



Figure 2. Mud-wasp larva developing into a pupa.

All of this I call research. Arthur's idea was original. It was exciting because it came from a questioning young mind, challenging because no one, so far as we know, had ever thought of doing it before. For when I queried Phil Rau of Kirkwood, Missouri, naturalist and bee specialist and T. D. A. Cockerell of Boulder, Colorado, another authority on wild bees, neither one had thought to try it. I recall Phil Rau's comment, after expressing pleased surprise at the suggestion, "I think I'll try it on some of my pets."

Frequently we hear someone in a library say, "I'm doing some research for a club paper." Perhaps. Probably she is merely searching for some material and is reading and taking notes on this.

Arthur's experiment is an example of simple research.

It is unnecessary, I suppose, to tell you that the dear little larvae fooled us. Whatever took place took place beneath that white outer "skin" which one day split to leave the pupa exposed—with its legs, crumpled wings, great eyes, and antennae already developed. The wings, of course, were to be inflated later. But every part was there.

Still we learned much. We learned how to carry on a simple research problem, which is "systematic investigation into a subject in order to *discover* facts or principles."

## The Parasitic Worms In High School Biology

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### Introduction:

One of the most fascinating units in High School Biology is the study of the parasitic worms. In an effort to make this topic worth while and practical we devised a unit plan for the teaching of parasitic worms which proved both instructive and interesting as a teaching device in the biology laboratory and classroom.

### Aims and objectives:

1. To study the parasitic worms from the standpoint of structures, prevention, disease causes, symptoms, carriers, and relation to public health.

2. To understand practical methods of prevention of these infections in our home community.

3. To indicate the functions and duties of the local, state, and federal public health agencies, in endoparasitic control.

4. To compare the so-called worms, with other animals studied.

5. To arouse appreciation for the keenest of observation of the ancient Hebrews in relation to what we now know to be infestation with trichina; respect for their ability to single out the swine as a transmitter of an illness; respect for their rulers who incorporated the knowledge in the priestly code of laws (Leviticus 11-7 & 8, 34 & 35).

6. To show that swine, as a vector or a transmitter of trichinosis is dependent upon the invention and improvement of such aids as the microscope and also upon modern research techniques in cutting and staining thin sections.

7. To stress in recitation periods, modern methods in animal husbandry; the prevention of the spread of trichinosis in swine is partially dependent upon the use of rat-free quarters (commonly known as hog pens). Hogs will eat rats if hungry. The rat is one of the intermediate hosts of the trichina. The

thorough cooking of any garbage, containing scraps of meat, and fed to hogs, is important prophylaxis.

#### Unit 1. Tapeworm

The Platyhelminthes, flatworms, include the *Taenia solium*, pork tapeworm, and the *Taenia saginata*, the beef tapeworm, and the liver flukes. The commonest length is 15 to 30 feet with up to 1,000 proglotids or segments. The scolex or head contains suckers only. The distribution is world wide, the cysts being found in the muscle of beef and dairy cattle, or hogs. The final host is the intestine of man. The tapeworm cycle is as follows: cattle eat grass and hay, etc., infected with tapeworm eggs; the eggs form from larvae which lose their intestinal membrane and travel to some muscle destination. Here they form a bladder worm or cyst. The *Cysticercus bovis*, are small white ovoid bodies commonly called cysts in beef muscle.

If infected meat is improperly cooked, black market or uninspected meat is eaten the cyst is carried into the human intestinal tract. Here the worm turns right side out, and the cyst is digested and finally attaches itself to the walls of the intestine. Infestation symptoms are capricious appetite, loss of weight, restlessness, occasional fits, and sometimes anemia.

The diagnosis is as follows: the mature worm passes thousands of eggs from mature proglotids which may be found on microscope examination. Sometimes the proglotids themselves are passed off with the excreta. The *Taenia solium*: hog tapeworm cycle is similar to the beef form except the intermediate host is the hog. Cysts are small bladders called pork measles. This tapeworm has hooks and suckers both on the Scolex.

The prevention is a sanitary sewage disposal, veterinary inspection, U. S. State or City (limitations), and thorough cooking of meat.

The Hebrews and Mohammedans regard eating pork as a religious sin, which is today valid as an endoparasitic prophylactic procedure. (Deuteronomy 14:8).

#### Unit 2. The Liver Flukes

The Flukes include the Distomata, Trematodes and *Fasciola hepaticum*. The complex

but interesting liver fluke cycle may be drawn on the blackboard and labeled, or illustrated with diagrammatic wall charts. This infection is important to live stock raisers of cattle and sheep.

Sheep with liver flukes in their liver shed thousands of eggs from feces or urine, which if they fall in water, the cycle may go on. The eggs change to free swimming miracidia (look like paramecium or ciliated epithelium) which must find a snail host. Miracidia are ingested by the snail or pass through the skin to the snail's liver. Here it changes to a free swimming cercariae where it emerges and swims to encyst itself on grass or water cress. If water cress is ingested and is eaten by sheep the cycle is continued. Man may also be infected with distomiasis by eating parasitized water cress.

In the Chinese liver fluke, the Miracidium can give rise to 10,000 cercaria. Human feces contain eggs, which emerge as a Miracidium and swim free in the water. Water snails pick up the redis stage, a sexual stage. Then the cercaria stage follows to be ingested by fish. Man eats raw fish (adult) and so becomes infested.

To prevent sheep liver fluke from reaching man, we avoid infected water cress, require meat inspection to locate flukes in sheep, and recommend final thorough cooking of sheep livers. The common symptoms of distomiasis is jaundice, due to the clogging of bile ducts with flukes; the membranes, blood and skin taking on a yellowish discoloration.

Schistosomes are widespread in the tropics (Philippines) and was a medical problem in General MacArthur's Pacific island hopping campaign. This is the flat worm that upset an Egyptian dynasty. It can enter the body through drinking water, skin bathing, and food washed in infected water. The disease caused by it is Schistosomiasis.

#### Unit 3. Nematelminthes (Round-worms) Trichinosis

The cycle of *Trichinia spiralis* starts when hogs or rats eat garbage infected with the trichinia. The ova pass into the hog's intestine where the larvae penetrate the walls of the intestine and enter mesenteric capillaries. They then move through the circulatory system to voluntary muscles, and there en-

cyst themselves. Severe myositis that does not respond to the ordinary treatments results. The symptoms resemble rheumatism with severe muscular pain. Should humans eat uncooked or uninspected pork which is trichinosed, there is a direct worm transmission to human subjects. The cysts are lost in digestive fluids, but the worms pass via intestines directly into human muscles where they encyst themselves. There is no treatment as no medicine can penetrate the cysts lodged in muscles. The disease can, however, be prevented by cooking, and inspection of pork, and raising hogs hygienically, observing sanitary preventive measures.

#### *Necator Americanus* (Hookworm)

How can we prevent hookworm infestation as typified by characters in *Tobacco Road*, *Little Abner's Dog Patch*, *Poor Whites*, *Share Croppers*, and *Migrant Workers*?

The cycle is started when eggs are dropped by hogs, humans and dogs, infected with the necator in the intestines and dropped on grass or weed plants. Humans may walk bare foot in infected grass, like Ma Abner. The eggs change to pointed larvae which penetrate the skin causing a local itch. The larvae then pass into the human blood stream and enter the pulmonary circulation to areoli (air sacs in the lungs) and cause damage to the lungs or sometimes tuberculosis. The larvae are then coughed up to the mouth and swallowed. They enter the intestines of the human and hook to the intestinal wall where they cause anemia, chronic exhaustion, and diarrhea. This disease affected the course of the Civil War as a high percentage of Southern troops according to medical records were infected with hookworm. World wide distribution is placed at 15,000,000 cases. The treatment is tetrachloroethylene or thymol, etc., given on an empty stomach. The prevention consists of cleaning up infection in hogs and dogs, treating all human cases, and building and maintaining sewage disposal and filtration plants.

#### *The Filaria* (*Wuchereria bancrofti*)

Have you ever heard of elephantiasis? It may be a symptom of Microfilarias which in the United States is found only in Charleston, S. C. Man is the definitive host of the Microfilaria in the blood stream.

The carriers are the Anopheles, *Aedes aegypti*, and Culex mosquitoes. The mosquito bites a person and the Microfilaria penetrates the skin. The worms may block lymph vessels causing elephantiasis, anemia, clogging up of the heart, and the valves so that death results.

The prevention of Filariasis is mosquito control, and sanitation. Microscopic tests of possible infected persons are made looking for filaria in the blood. Antimony and bismuth salts are used in treatment.

#### *The Ascarid Worms*

*Ascaris lumbricoides* is from one to twenty inches long. Two hundred thousand eggs may be laid daily from each female, and pass into the ground from the hog, dog, or human hosts.

The Ascarids mature in human intestines. Inside the egg shell a small worm develops. If the ova are swallowed from roots or stems or leafy foods, they pass into and develop in the human intestine, where they burrow to enter the blood vessels, lungs, air sacs, to lodge in the intestine or coughed up into the mouth. Usually no symptoms are in evidence, but children may show symptoms of nervousness.

Prevention is sanitary disposal of feces. Infestation are usually due to eating fresh vegetables from soil contaminated with human feces. The habitat, *Ascaris* is common in the Southern United States. Hog ascarids do not infect humans and vice versa. Diagnosis is made by finding the ova in feces on microscopic examination.

#### *Student Projects*

1. You are a public health official in a Southern state. What (and why) would you tell people to do to prevent tapeworm and Ascarid hookworm?
2. What can you do as a housewife to prevent tapeworm and Trichinosis infestation in your family.
3. What is the first line of defense against most flat or round worm diseases?

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There are bright prospects that American farmers will be able to grow and harvest "cortisone crops" from certain plants—which would mean plentiful, less expensive hormones for medical use.