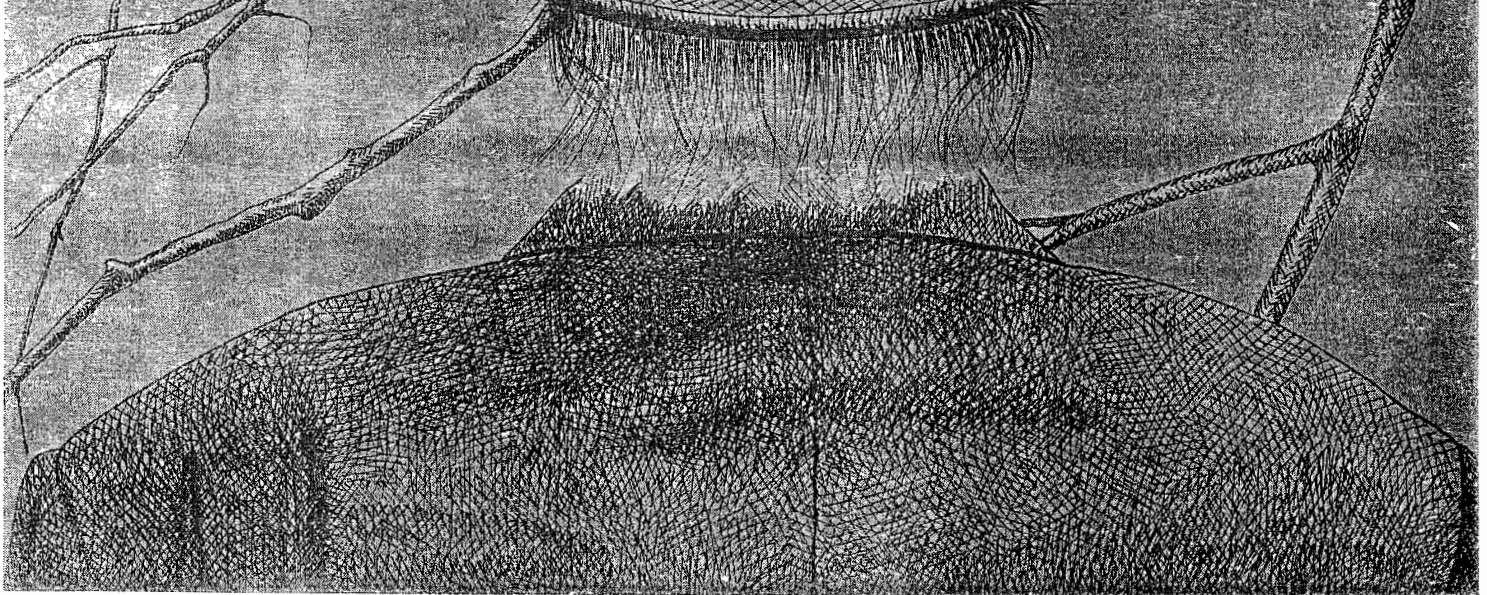
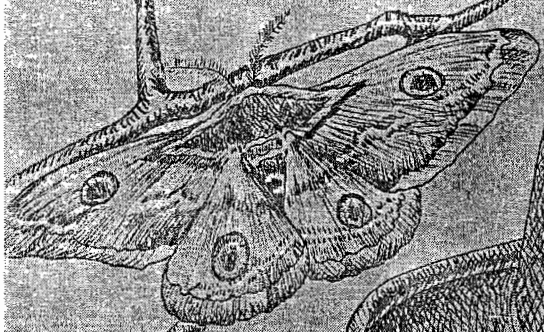


JEAN HENRI FABRE

THE INCOMPARABLE OBSERVER





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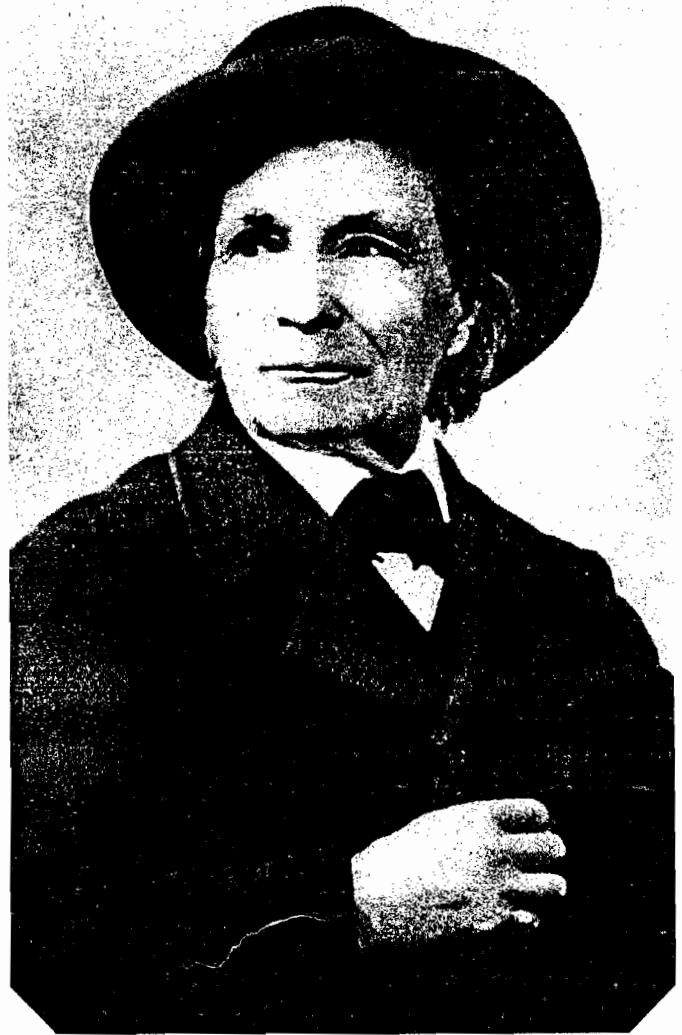
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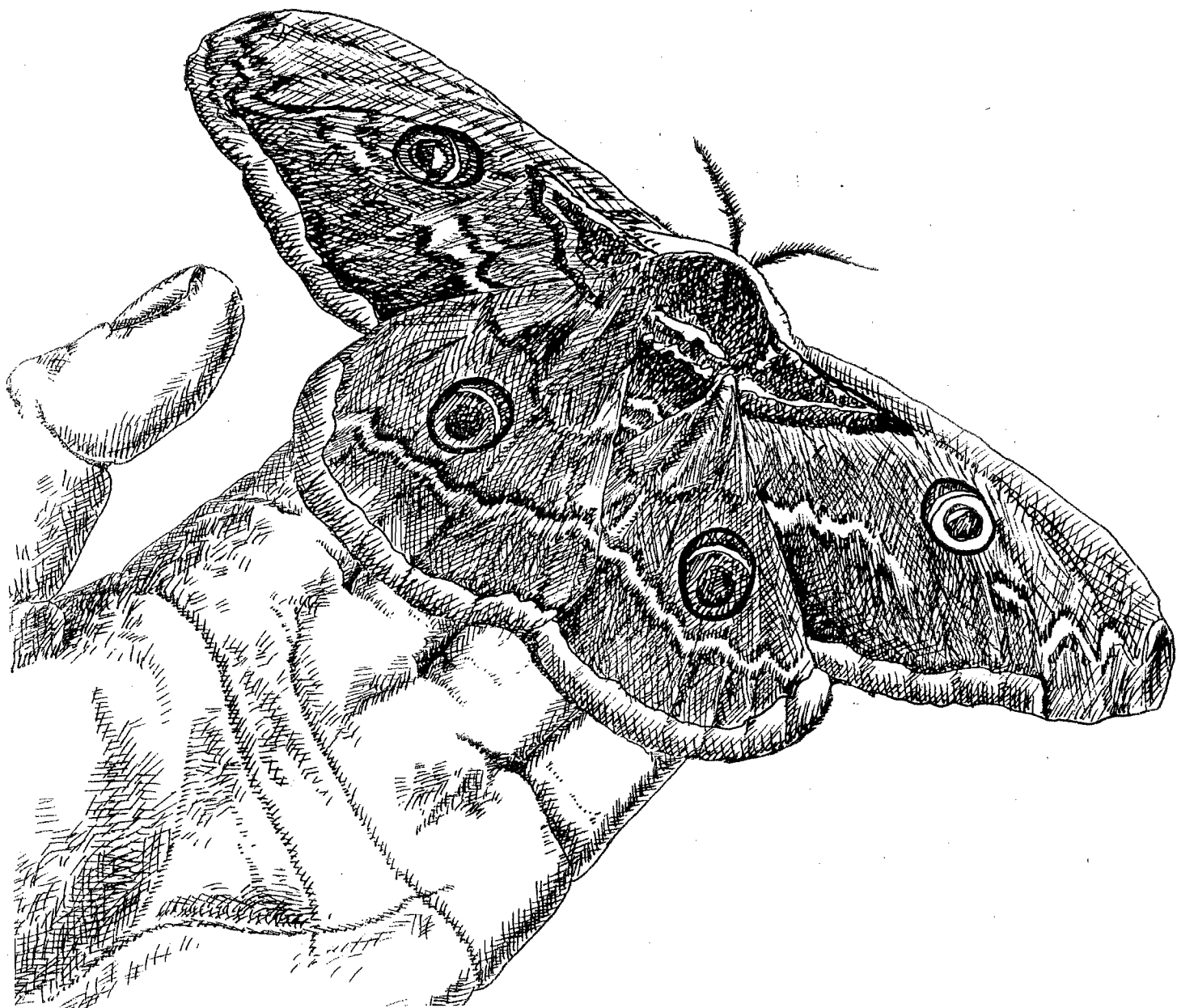
INTRODUCTION

Jean Henri Fabre (1823-1914) was an amateur French naturalist with no formal training in science. He enjoyed none of the modern scientific tools and techniques we now take for granted, but labored painstakingly with only tweezers, a penknife, and a magnifying glass. Yet his keen observations recorded in his charming, nearly poetic style are now recognized as national treasures and preserved in a museum in Serignan France.

A schoolteacher for many years, Fabre eventually resigned his job because the administration would not permit girls to attend his science classes. He then bought a small house with a plot of land in Provence and retired there to work in his open-air laboratory.

Very little was known about insect behavior in the 1800s. Fabre recorded his observations and experiments over many years, and published them in 10 volumes called *Souvenirs Entomologiques* (1879-1907). The following selection is adapted from translations of his work.





Adapted from *The Life of the Caterpillar* by Jean Henri Fabre

AN IDEA IS BORN

"Papa! Come quick! Come see the moths. They are big as birds!" Thus began Jean Henri Fabre's adventures with the great peacock moth. In his journal he describes the magnificent insect as:

".....the largest in Europe, clad in maroon velvet with a necktie of white fur. The wings, with their sprinkling of gray and brown, crossed by a faint zig-zag and edged with smoky white, have in the center a round patch, a great eye with a black pupil and a variegated iris containing successive black, white, chestnut and purple arcs."

QUESTIONS:

- *How would you describe Fabre's writing style?*
- *How does his description of the great peacock compare with your description of the cecropia moth?*
- *What kind of data did you include that is missing in this part of Fabre's notes?*

Just that morning, Fabre had watched in amazement as a female great peacock moth emerged from her cocoon. Very gently, he had placed the moth in a wire mesh cage in his laboratory.

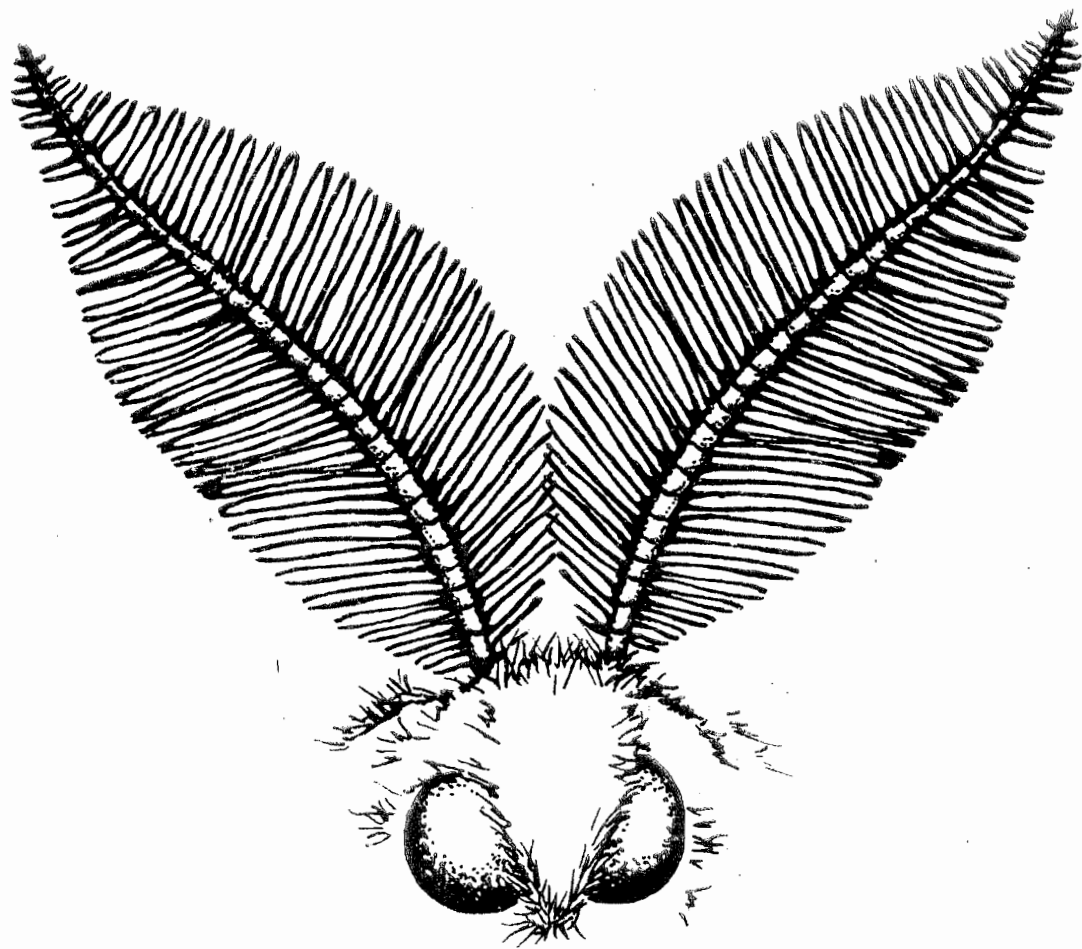
Now at 9:00 P.M., the whole house is a-flutter with great peacock moths. The visitors are all males and only males. They flap about in nearly every room in the house, about forty altogether. Fabre described the scene in his journal:

".....forty lovers eager to pay their respects to the marriageable bride born that morning amid the mysteries of my study."

QUESTIONS:

- *If you were in a house filled with forty male moths and one female moth, what questions would you have? How could you find answers?*
- *What kinds of experiments would you do? What data would you collect?*

Fabre's mind is filled with questions. How did these males find their way to the female? It is a dark and overcast night. The house is hidden in a thick tangle of trees and hedges, with only soft candlelight within. Surely the male moths didn't see their way to the female. What senses led them to her?



"One suspects the antennae.... Are those glorious plumes mere ornaments, or do they at the same time play a part?"

QUESTION:

- *What sensory organs do you think the male moths used to find the female?*
- *How do insects see, taste, hear, feel, and smell?*

Fabre writes:

“One suspects the antennae.... Are those glorious plumes mere ornaments, or do they at the same time play a part?”

QUESTIONS:

- *What is Fabre’s question? Restate it in your own words.*
- *How do you think he will go about finding an answer? Suggest a possible experiment he might conduct involving the males’ antennae.*

THE FIRST EXPERIMENT

The next morning Fabre is eager to begin his first experiment. Eight male moths remain in his study. The rest have flown back out through the open windows overnight. Carefully he snips off their antennae near the base. The moths seem unharmed; in fact, they hardly seem to notice the loss.

QUESTIONS:

- *Are you disturbed by the amputation of the moths’ antennae?*
- *Can you suggest other ways Fabre might have learned more about the function of the antennae without snipping them off?*

Next, Fabre moves the wire cage containing the female to a back porch, about 50 yards away.

QUESTIONS:

- *Why do you think Fabre moved the female?*
- *How will changing the female’s location help him learn more about the function of the males’ antennae?*

By evening, six of the eight male moths have flown out the open windows. The other two are weak and dying, not because they lost their antennae, but because they have reached the end of their very short life span.

Now Fabre expands his question.

QUESTION:

- *What do you think his new question is?*

He asks himself:

“Though deprived of their antennae, will they be able to find the cage, now put in another place, at a considerable distance from its original position?”

All that evening, Fabre returns again and again to the caged female. Each time he nets the visitors and lets them loose in a nearby room. In all he captures 25 moths, all males. Only one male without antennae returns. But he decides that he cannot draw a conclusion from so little data.

QUESTIONS:

- *Why not? How could Fabre collect more data?*

REPEATING THE FIRST EXPERIMENT TO COLLECT MORE DATA

The next morning Fabre sets about collecting more data. He snips off the antennae of the 24 new males who visited the night before, and leaves the window open so that they may fly away. He again moves the female to a new location, this time in another wing of the house.

By evening only 16 of the males whose antennae have been removed have flown away. The rest lie dying, having lived out their short life span. Now he asks, of the 16 males who have left, how many will return to the female's cage this evening?

QUESTIONS:

- *Make predictions. Speculate on the number of antennaeless male moths that will return.*
- *What would it mean if a large percentage of males without antennae returned? What if a small percentage returned?*

Result: Not a single male without antennae returns that night. All the newcomers have antennae, and Fabre concludes:

“This result would seem to show that the amputation of the antennae is a rather serious matter.”

QUESTIONS:

- *Does this seem like a logical conclusion to you? Is it a strong or a weak statement?*
- *Could Fabre have said more, based on his evidence?*

Still, Fabre has doubts, and continues to experiment according to the same plan for several more days. No males without antennae return. After eight days, the female dies, and puts an end to further tests. In all, about 150 males visited the cage during the eight nights of the experiment.

QUESTIONS:

- *Why does Fabre repeat the experiment each night? What is the value of repeating the same experiment several times?*
- *Are the new data convincing?*
- *What new questions do you think Fabre has now?*

Fabre is left with troublesome new questions:

“What is the meaning of the staying away of those who have lost their antennae? Does it show that the absence of these organs has made them incapable of finding the wire bell in which the prisoner awaits them? Not at all.They prove only that their time is up.... and their non-return is valueless as evidence. For lack of time necessary for experimenting, the part played by the antennae escapes us. Doubtful it was and doubtful it remains.”

QUESTIONS:

- *Why is Fabre unable to draw a firm conclusion? What variable in the experiment can he not control?*
- *Why is he still doubtful? How do his doubts relate to his prior knowledge of the moth's life cycle?*
- *Fabre is skeptical. Is this a good trait in a scientist? Why or why not?*

INTERPRETING THE RESULTS LEADS TO A NEW IDEA

Fabre rethinks the experimental situation. Cocoons of the great peacock moth were very rare in his area because the almond trees on which the caterpillars feed were scarce. The nearest almond trees were about a mile and a half away. So these males must have traveled a great distance. How did they find their way? Both sight and sound seem out of the question, and he thinks that only the sense of smell remains as a possibility. He concocts a smelly new experiment.

QUESTIONS:

- *Why does Fabre think that sight and sound are out of the question? How does he rely on his prior knowledge of the moth to come to this conclusion?*
- *Suggest a new experiment that focuses on the male moth's sense of smell.*

THE SECOND EXPERIMENT

Fabre reasons that if he masks the odor that the female might be giving off to attract a mate, then the males will not be able to find her. So he sprinkles naphthalene (a very strong smelling chemical made from coal tar) around the room. For good measure he also places a capsule full of it right inside the female's wire cage. The odor in the room is powerful, almost overwhelming to humans.

QUESTIONS:

- *Make a prediction: What do you think happens next?*
- *If no males arrive, what might that mean? If males do arrive, what might that mean?*

Result: the male moths arrive again that night and fly straight to the caged female.

QUESTIONS:

- *Draw a conclusion from the evidence.*

Within days, this female dies too, and there is no more to be done until next year.

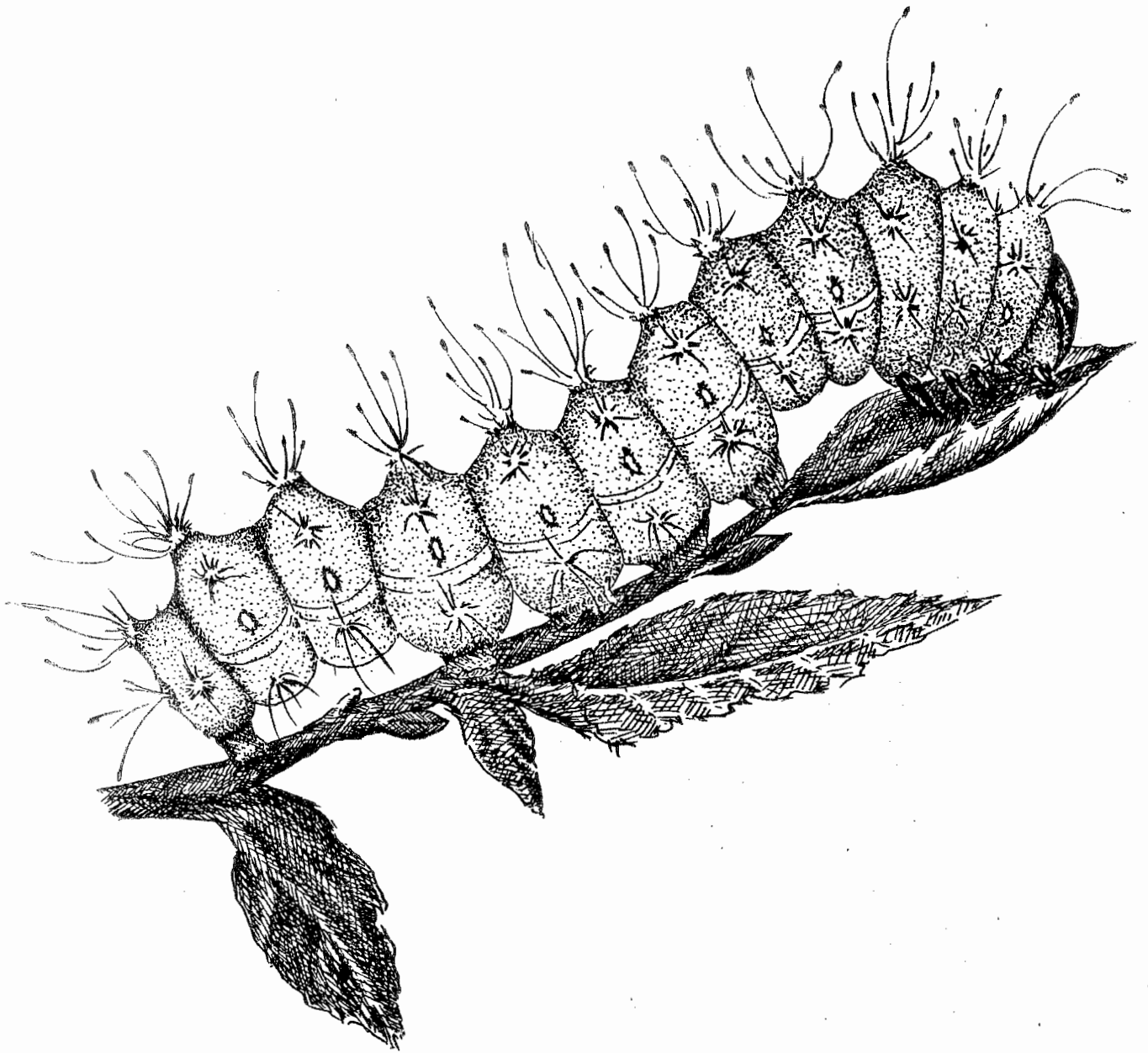
PERSISTENCE

The following summer, Fabre enlists the help of neighborhood children to collect great peacock moth caterpillars and he raises a crop for his experiments. Unfortunately, bad weather kills them all, and he has to wait until the following year to continue.

In the next year, he again collects and raises caterpillars, this time successfully. In addition to repeating his old experiments, he devises several new ones to find answers to some new questions.

QUESTION:

- *Why do you think it is important for Fabre to repeat some of his old experiments?*
- *What new questions do you think he will use as a basis for his next experiments?*
- *Where do ideas for experiments come from?*



Vabre enlists the help of neighborhood children to collect great peacock moth caterpillars and he raises a crop for his experiments.

A NEW IDEA

The recently invented wireless telegraph has sparked a remarkable new idea in Fabre's mind:

".....Can the newly hatched bride have at her disposal electric or magnetic waves, which one sort of screen would arrest and another let through? ...Does she employ a kind of wireless telegraphy? I see nothing impossible in this: insects are accustomed to invent things quite as wonderful."

QUESTIONS:

- *Restate Fabre's new question in your own words.*
- *What kinds of experiments might he do to find out if the female moth gives off electrical or magnetic messages to attract the male?*

THE THIRD EXPERIMENT

Fabre sets about building different kinds of boxes, each of a different material: tin, wood, and glass. One at a time, he carefully seals a female inside each different kind of box and blocks all the openings with thick putty.

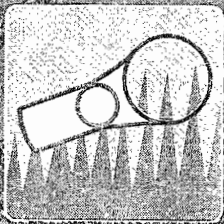
QUESTIONS:

- *What new variable has Fabre changed? Notice that this variable involves only the female. The antennae of the males will not be removed.*
- *Why do you think Fabre built boxes of different materials to enclose the females?*
- *Make a prediction: What do you think happened?*
- *Do you think females transmitted magnetic or electrical waves and attracted males through the sealed boxes?*

Result: With the female tightly sealed in, not a single male ever arrives. But once when Fabre put a female in a cardboard hatbox inside a closed wooden cupboard, male moths soon swarmed around the cupboard doors.

QUESTION:

- *Explain what you think was happening because of the different types of containers. What kinds of materials would transmit electrical and magnetic signals? What kinds would let an odor escape?*



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