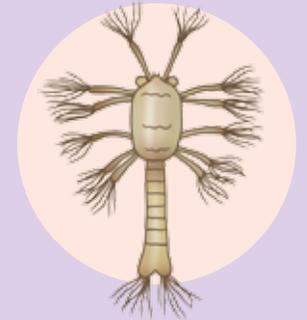
Whiteleg shrimps are so popular! You can find them in many delicious dishes. The main producer countries are Thailand, Vietnam and China.

I am a Nauplius. I have a yolk sac to provide me nutrients, I do not need food!



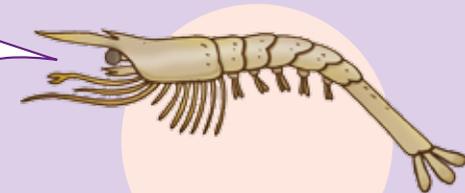
Nauplius stage

I am a bit grown-up and so starving. Let's find some food to eat!



Protozoa stage

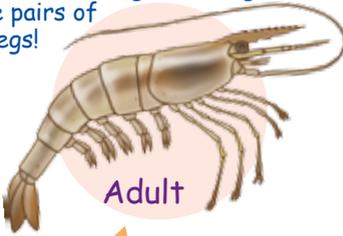
I think I am old enough to eat zooplankton. Let's look for a big one! Yummy!



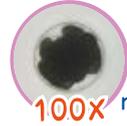
Mysis stage

Whiteleg shrimp life cycle through MuEye Microscope

Long antennas, strong swimming legs, five pairs of walking legs!



Adult



100X

Fertilized egg is ready for hatching.



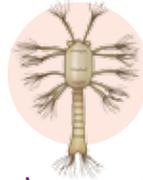
Egg



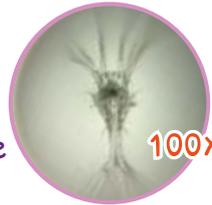
100X

It has unsegmented body with appendages. It looks like spider!

Nauplius stage



Protozoa stage

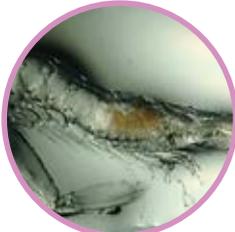


100X

Eye is a black spot. Mouth is developed. Head and body are separated.



Mysis stage



Post-larvae stage

Three pairs of walking legs are appeared. Swimming legs are clearly seen.

Swimming legs



50X



50X

Eyes and mouth are clearly seen.



25X

We can see its abdominal segments and uropods!

* Numbers in images represent magnification of MuEye lens.



Giant Freshwater prawn

Giant freshwater prawn or giant river prawn is native to Indo-pacific region especially southeast asia. It is also a main ingredient of the most popular Thai dish “Tom Yum Koong”. Although this giant prawn is freshwater species, its egg and larval stage require brackish water to hatch and survive. Fertilized eggs will float along tide current for 19 days before hatching to larvae which swim upside down. After metamorphosis, they will swim in the same way as adult prawns and move back to freshwater area.



Prawn larva
1 day old



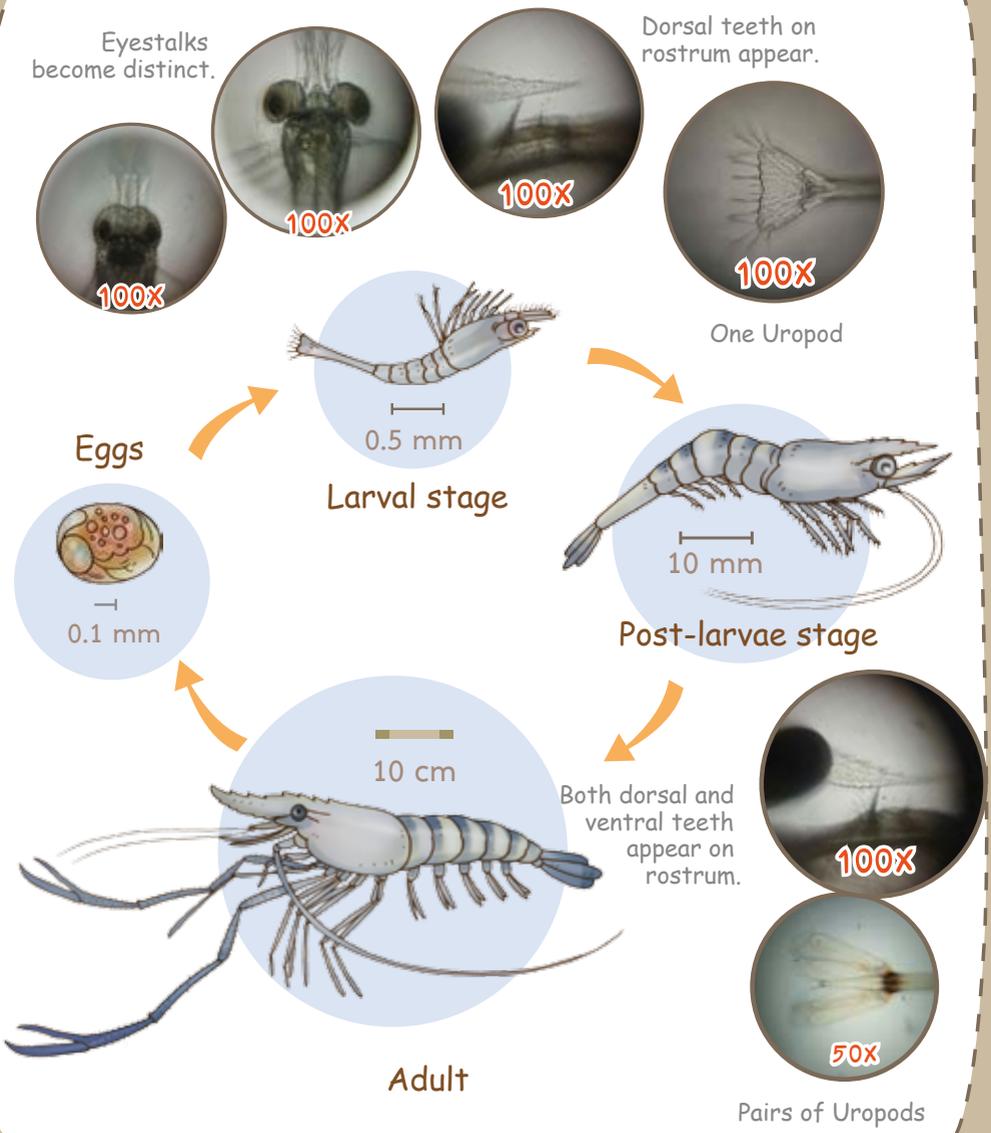
Prawn larva
2 days old



Prawn larva
30 days old



Giant freshwater prawn life cycle through MuEye Microscope



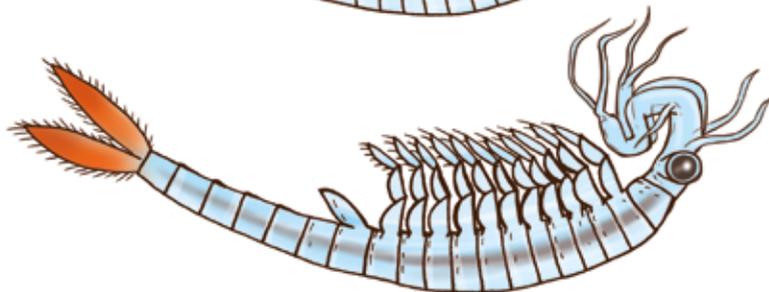
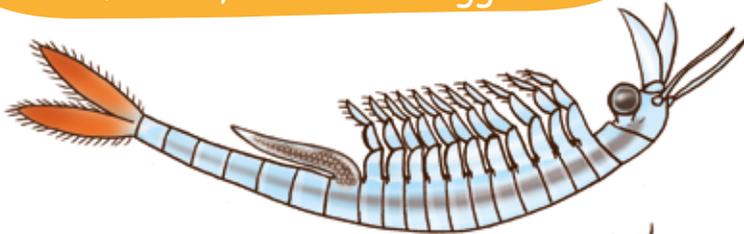
* Numbers in images represent magnification of MuEye Lens.

Fairy shrimp

Fairy shrimp looks like a small shrimp with translucent body and color-rich tail. It can be found in fresh water such as pond, lake or even a temporary pools created after raining. During rainy season, dry areas all fill up with water and then fairy shrimps start hatching. After 5-7 days of nauplius stage, adult stage will be reached. Before the vernal pool dries up, the shrimp females will produce hardy resting eggs and lay them underground to avoid predators. Then, they can survive the dry season and hatch again when the rain comes.

There are three new species of the world discovered in Thailand such as *Streptocephalus sirindhornae*, *Branchinella thailandensis* and *Streptocephalus siamensis*.

I am female, I have two egg sacs.



I am male with a big head.

Fairy shrimp life cycle through MuEye microscope

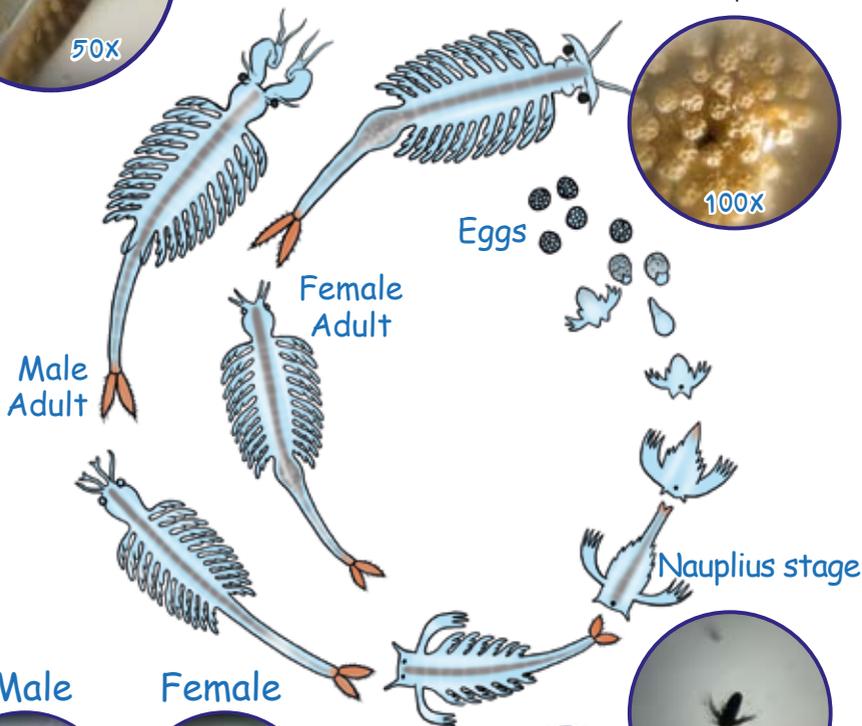


An egg sac in female adult

Fertilized eggs have a hard cover, called "Cysts".



Eggs



Male Adult

Female Adult

Nauplius stage

Male

Female

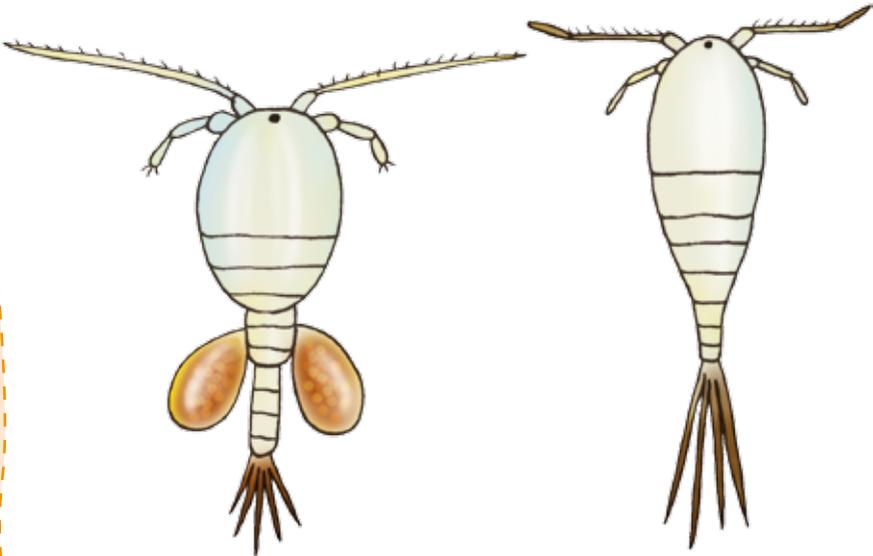


Adult fairy shrimps have compound eyes, two sets of antennae (one is small, another one is big and long especially for male), and 11 pairs of swimming legs.

* Numbers in images represent magnification of MuEye Lens.

Copepod

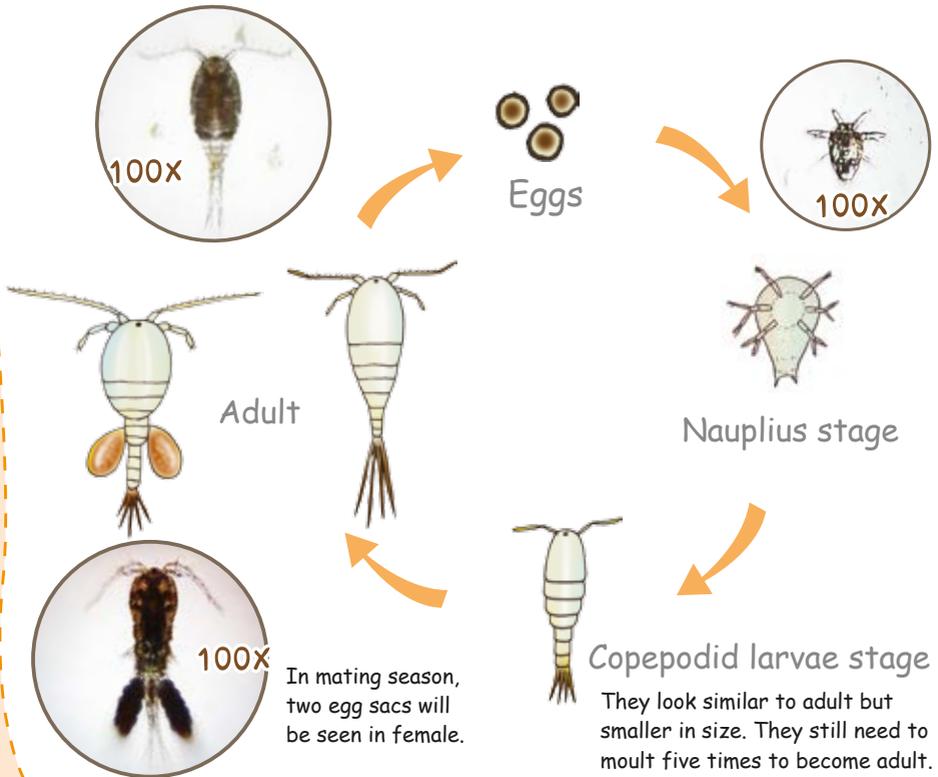
Copepod is a small crustacean which is mostly a planktonic species drifting in water for all stages of its life-cycle. It can be found in both freshwater and marine ecosystem. Copepods eat phytoplankton, meanwhile, they are major food for small fish. Therefore, copepod is an important species in both freshwater and ocean ecology. Without copepods we might not have a big fish served right on our dinner table!



Female copepod
with egg sacs

Male copepod

Copepod life cycle through MuEye Microscope



* Numbers in images represent magnification of MuEye Lens.

If we collect water from natural sources (i.e. ponds, swamps or water-filled recesses of plants) and see with MuEye microscope, we will always find all stages of copepod mixing in one sample. Female copepods are easy to identify because of attractive egg sacs on their body.

Assignment

Discover a crustacean near you!

Name of crustacean

Its habitat Freshwater Marine

Sample collection method

How does it look like with your naked eyes?	How does it look like under MuEye microscope?
	<div data-bbox="919 539 1065 683" style="border: 2px solid purple; border-radius: 50%; padding: 5px; display: inline-block;">Magnification X</div>

Assignment

Study a crustacean life cycle!

Date	How does it look like under MuEye Microscope?
	<p>Magnification X</p>
	<p>Magnification X</p>
	<p>Magnification X</p>

Assignment

Discover a crustacean near you!

Name of crustacean

Its habitat Freshwater Marine

Sample collection method

How does it look like with your naked eyes?	How does it look like under MuEye microscope? Magnification X

Assignment

Study a crustacean life cycle!

Date	How does it look like under MuEye Microscope?
	<p>Magnification X</p>
	<p>Magnification X</p>
	<p>Magnification X</p>

Advisors

1. Dr. Thaweesak Koanantakool President of National Science and Technology Development Agency
2. Dr. Sarun Sumriddetchkajorn Executive Director of National Electronics and Computer Technology Center
3. Dr. Kanyawim Kirtikara Former Executive Director of National Center for Genetic Engineering and Biotechnology
4. Dr. Omjai Saimek Vice President of National Science and Technology Development Agency
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6. Dr. Kalaya Udomvitid Deputy Executive Director of National Electronics and Computer Technology Center
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Creative & Editorial Staffs

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17. Ms. Sirisuda Rodthong Business Development and Technoloy Transfer Division



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- Ms. Warunya Ounnankard, Teacher of “Banjongkam Provincial Administration Organization School” Mae Hong Son, Thailand
- Center of Excellence for Marine Biotechnology, Department of Marine Science, Faculty of Science, Chulalongkorn University, Bangkok, Thailand
- Sirindhorn Science Home, Pathum Thani, Thailand
- Dr. Nukul Saengphan and Dr. Auaaree Sooksomnit, Suphanburi College of Agriculture and Technology, Suphanburi, Thailand



Crustaceans are important creatures driving our ecosystem and food chain. MuEye boy is going to reveal a secret of these tiny lives by seeing through **MuEye Microscope**.



NECTEC¹
a member of NSTDA

National Electronics and Computer Technology Center
112 Thailand Science Park, Phahonyothin Road,
Khlong Nueng, Khlong Luang, Pathum Thani 12120, Thailand
Tel 02 564 6900 Ext. 2106, 2356