

# Cursed Curd Entomology Exam **Key**



March 15-22, 2025

Instructions:

- You will have **50 minutes** to complete your exam. At the end of this time period, you must stop working. Partial credit will be awarded, so attempt as many questions as you can!
- Each team is allowed a 2" or smaller 3-ring binder, one field guide, a magnifying glass, and a copy of the National list of insects.
- **Ties will be broken** from the responses of questions, as specified in the test.

School/Team Name: \_\_\_\_\_

Team Number

Written by Ren Chai (Montgomery High School '25), Krish Shah (Seven Lakes High School '25), also Eddie

Questions? Comments? Email us here:  
[aaron.chai.mtsd@gmail.com](mailto:aaron.chai.mtsd@gmail.com) — [krishshah676@gmail.com](mailto:krishshah676@gmail.com)

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# Introduction

We, uh, lost our original test, so we asked everyone else to help us patch together a new one.

## Air Trajectory

We got tired of aiming the launcher, so we're trying to get an insect to do it instead.

1. (1 point) Which of the following describes a type of insect leg that specializes in jumping?  
A. Cursorial B. Fossorial C. Natatorial D. Raptorial **E. Saltatorial**



2. (1 point) Identify the above specimen to the lowest taxonomic level on the 2025 National Entomology List.

**Acrididae**

3. (2 points) What is the tarsal formula of this specimen?

**3-3-3**

4. (2 points) What structure allows insects to jump so many times higher than their body height, and why?

**Solution: Exoskeleton has a high surface area (1), which provides a higher surface area for muscles to pull on (1)**

5. (1 point) Which of the following best describes this species?  
A. Apterygota **B. Neoptera** C. Paleoptera D. Polyptera
6. (1 point) True or false: Some species in the same order/family as this specimen could jump 0.5 meters vertically onto an elevated target.  
**A. True** B. False

7. (2 points) Imagine placing one of these insects in the launch area. How many of the following near target distances could the insect jump to? In other words, which of these horizontal distances could this insect jump? You may assume that this specimen is the longest jumping species in the order/family and that this is a standing jump.
- 2 m
  - 4 m
  - 6 m
  - ✓ **None of these**

## Anatomy and Physiology

8. (1/2 point) What is the function of sclerotin in the insect cuticle?

**Solution: Sclerotin makes the cuticle hard and tough.**

9. (1/2 point) What is the function of resilin in the insect cuticle?

**Solution: Resilin makes the cuticle elastic.**

10. (1/2 point) What is the function of ecdysone in insects?

**Solution: An increase in ecdysone triggers molting.**

11. (1 point) Which of the following are NOT shed when an insect molts? Select all that apply.

- Stomodaeum
- ✓ **Mesentron**
- Proctodaeum
- Tracheae
- ✓ **Tracheoles**

12. (1 point) When an insect emerges from its discarded cuticle, they are roughly the same size. How do insects increase in size when they molt?

**Solution: Shortly after emerging, insects can inflate their bodies by pumping hemolymph and inflating air sacs before their exoskeleton hardens.**

13. (1½ points) Most insects have a hinge joint or ball-and-socket joint between the coxa and trochanter. However, weevils have a different type of joint. What type of joint is it? What sort of advantage does it confer?

**Solution: Screw joint. It helps weevils climb and improves their grip underneath the body.**

14. (2 points) Select the four muscle types in insects.

- Appendicular**
- Axial
- Cardiac
- Digestive
- Flight**
- Granulated
- Segmental**
- Smooth
- Visceral**

15. (1½ points) Which of the following muscles are asynchronous? Select all that apply.

- Abductor muscles of cerci in Dermaptera
- Adductor muscles of cerci in Dermaptera
- Cibarial pump muscles in Hemiptera
- Extensor muscles of maxillae
- Flexor muscles of maxillae
- Flight muscles**
- Haltere muscles in Diptera**
- Malpighian tubule muscles
- Tymbal muscles in Cicadidae**

16. (1½ points) Why are sarcoplasmic reticula more densely packed in synchronous muscles than asynchronous muscles?

**Solution: The sarcoplasmic reticulum is an organelle that regulates  $Ca^{2+}$  ion concentration. Asynchronous muscles have a tonic concentration of  $Ca^{2+}$  ions instead of a concentration that cycles with each contraction; Since they can generate power at a constant concentration, they don't need the same density of sarcoplasmic reticula as synchronous muscles. A tonic concentration of  $Ca^{2+}$  gives them a long twitch duration, so they keep moving for longer after a nerve impulse than a synchronous muscle.**

# Astronomy



*Scarabaeus* is a genus of dung beetles. They will go to dung heaps, form balls of dung, and roll them away from the heaps.

17. (1/2 point) What family is *Scarabaeus* the type genus of?

**Solution: Scarabaeidae**

18. (1/2 point) *Scarabaeus* beetles are rollers. What are the other types of dung beetles? (You may select multiple options.)

- Borers
- Buriers
- Dwellers
- Stackers
- Tunnelers

19. (2 points) Why is it important for these beetles to quickly move dung balls away from the dung heap?

**Solution: Intraspecific competition. Dung beetles will often steal balls of dung from each other, and quickly rolling the balls away from the dung heap reduces the chance that another beetle will steal the ball, as competition is the fiercest closest to the dung heap.**

20. (1 point) In a 2003 study by Dacke et al., researchers found that *Scarabaeus zambesianus* could navigate using the polarization of moonlight.

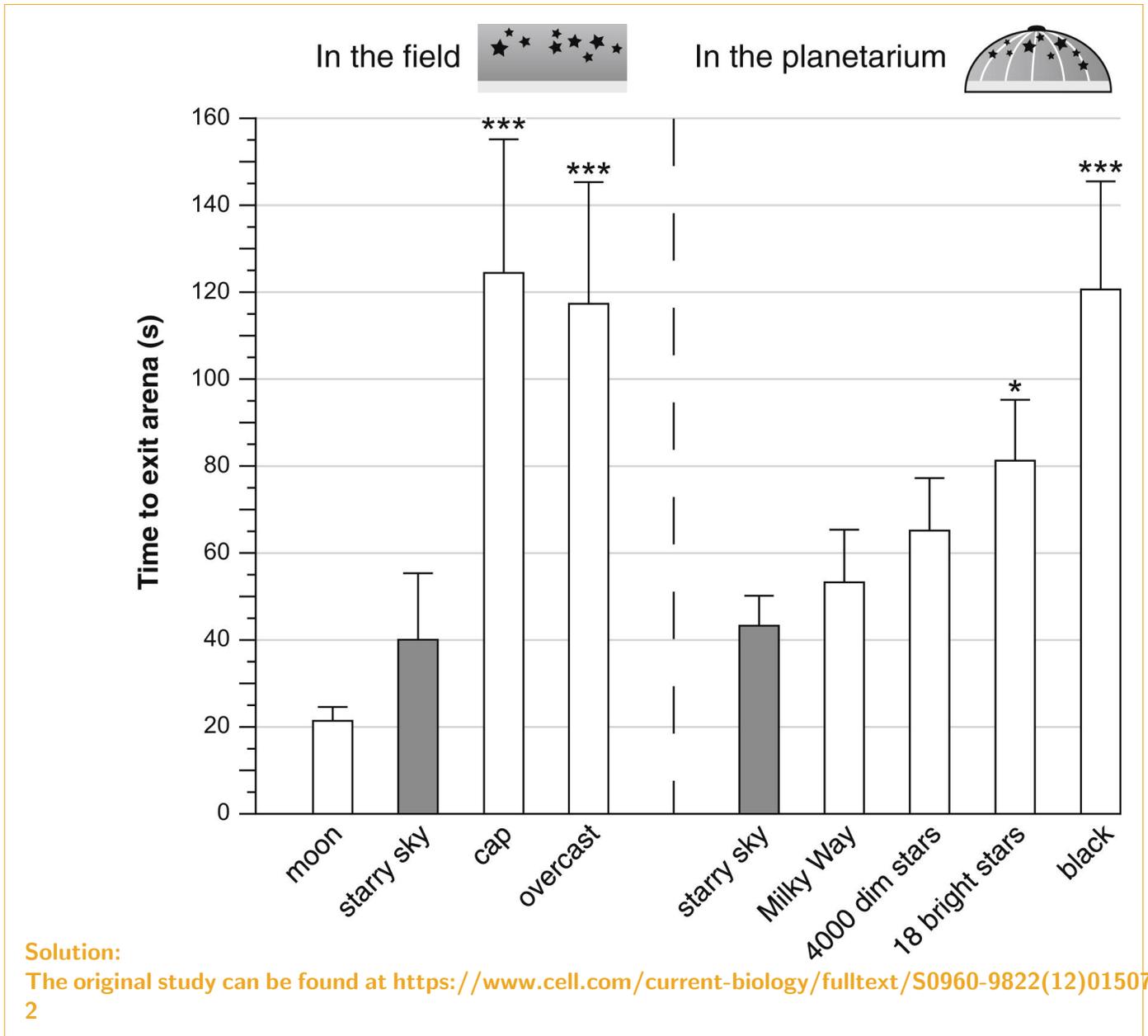
**Solution:** The study can be found at <https://www.nature.com/articles/424033a>

21. (3 points) In a 2009 study by Dacke et al., researchers found that *Scarabaeus satyrus* used multiple different features of the night sky to navigate. One of their experiments involved putting beetles inside a planetarium, onto which they projected certain features of the night sky, and seeing how fast the beetles could roll their balls to the edge of a circular arena from a dung heap at the center.

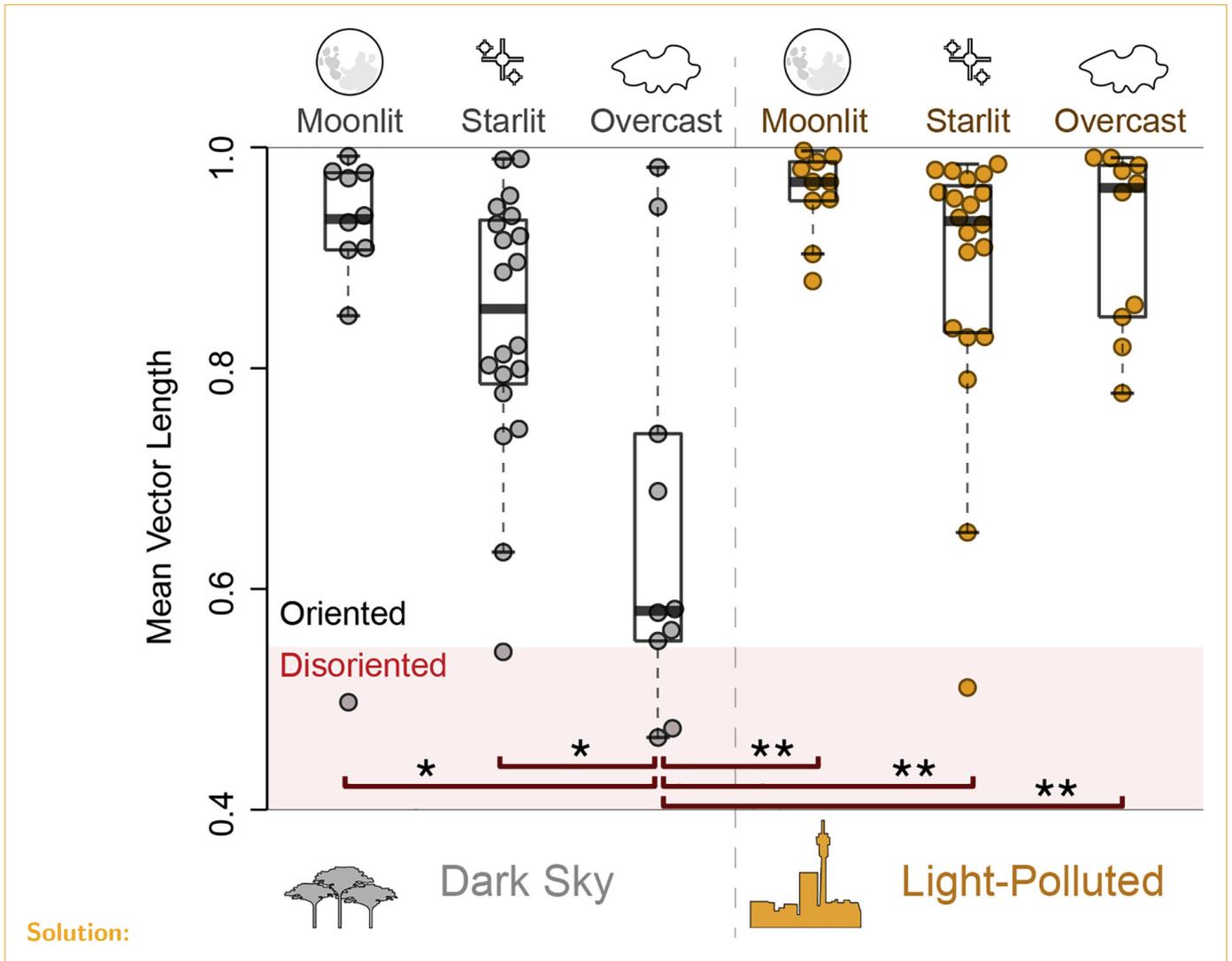
Order the visual stimuli from least to most rolling time of the beetles:

1. Complete starry sky, with more than 4000 stars and the Milky Way
2. 4000 dim stars
3. Just the Milky Way
4. The 18 brightest stars
5. Total darkness

**Solution:** 1, 3, 2, 4, 5



22. (1/2 point) In a 2021 study by Foster et al., scientists investigated whether light pollution interfered with *Scarabaeus satyrus*'s ability to navigate at night. In which of the following conditions was the difference in dung beetle orientation precision the largest?  
 A. Moonlit B. Starlit C. Overcast
23. (1/2 point) In the condition specified in the previous question, where was orientation more precise?  
 A. Light-polluted urban site B. Dark sky rural site



24. (1 point) Why was that the case?

**Solution: The dung beetles switched to finding their orientation using landmarks on the ground instead of in the sky.**

-OR-

**Light pollution made it harder for the dung beetles to orient themselves using the sky.**

25. (1 point) Foster et. al. found that turning on a single floodlight nearby created a beaconing effect, in which beetles were much more likely to head towards the light. What piece of insect collecting equipment makes use of this effect?

**Solution: Light trap**

**Solution: The original study can be found at [https://www.cell.com/current-biology/fulltext/S0960-9822\(21\)00833-2](https://www.cell.com/current-biology/fulltext/S0960-9822(21)00833-2)**

# Bungee Drop

Nothing in the rules of Bungee Drop says that you can't build your cord out of living creatures!



As this screenshot from a viral video shows, ants are definitely strong enough to form a chain long enough for Bungee Drop.

26. (4 points) How did this structure form?

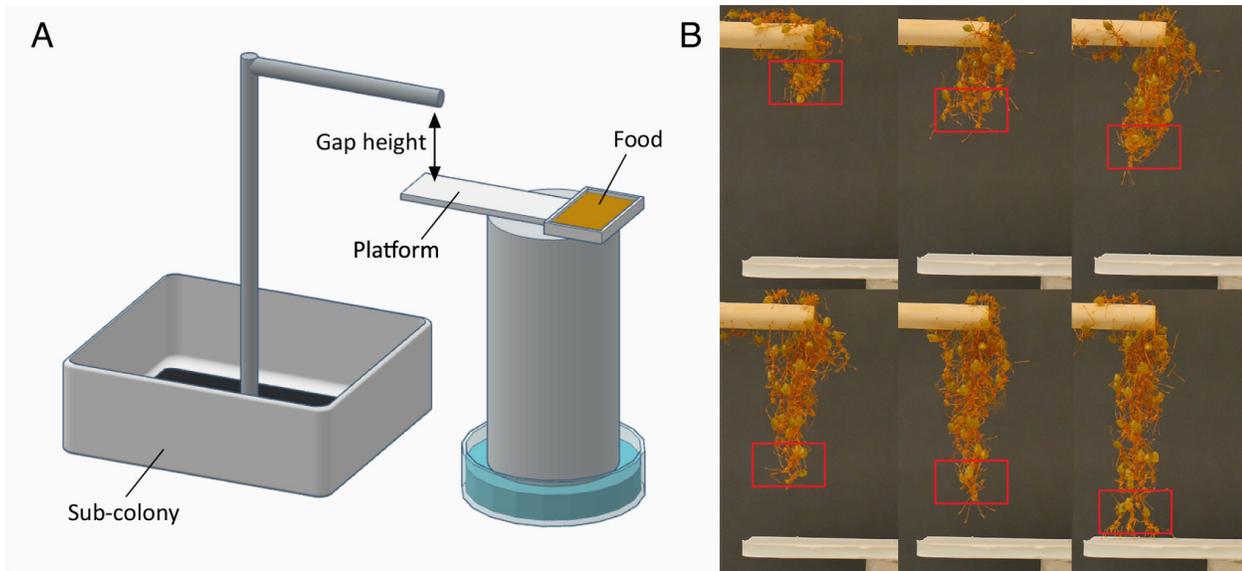
**Solution: According to Dr. Daniel Kronauer: Ants were walking along the underside of the overhang to forage at the paper wasp nest. The traffic was sufficiently heavy that ants began to form flanges, with a layer of ants holding on to each other forming to facilitate the traffic. Under the weight of all the ants, part of the flange became detached from the overhang, forming a small loop. As the loop was pulled downwards, more ants came to reinforce it and it grew in length. It expanded horizontally as more ants were unable to cling to the horizontal surface. Eventually, the loop was attached at only the two strongest points: the edge of the overhang and the wasp nest.**



A 2015 study by Reid et al. investigated the formation of army ant bridges horizontally.

27. (2 points) Where on the bridge shown above did the ant bridge form, and how did the size and position of the ant bridge change over time?

**Solution:** They found that ant bridges start at the narrowest point of the gap. As ant traffic increases, more ants join the bridge, making it longer and covering a wider gap. This creates a more direct path for foraging ants.



A 2023 study by Carlesso et al. investigated how weaver ants decide to form chains to bridge vertical gaps.

28. (2 points) How did the ants decide whether or not to make a chain?

**Solution:** Each individual ant walks to the end of the chain and estimates the length of the gap remaining. (For the first ant, the end of the chain is the surface it is on.) It decides whether or not it is worth it to add on to the end of the chain. Eventually, the chain is either completed, or the ants forming the chain give up.

29. (2 points) How did the researchers manipulate the ants to forming chains with longer total lengths?

**Solution:** The researchers slowly moved the bottom platform down and kept the remaining gap length at a constant length.

# Chemistry Lab



30. (1 point) Identify the above specimen to the lowest taxonomic classification on the national list.

**Reduviidae**

31. ( $\frac{1}{2}$  point) Which of the following best describes the metamorphosis of this specimen?  
A. Ametabolous B. Anisometabolous **C. Hemimetabolous** D. Holometabolous
32. (2 points) Briefly state the function(s) of this specimen's saliva.

**Solution: Kills/paralyzes prey or liquefies the insides for extraoral digestion (2 for any of these)**

33. (1 point) Name a general class of enzyme that you would expect to see in the saliva of this species.

**Protease/Phospholipase**

34. ( $1\frac{1}{2}$  points) Is this specimen a good candidate for a biological control program? What makes it a good/bad candidate?

**Solution: Yes ( $\frac{1}{2}$ ) because it kills more than needed to eat/can kill things larger than it (1)**

**Solution:** Information from [https://biolifejournals.com/pdf/cimg020605\\_321n.pdf](https://biolifejournals.com/pdf/cimg020605_321n.pdf)



35. (1 point) Identify the above specimen to the lowest taxonomic classification on the national list.

**Carabidae**

36. ( $\frac{1}{2}$  point) This specimen's tribe is named for a specific chemical defense mechanism possessed by the tribe. Given that this reaction is highly exothermic, which of the following would most likely best describe the temperature of the fluid that is released?  
 A. Cold    B. Lukewarm    **C. Hot**    D. Depends on ambient temperature
37. ( $1\frac{1}{2}$  points) Given that the reaction occurs between  $\text{H}_2\text{O}_2(\text{aq})$  and  $\text{C}_6\text{H}_4(\text{OH})_2(\text{aq})$ , predict the balanced chemical reaction that occurs between them. You are not required to write the states/phases.

**Solution:**  $\text{C}_6\text{H}_4(\text{OH})_2(\text{aq}) + \text{H}_2\text{O}_2(\text{aq}) \longrightarrow \text{C}_6\text{H}_4\text{O}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ ,  $\frac{1}{2}$  for  $\text{C}_6\text{H}_4\text{O}_2$  as a product,  $\frac{1}{2}$  for  $\text{H}_2\text{O}$  as a product,  $\frac{1}{2}$  for the correct coefficients (1 & 2).

38. (1 point) What is chemical responsible for the irritating effect of this chemical defense mechanism?

**1,4-benzoquinone or para-quinone,  $\frac{1}{2}$  for  $\text{C}_6\text{H}_4\text{O}_2$**

## Codebusters

These insects encode a secret word! You'll have to identify them first.



1



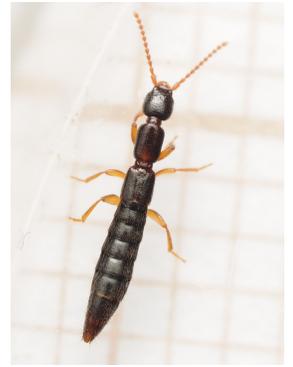
2



3



4



5



6



7



8



9



10



11



12



13



14



15



16



17



18



19



39. ( $\frac{1}{2}$  point) Identify specimen 1 to the lowest taxonomic classification on the national list.

**Gryllotalpidae**

40. ( $\frac{1}{2}$  point) Identify specimen 2 to the lowest taxonomic classification on the national list.

**Calliphoridae**

41. ( $\frac{1}{2}$  point) Identify specimen 3 to the lowest taxonomic classification on the national list.

**Lampyridae**

42. ( $\frac{1}{2}$  point) Identify specimen 4 to the lowest taxonomic classification on the national list.

**Lycaenidae**

43. ( $\frac{1}{2}$  point) Identify specimen 5 to the lowest taxonomic classification on the national list.

**Staphylinidae**

44. ( $\frac{1}{2}$  point) Identify specimen 6 to the lowest taxonomic classification on the national list.

**Raphidiidae**

45. ( $\frac{1}{2}$  point) Identify specimen 7 to the lowest taxonomic classification on the national list.

**Asilidae**

46. ( $\frac{1}{2}$  point) Identify specimen 8 to the lowest taxonomic classification on the national list.

**Chironomidae**

47. ( $\frac{1}{2}$  point) Identify specimen 9 to the lowest taxonomic classification on the national list.

**Panorpidae**

48. ( $\frac{1}{2}$  point) Identify specimen 10 to the lowest taxonomic classification on the national list.

**Meloidae**

49. ( $\frac{1}{2}$  point) Identify specimen 11 to the lowest taxonomic classification on the national list.

**Elateridae**

50. ( $\frac{1}{2}$  point) Identify specimen 12 to the lowest taxonomic classification on the national list.

**Vespidae**

51. ( $\frac{1}{2}$  point) Identify specimen 13 to the lowest taxonomic classification on the national list.

**Lestidae**

52. ( $\frac{1}{2}$  point) Identify specimen 14 to the lowest taxonomic classification on the national list.

**Ixodidae**

53. ( $\frac{1}{2}$  point) Identify specimen 15 to the lowest taxonomic classification on the national list.

**Siphonaptera**

54. ( $\frac{1}{2}$  point) Identify specimen 16 to the lowest taxonomic classification on the national list.

**Diplura**

55. ( $\frac{1}{2}$  point) Identify specimen 17 to the lowest taxonomic classification on the national list.

**Gomphidae**

56. ( $\frac{1}{2}$  point) Identify specimen 18 to the lowest taxonomic classification on the national list.

**Dermaptera**

57. ( $\frac{1}{2}$  point) Identify specimen 19 to the lowest taxonomic classification on the national list.

**Myrmeleontidae**

58. ( $\frac{1}{2}$  point) Identify specimen 20 to the lowest taxonomic classification on the national list.

**Mantodea**

Now, let's decode this word!

59. (0 points) Write out the SECOND letter of each order/family name, in order.  
(You can skip to a later step in the decoding process without losing points.)

**Solution: R A A Y T A S H A E L E E X I I O E Y A**

60. (0 points) Change all letters from A to M (inclusive) to A, and all other letters to B.

**Solution: B A A B B A B A A A A A A B A B A B A**

a: AAAAA h: AABBB o: ABBBA v: BABAB  
 b: AAAAB i: ABAAA p: ABBBB w: BABBA  
 c: AAABA j: ABAAB q: BAAAA x: BABBB  
 d: AAABB k: ABABA r: BAAAB y: BBAAA  
 e: AABAA l: ABABB s: BAABA z: BBAAB  
 f: AABAB m: ABBAA t: BAABB  
 g: AABBA n: ABBAB u: BABAA

61. (0 points) Use the 26-letter Baconian table to decode the secret word. (Greatest apologies to those of you who have memorized the 24-letter table.)

**Solution: TICK**

62. (1 point) The encrypted word corresponds to which image?

**Solution: 14**

## Disease Detectives



63. (1 point) Identify the order of the above specimen.

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**Ixodida**

64. (1 point) Which of the following describes this specimen's diet?  
A. Detritivorous B. Folivorous C. Frugivorous **D. Sanguivorous**
65. (2 points) Which of the following are spread by this specimen? (select all that apply)
- Lyme's disease**
  - Chagas disease
  - Powassan encephalitis**
  - Rocky Mountain Spotted Fever**
  - Zika virus
66. (1 point) What term describes a parasitic infection of fly larvae into the skin?

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**Myiasis**

67. (1 point) Which of the following are primary families involved in the aforementioned process? Ignore families involved in the accidental process. (select all that apply)

- Bombyliidae
- Tephritidae
- Calliphoridae
- Muscidae



68. (1/2 point) Identify the ORDER of this specimen.

**Diptera**

69. (1/2 point) The above specimen would likely transmit which of the following diseases?

- A. Onchocerciasis B. Tularaemia C. Tungiasis **D. West Nile Virus**

70. (2 points) Suggest four ways of controlling an outbreak of the disease above.

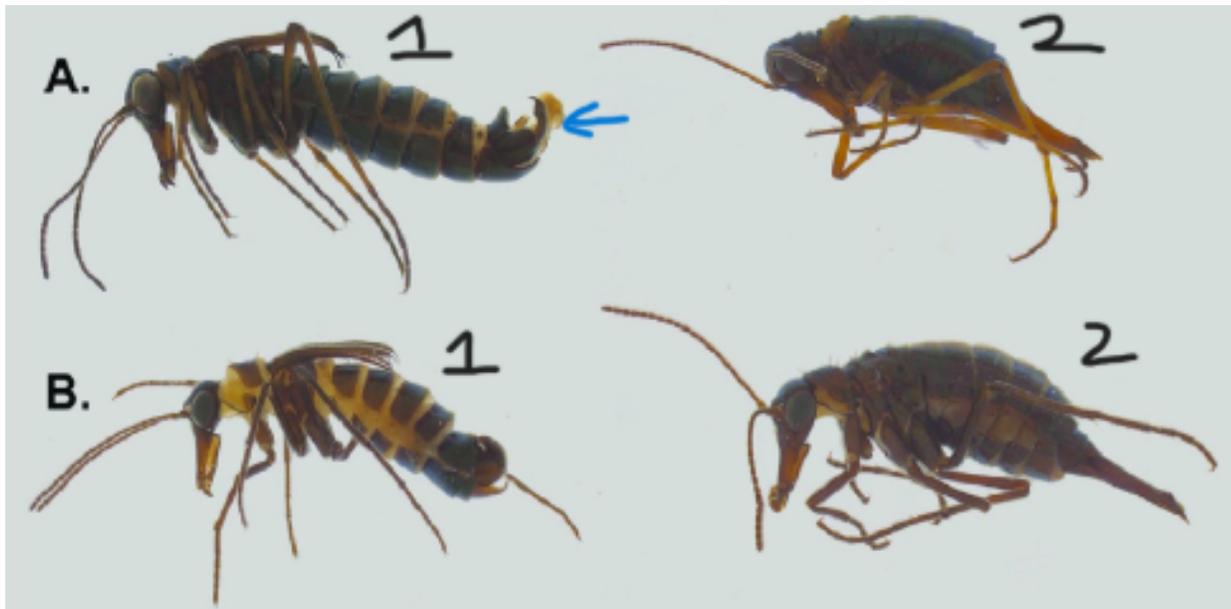
**Solution: Mosquito nets, eliminate standing water, deploy mosquito traps, insecticides targeting adults, water-based insecticides targeting larvae, release predators of larvae to water**

71. (1 point) Which order contains the insects that transmit typhus?

**Psocodea**

## Dynamic Planet

You were wandering around the glacier areas trying to study how glaciers were formed in the boreal forests of the north when you stumbled upon these bugs... didn't know what they were but you collected a few samples.



72. ( $\frac{1}{2}$  point) Identify the order of these insects.

**Solution: Mecoptera**

73. ( $\frac{1}{2}$  point) Identify the family of these insects.

**Solution: Boreidae**

74. (1 point) Which insects are male? Select all that apply.

A1

A2

B1

B2

75. (2 points) What distinguishing factors differentiate the two, and what is exhibited?

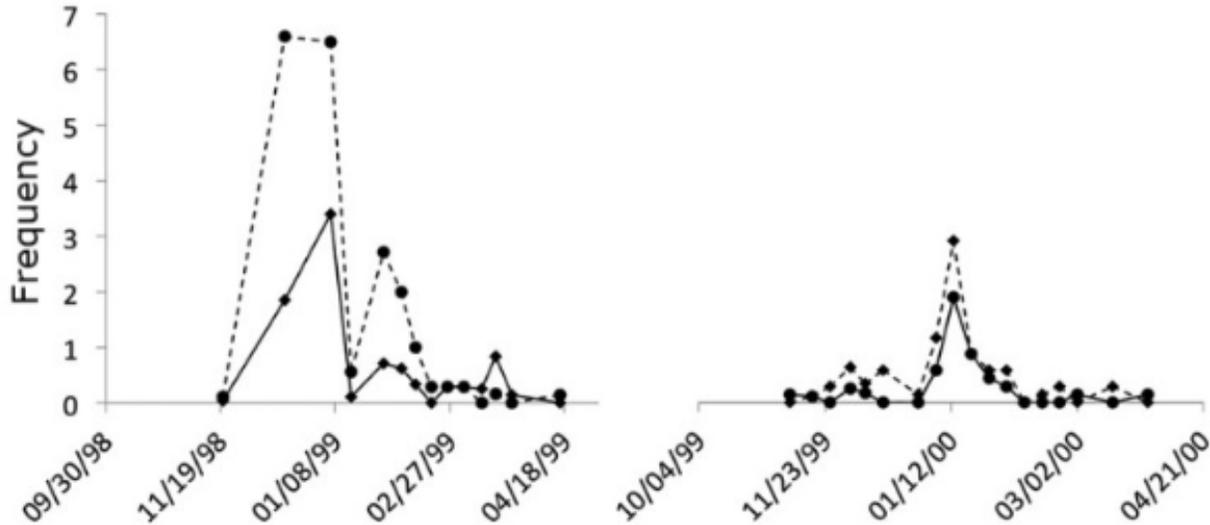
**Solution: Possible solutions for point 1: Wing structure: males have short reduced wings, females don't have wings. Abdomen & Genitalia: males have upturned abdominal tips with claspers and females have an ovipositor. Size: Males are smaller and slender.**  
**Possible solutions for point 2: Sexual dimorphism**

76. ( $\frac{1}{2}$  point) The blue arrow is pointing to the claspers of specimen A1.

77. ( $\frac{1}{2}$  point) What is that structure used for?

**Solution: Grabbing females during mating**

You collected more data with pitfall traps that you set up during the few trips back and forth from the glaciers in the boreal forests. Here is data from the traps:



78. (1 point) Which line (dotted or full) represents the female and which line represents the male? How would you know?

**Solution: The dotted line represents the males because they are typically more active, especially during the winter/mating season.**  
**+1/2 for mentioning how they mate during the winter; +1/2 for mentioning that they are more active in general**

You also spotted another insect along your grand walks along the edges of the melting glaciers (caused by climate change (ouch)) after dark.

79. (1 point) What order is this insect most likely from? (You don't get a picture.)

**Solution: Notoptera**

80. (1 point) What term, which stems from the locations it inhabits, is used to describe it?

**Solution: Extremophile**

81. (1 point) You identify this insect as a female. List two places where you could find its eggs.

**Solution: Wood/Stone/Decaying plants. NO points if moss.**

82. (1 point) You attempt to carry all the insects in your hand to examine further. Unfortunately, they all died. Why?

**Solution: All of these insects are adapted to tolerate cold temperatures and avoid freezing. However, this gives them a narrow range of temperatures they can tolerate. They died from being too hot or from desiccating.**

## Ecology

83. (1 point) Which of the following terms refers to a species that is used to determine the health of an ecosystem?  
A. Flagship   **B. Indicator**   C. Keystone   D. Sentinel



84. (1 point) Identify the order of the above specimen.

**Ephemeroptera**

85. (1 point) What is the name of the unique winged immature form of this order?

**Subimago**

86. (1 point) Adults of this order tend to be...

- Primary consumers
- Secondary consumers
- Tertiary consumers
- Decomposers
- None of these**

87. (2 points) Describe the role of this specimen in bioturbation and which stage of development is most directly involved in this process.

**Solution: Nymphs/naiads (1), bioturbation is modifying soil, so the answer can be anything related to the nymphs burrowing into soil, changing currents, etc. (1)**

88. (2 points) The EPT index refers to three specific insect orders that are usually used to determine water quality. This specimen is from one of these orders. Name the other two.

**Plecoptera**

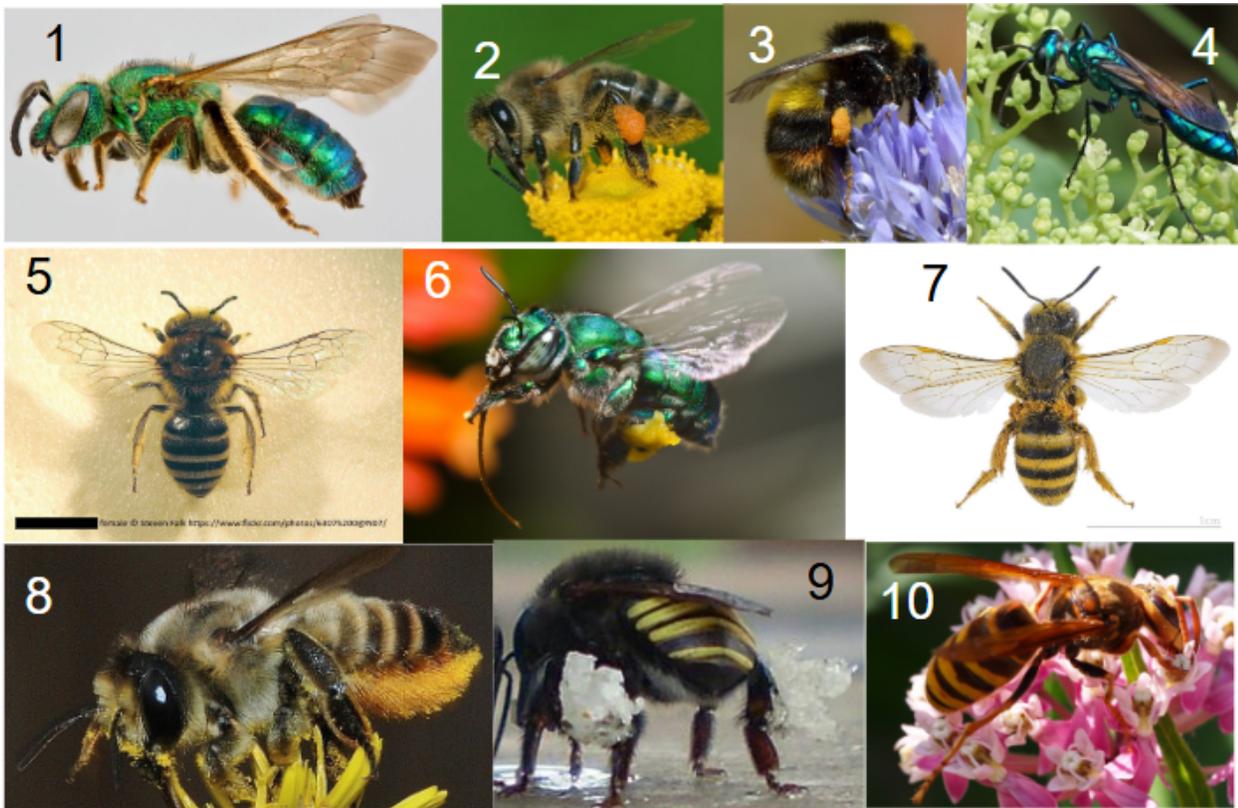
**Trichoptera**

89. (2 points) A high EPT index would likely indicate which of the following? (select all that apply)

- Low water quality
- High water quality**
- Low evenness
- High evenness
- Low richness

## Entomology

Yes, there is an Entomology section on the Entomology test.



When identifying the insects, keep in mind that the same family may be used more than once.

90. (1/2 point) Identify the family of insect 1.

Halictidae

91. (1/2 point) Identify the family of insect 2.

Apidae

92. (1/2 point) Identify the family of insect 3.

Apidae

93. (1/2 point) Identify the family of insect 4.

Sphecidae

94. (1/2 point) Identify the family of insect 5.

Colletidae

95. (1/2 point) Identify the family of insect 6.

Apidae

96. ( $\frac{1}{2}$  point) Identify the family of insect 7.

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**Halictidae**

97. ( $\frac{1}{2}$  point) Identify the family of insect 8.

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**Megachilidae**

98. ( $\frac{1}{2}$  point) Identify the family of insect 9.

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**Apidae**

99. ( $\frac{1}{2}$  point) Identify the family of insect 10.

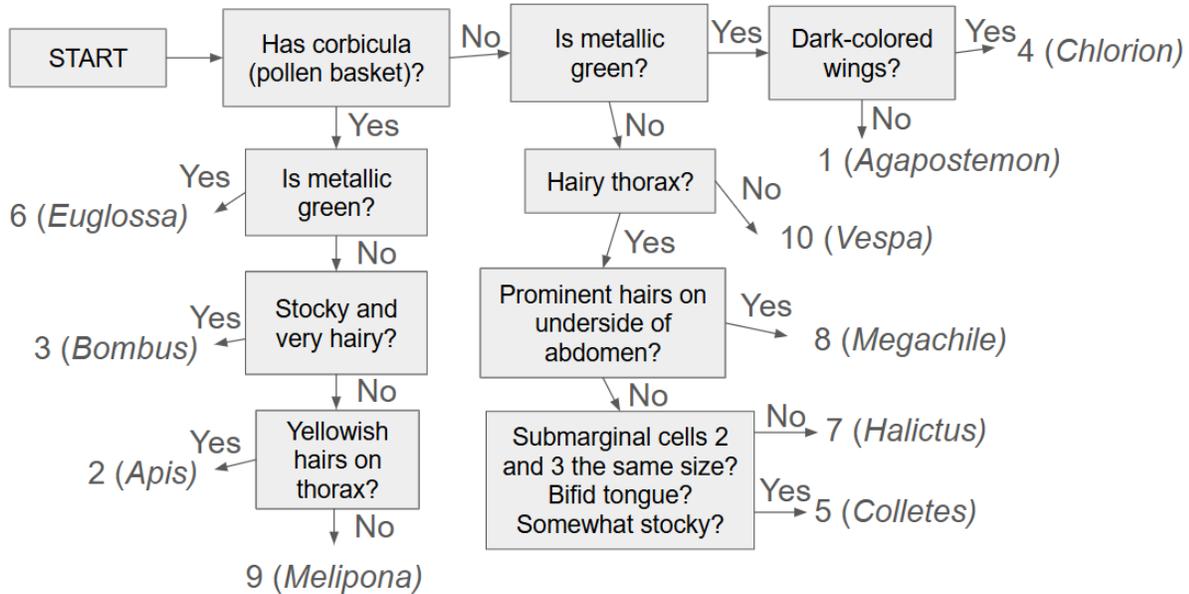
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**Vespidae**

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100. (5 points) **TIEBREAKER #1** Create a dichotomous key for all 10 insects. Identify the insects by number (since multiple insects may share a family). (TIEBREAKER #1)

**Solution: Sample solution (genera names provided here but not expected):**



## Electric Vehicle

I will prove that insects are better at the 10-meter sprint than machines!  
Here is my insect racer:



101. ( $\frac{1}{2}$  point) Identify the order of this insect.

**Solution: Blattodea**

102. ( $\frac{1}{2}$  point) This insect is known to be a household pest. **A. True** B. False

103. ( $1\frac{1}{2}$  points) How fast can this species of insect run? Give your answer in meters per second.

**Solution: 1.5 m/s**

104. ( $3\frac{1}{2}$  points) How does the gait of this insect change as its speed increases? Why?

**Solution: The American Cockroach usually walks on all six legs in an alternating tripod gait, but switches to a bipedal gait (it only runs on the hindmost pair of legs) at the fastest speeds. At such high speeds, the bipedal gait is more energy-efficient.**

105. (1 point) Only one family of insect has a member that can run faster than this insect. What family is it?

**Solution: Cicindelidae**

106. (1 point) How fast can the fastest member of that family run?

**Solution: 2.5 m/s (Record held by *Rivacindela hudsoni*)**

107. (2 points) Why aren't we using that family of insects instead?

**Solution: Tiger beetles sprint for short distances, then stop to regain their vision. This is not ideal for running the full 10 meters.**

## Experimental Design

You will design an experiment testing the behavior of the fruit fly *Drosophila melanogaster*. You have the following materials:

- *Drosophila melanogaster* adults
- Fly enclosures
- Water
- Vinegar
- Apple juice
- Apples
- Bread
- Paper (in sheets)
- Paper cups
- Paper bowls
- Scissors
- Hole puncher
- Measuring cup
- Ruler
- Stopwatch
- Electronic balance

108. (7 points) **TIEBREAKER #4** Describe the procedure of your experiment.

**Solution: Multiple solutions likely exist. A sample solution is given here:**

1. We want to find how vinegar concentration affects attraction of flies.
2. Using the measuring cup, create six water-vinegar solutions of 0%, 20%, 40%, 60%, 80%, and 100% vinegar respectively.
3. Fill one paper cup with 50mL of the 0% solution. Repeat for every other concentration until there is one cup for each concentration.
4. Put a randomly selected fly inside a fly enclosure with the 0% solution cup. Start the stopwatch.
5. Stop the stopwatch when the fly starts feeding from the cup. Record time taken and the concentration of vinegar.
6. Repeat steps 4-5 6 times.
7. Repeat steps 4-6 for every concentration of vinegar.
8. Create a scatter plot for vinegar concentration vs time to feeding. Find a best-fit curve and analyze how strongly the data fits the curve to tell how strongly increasing vinegar concentration affects time to feeding.

109. (1 point) What is your independent variable?

**Solution: (For sample solution above:) Vinegar concentration**

110. (1 point) What is your dependent variable?

**Solution: (For sample solution above:) Time before a fly starts feeding**

111. (1 point) What is your hypothesis?

**Solution: (For sample solution above:) Increasing vinegar concentration causes the time before a fly starts feeding to decrease, since it will be easier to detect.**

## Forensics

The reason why we lost our original copy of the test was because we entrusted it to a certain human named Victor Timothy "Vic Tim" Mann, who was supposed to deliver the test through the forests of Brazil. (It makes sense in context.) Two months after he departed, his dead body was found in an advanced state of decay, with only a small amount of muscle left uneaten.

These larvae were found on Vic Tim's cadaver:



They were distributed all over the body. Additionally, many puparia were found a couple meters away from the body.

112. (1/2 point) Identify this insect's family.

**Solution: Calliphoridae**



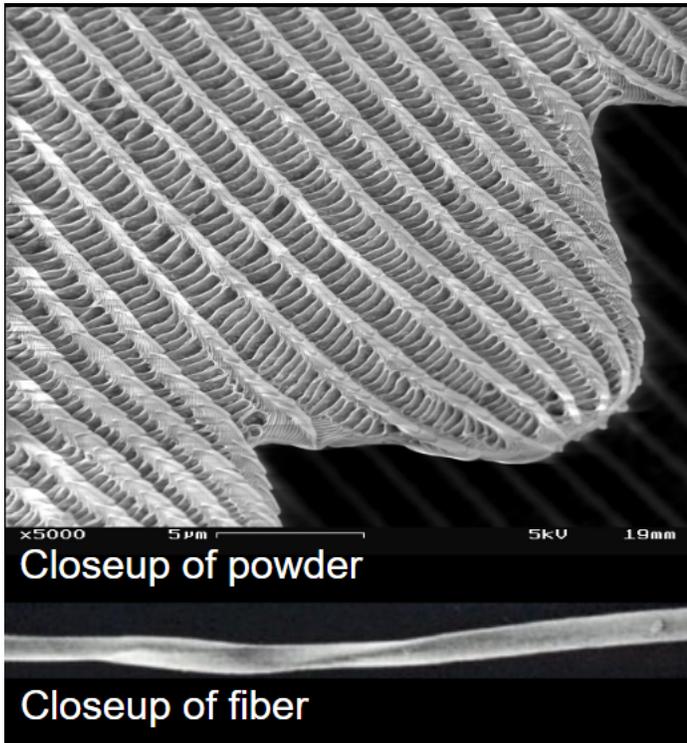
We also found this insect.

113. (1/2 point) Identify this insect's family.

**Solution: Staphylinidae**

114. (2 points) For how long had Vic Tim been dead?

**Solution: 20-50 days (Full credit for single number in this range, or range with its mean in this range)**



We found a very small amount of powder on the body, as well as a couple of fibers. We looked at them under a microscope.

115. (1 point) Identify the powder.

**Solution: Lepidoptera wing scale**

116. (1 point) Identify the fiber.

**Solution: Strand of silk**



Lonoma



Mario



Ruffy



The Tony Gang

Here are our suspects. They have each been given a chance to prove their innocence. (They might be lying.)

**Lonoma:** I was pupating when Mr. Mann died. I can't kill someone while pupating.

**Mario:** Human cadavers are of no use to me, since any meat that I do eat comes from small insects. I'm not a voracious predator of maggots either.

**Ruffy:** Vic Tim was already dead when I got to him. I decided this was as good a spot as any to lay my eggs, so I did.

**The Tony Gang:** Every day, we follow a pheromone trail to our aphid hunting grounds. Then one day a dead body shows up out of nowhere. We took advantage of it, but he was already dead when we got there.

117. ( $\frac{1}{2}$  point) Identify the family of Lonoma.

**Solution:** Saturniidae

118. (1/2 point) Identify the order of Mario.

**Solution: Dermaptera**

119. (1/2 point) Identify the family of Ruffy.

**Solution: Calliphoridae**

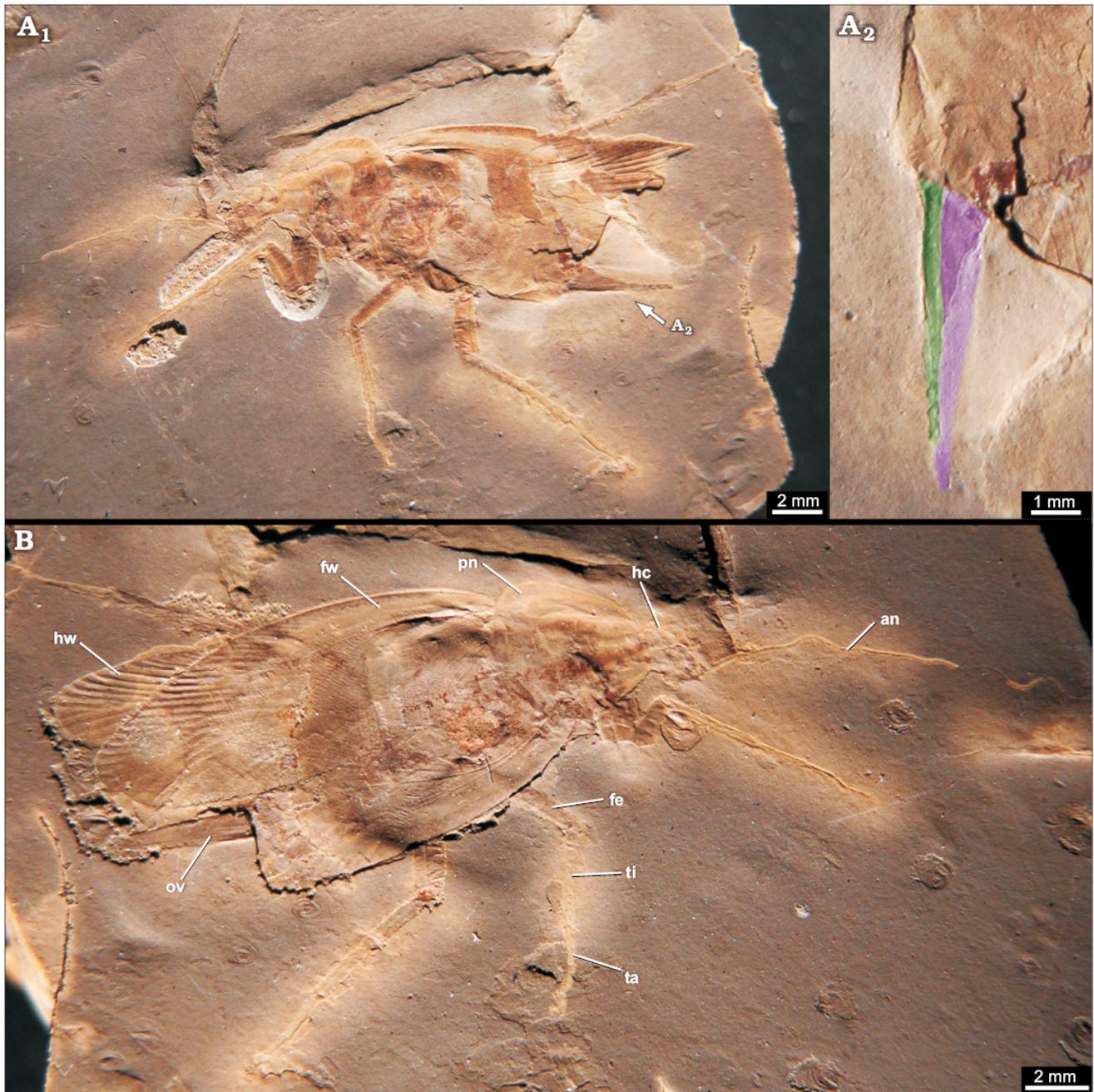
120. (1/2 point) Identify the family of the Tony Gang.

**Solution: Formicidae**

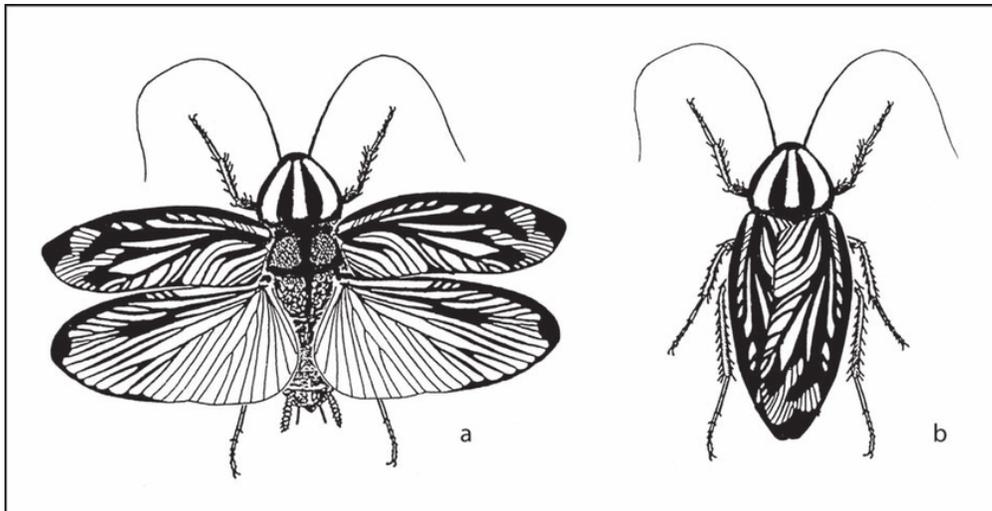
121. (3 points) How did Vic Tim die? (At least one of the suspects was involved.)

**Solution: Vic Tim leaned against a tree that happened to be covered with caterpillars nearing pupation (of which Lonoma was one of them). He got in contact with far too many urticating bristles that injected a powerful anticoagulant into his bloodstream. This anticoagulant melted through his innards, causing internal bleeding. Then he died. Meanwhile, the caterpillars pupated, creating the silk on the crime scene. They then emerged, and some scales from the adults fell off onto the crime scene. (Vic Tim had been dead for long enough for all of that to happen.)**

# Fossils



Fossil insect #1



**Solution:**  
**Reconstruction of Syscioblatta.**

122. (1 point) What family contains the closest living relatives of the above insect?

**Solution: Blattodea or Mantodea (accept either) (It diverged before those two families split from each other)**

123. (1 point) What is the organ highlighted in  $A_2$ ? How does it differ from the insect's closest living relatives?

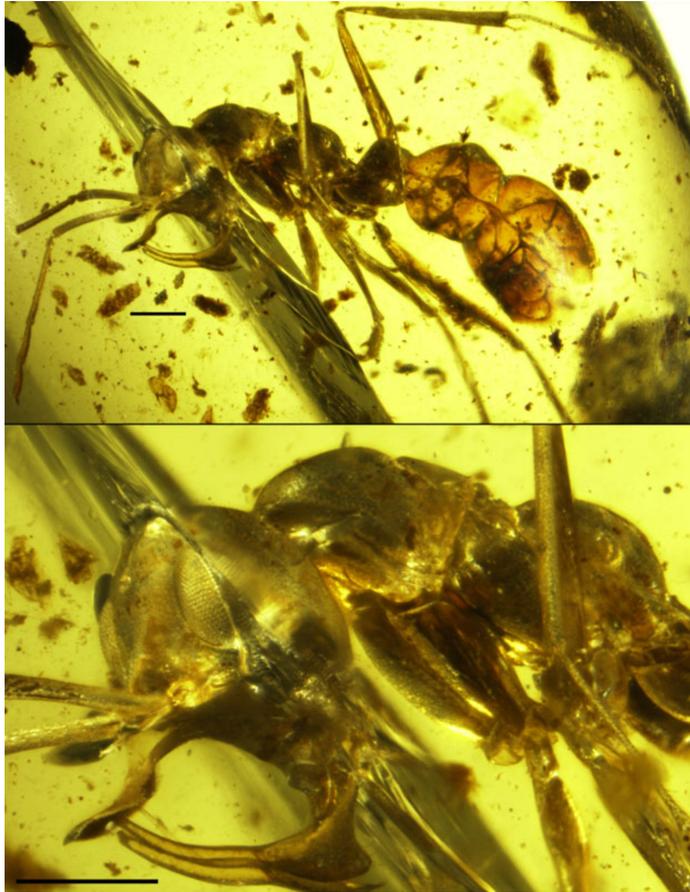
**Solution: It is the ovipositor. Unlike extant members of Dictyoptera, it is long and not adapted for depositing oothecae.**

124. ( $\frac{1}{2}$  point) When it was alive, what did this insect likely feed on?

**Solution: Dead plant and animal matter.**

125. ( $\frac{1}{2}$  point) What type of leg does this insect have?

- A. Cursorial**
- B. Natatorial
- C. Raptorial
- D. Saltatorial



Fossil insect #2

**Solution: *Linguamyrmex vladi***

126. (1 point) Identify the family of this insect.

**Solution: Formicidae**

127. (1/2 point) What is notable about its mouthparts?

**Solution: The mandibles are oriented vertically, not horizontally.**

128. (1/2 point) When it was alive, what did this insect likely feed on?

**Solution: Other insects.**

129. (1 point) What habitat did this insect live in? How can you tell?

**Solution: Amber comes from tree resin, so it likely lived in forested environments. Its long legs suggest it was arboreal.**



Fossil insect #3

**Solution: Meganeura monyi**

130. (1 point) What ORDER contains the closest living relatives of this insect?

**Solution: Odonata**

131. (1 point) What feature of the wing shared by this insect's living relatives does not occur on this insect?

**Solution: Pterostigma**

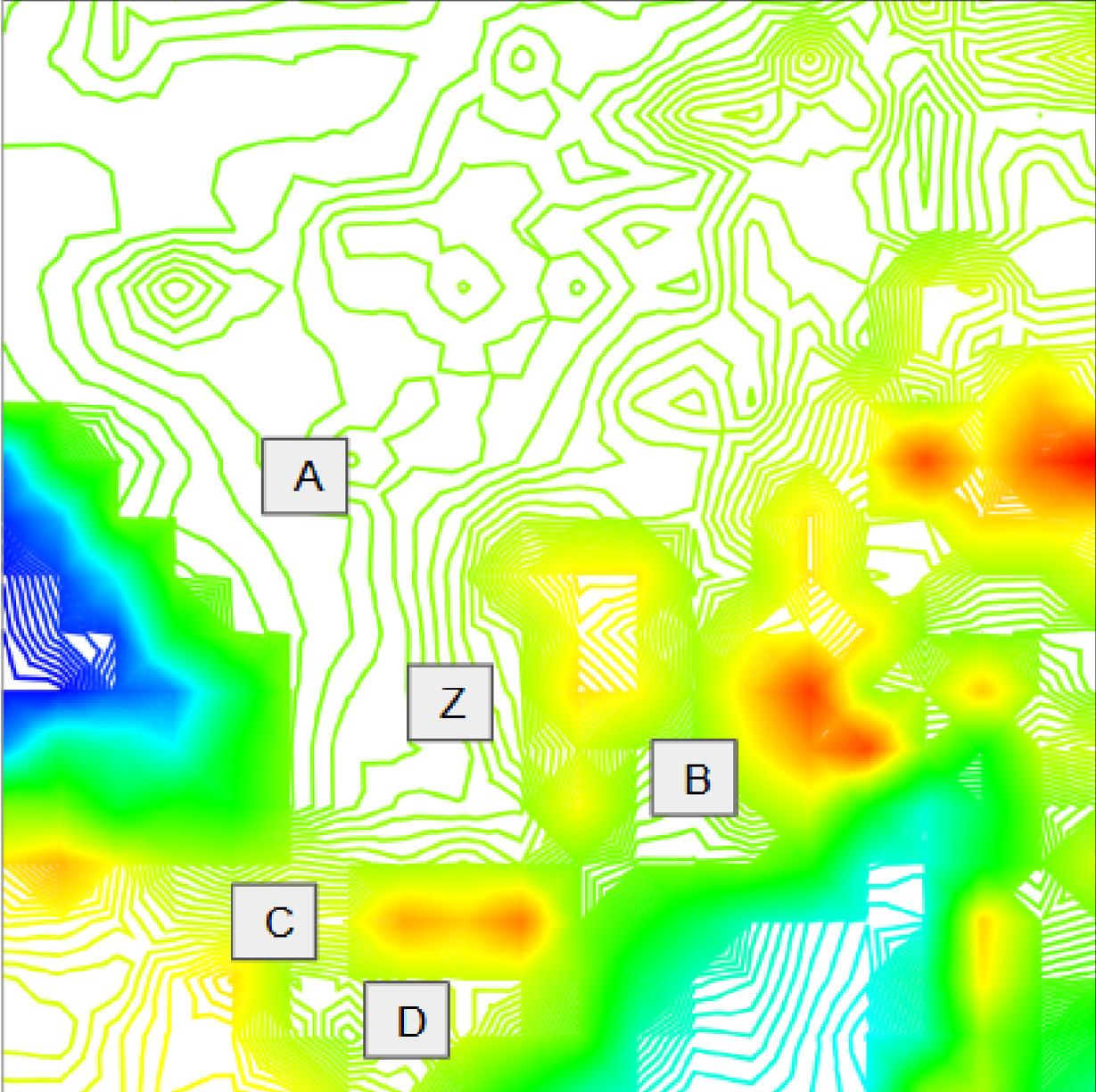
132. (1 point) This insect had a wingspan of 68cm, much larger than any of its living relatives. Give at least one reason why it was able to grow so large.

**Solution: Oxygen levels were higher in the past, allowing larger insects to breathe effectively. It did not have to compete with flying vertebrates for its niche (since flying vertebrates hadn't evolved yet).**

133. (1 point) Which of the fossil insects lived the earliest?

- A. Fossil insect #1
- B. Fossil insect #2
- C. Fossil insect #3**

## Geologic Mapping

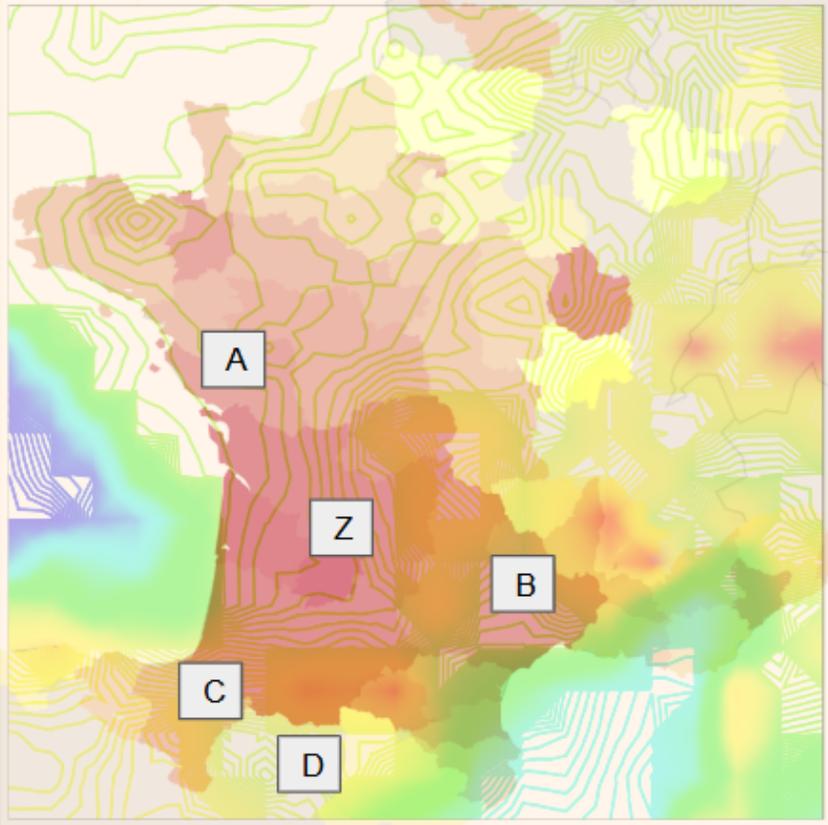


Each line in this topographic map represents 50 meters of elevation.

134. (1 point) In 2004, invasive Asian giant hornets were found at location Z; The hornets began to establish themselves and expanded their range. Which of the following locations was the last to report Asian giant hornet sightings?  
A. A B. B C. C **D. D**

### The Asian hornet is sweeping across south-west Europe

Map shows the hornet has spread from France into Spain, Portugal, Italy, Belgium and Germany



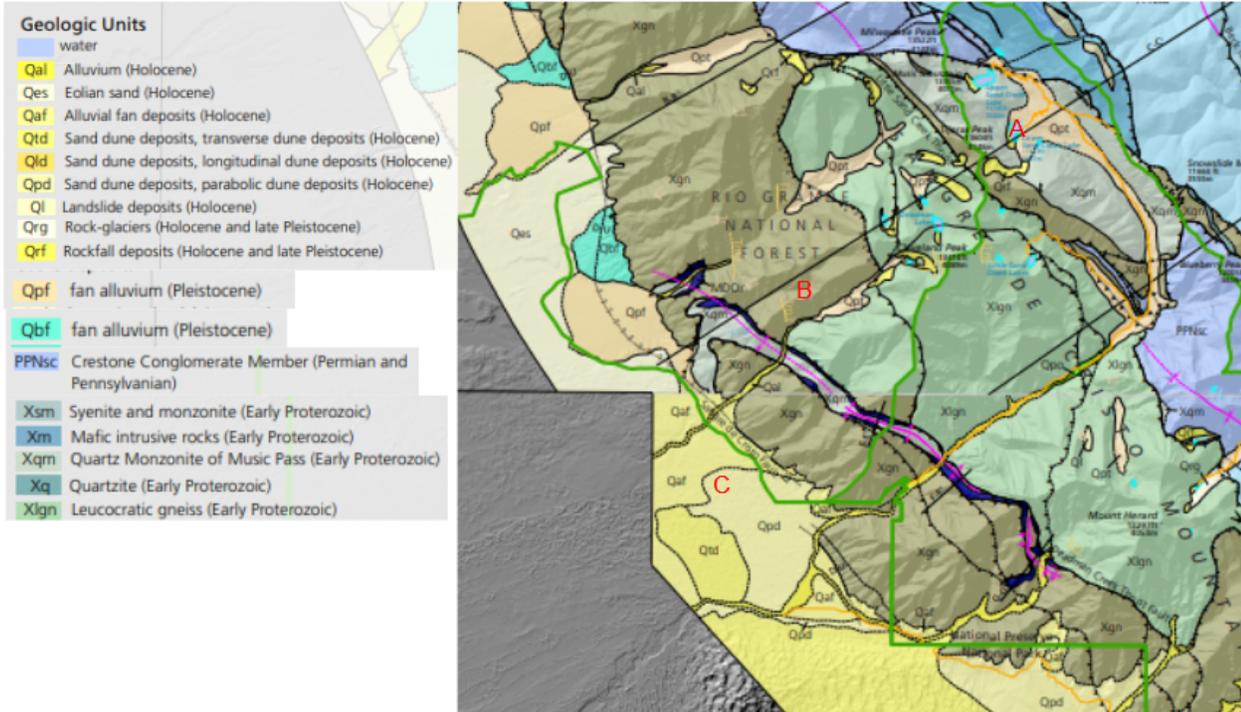
Source: Quentin Rome — Muséum National d'Histoire Naturelle, 2016  
Graphic by John Burn-Murdoch / @burnmurdoch

FT

**Solution:**

135. (2 points) Explain your answer to the above question.

**Solution: The mountains and ocean (shown by rapidly increasing and decreasing elevations respectively) were not suitable habitats for the Asian giant hornets, so they were less able to cross those barriers.**



136. (1 point) In which location would you most expect to find a member of Colletidae?  
A. A B. B C. C

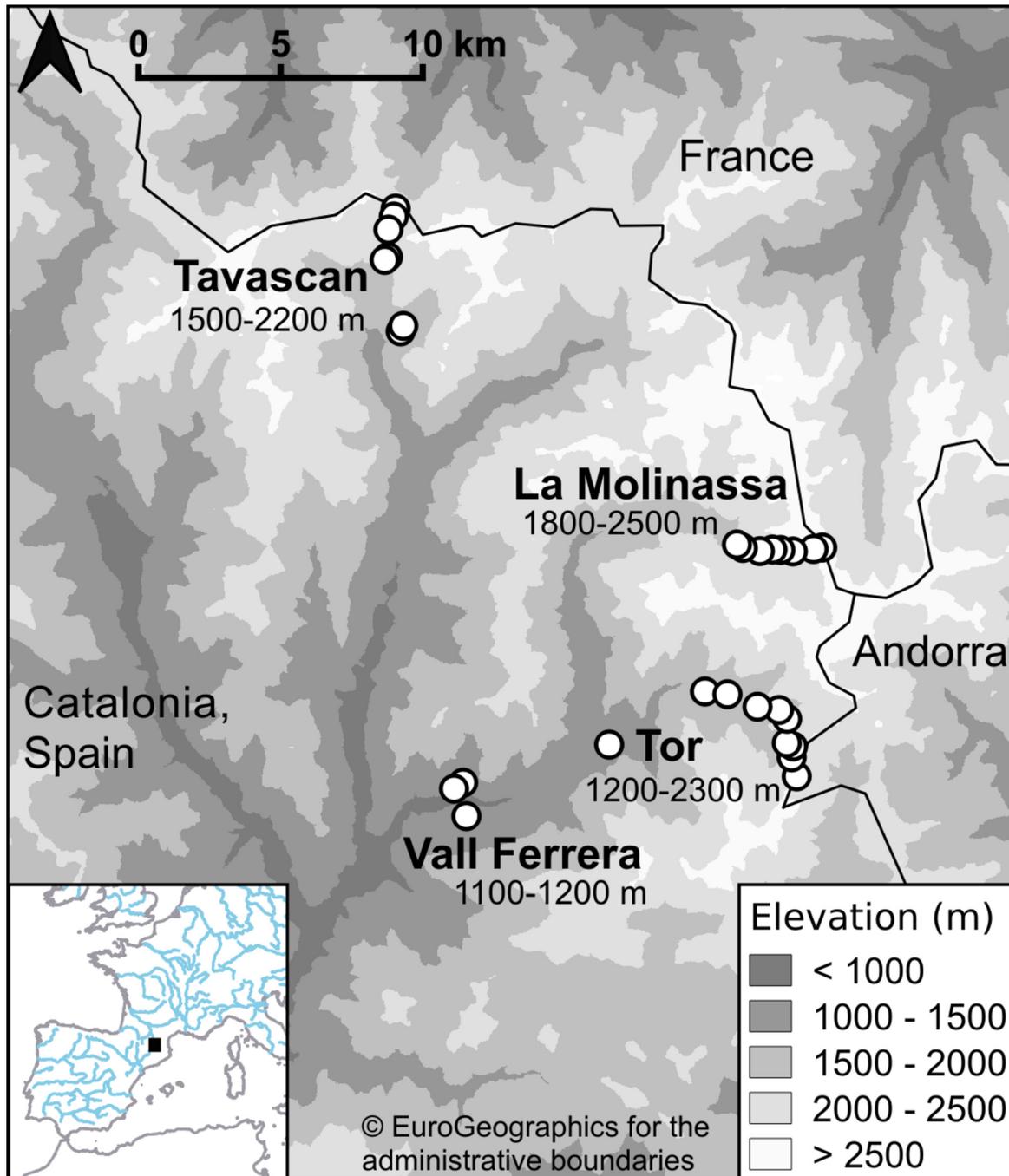
**Solution: Members of Colletidae commonly burrow in sandy areas.**

137. (1 point) In which location would you most expect to find a member of Gomphidae?  
A. A B. B C. C

**Solution: Members of Odonata are often associated with water.**

138. (1 point) In which location would you most expect to find a member of Membracidae?  
A. A B. B C. C

**Solution: Membracidae is arboreal, and would be expected to be in the Rio Grande National Forest.**



In a 2024 study by Thomas et al., researchers investigated the species richness of Orthoptera at different elevations.

139. (1½ points) Which location contained the site with the maximum number of taxa?
- Tavascan
  - La Molinassa
  - Tor

**D. Vall Ferrera**

140. (1 point) At the highest elevations of 2400m-2500m, how many species were observed?

**Solution: 1**

141. (1½ points) In their generalized linear model for the relationship of Orthoptera species richness with elevation, what factor contributed the most to species richness?

**A. Elevation band (m)**

B. Sampling effort

C. Vegetation cover

D. Maximum vegetation height (cm)

## Helicopter

Insects can fly for longer than any wooden helicopter you can build! Well, some of them, anyway.

142. (1 point) Insect wings can be less than 1 micrometer thick! How do they maintain their rigidity?

**Solution: Their veins are thickened and more rigid.**

143. (½ point) What clade of insects have indirect flight?

**Solution: Neoptera**

144. (1 point) What is the difference between direct and indirect flight?

**Solution: In direct flight the flight muscles attach to the wings. In indirect flight, the flight muscles pull on the exoskeleton of the thorax which pulls the wings with it.**

145. (½ point) What type of wing coupling do day-flying butterflies have?

**Solution: Amplexiform**

146. (½ point) What type of wing coupling did this evolve from?

**Solution: Frenulo-retinacular**

147. ( $\frac{1}{2}$  point) Describe how the wing morphology changed as their wing coupling system changed.

**Solution: The frenulum and retinaculum were lost.**

148. (2 points) Name four ORDERS of insects that contain members that can hover.

**Solution: Odonata, Diptera, Lepidoptera, Hymenoptera ( $\frac{1}{2}$  point each)**

149. (1 point) Which of those orders contain members that hover while ovipositing?

**Solution: Odonata, Diptera ( $\frac{1}{2}$  point each)**

150. (1 point) What family in Odonata gains their common name from their hunting behavior where they fly back and forth in the same area?

**Solution: Aeshnidae (Apparently, this behavior is called "hawking", earning them the common name of "hawker")**

151. (2 points) In what conditions will a dragonfly fly for the longest period of time without stopping to rest?

**Solution: Warm conditions. Insects do not maintain a constant body temperature, and flight muscles are less effective when it is cold. Dragonflies will stop to bask in the sun and warm up their flight muscles.**

# Materials Science



152. (1/2 point) What is the family of this insect?

**Solution: Saturniidae**

153. (1 point) What is silk that is made from the cocoons of this insect called?

- A. Ahimsa silk
- B. Coa vestis
- C. Sea silk
- D. Tussar silk**
- E. Xiangyunsha silk

154. (1/2 point) Silk from the cocoons of this insect has a shorter strand length than silk from silkworm cocoons.

155. (1/2 point) This makes it less durable than silk from silkworm cocoons.

156. (1 point) What shape is the cross-section of each silk fiber from this insect?

- A. Circular
- B. Crescent-shaped
- C. Elongated wedge**
- D. Triangular

157. (1 point) Silk is made up of filaments of fibroin connected with a glue-like layer of which protein?

- A. Sericin**
- B. Resilin
- C. Spidroin
- D. Sclerotin

158. (1 point) How is the above protein used in medicine? What properties of it make it useful?

**Solution: Sericin is used for wound suturing due to its elasticity, tensile strength, affinity for keratin, and antimicrobial properties.**

159. (1½ points) What is fibroin's secondary structure? What forces are largely responsible for this?

**Solution: Fibroin folds into pleated sheets due to hydrogen bonding.**

160. (1 point) What material properties of silk arise due to fibroin's secondary structure?

**Solution: Fibroin's pleated secondary structure makes it pack tightly, making silk stiff and tough. Fibroin is responsible for silk's high tensile strength. Its tight packing also makes it insoluble in water.**

161. (1 point) Fibroin is generally insoluble in water. What can be added to water to make fibroin dissolve in it?

**Solution: Chaotropic salts such as calcium chloride will disrupt hydrogen bonding, making fibroin dissolve.**

162. (1 point) How can mass spectrometry be used to determine the species of moth that produced a given silk sample?

**Solution: Mass spectrometry can be used to determine the ratio of sericin to fibroin, allowing for the species of moth to be determined.**

## Microbe Mission



163. (1 point) Identify the above specimen to the lowest taxonomic level on the national list.

**Curculionidae**

164. (1 point) Which of the following would this specimen most likely eat? (select all that apply)

- Algae
- Fruit**
- Insects
- Wood**

165. (1 point) This specimen contains bacteria within its gut to help it digest its food. Which of the following best describes the relationship between the specimen and the bacteria?

- A. Amensalism B. Commensalism **C. Mutualism** D. Parasitism E. Predation

166. (1 point) What effect does this specimen have on forests in areas where it is invasive.

**Solution: Damage trees and forest health by killing mature trees**

167. (1 point) When faced with predators, what does this specimen typically do?

**Solution: Play dead**

168. (2 points) Rank the density of symbiotic bacteria in the gut of each stage of life of this specimen.

**Solution: Larvae, adult, pupae, eggs**  
**½ for each correct**

169. (3 points) This specimen also maintains a symbiotic relationship with fungus species. What type of relationship is this? What does each species gain/lose?

**Solution: Mutualism (1), fungi are guided/transported by the beetles (1 for either), beetles rely on fungi to find hosts/reduce natural defenses (1 for either, 0.5 for saying makes the wood easier to eat)**  
**Important: the fungi are not found in the gut, so no credit should be given for answers stating this.**

## Optics

170. (½ point) In an apposition eye, how many pigment cells line a single ommatidium?

- A. 3
- B. 6**
- C. 12
- D. 24
- E. 48

171. (1 point) What purpose do the pigment cells serve?

**Solution: The pigment cells absorb light entering from an angle, making the image from each ommatidium clearer.**



172. (1 point) What is the name of the above phenomenon and why does it occur?

**Solution: It is a pseudopupil. It appears because ommatidia pointed towards the viewer don't reflect much light back, making them appear darker.**

173. (1 point) How do compound eyes allow insects to respond very quickly to movement?

**Solution: Each ommatidium has a very narrow field of view, so a moving object would flicker in and out of the ommatidia very quickly.**

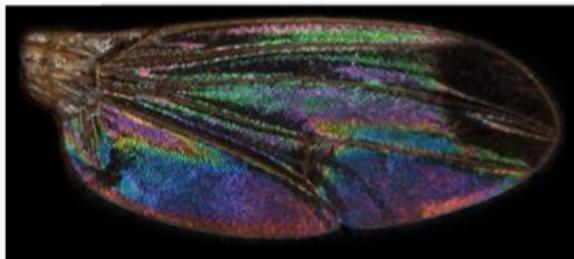
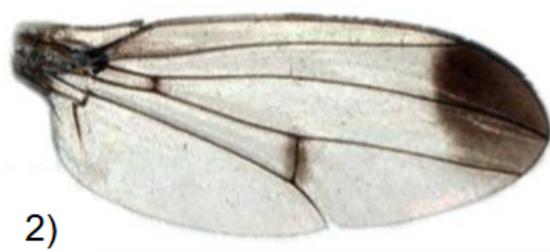
174. ( $\frac{1}{2}$  point) How many images are formed by a superposition eye?

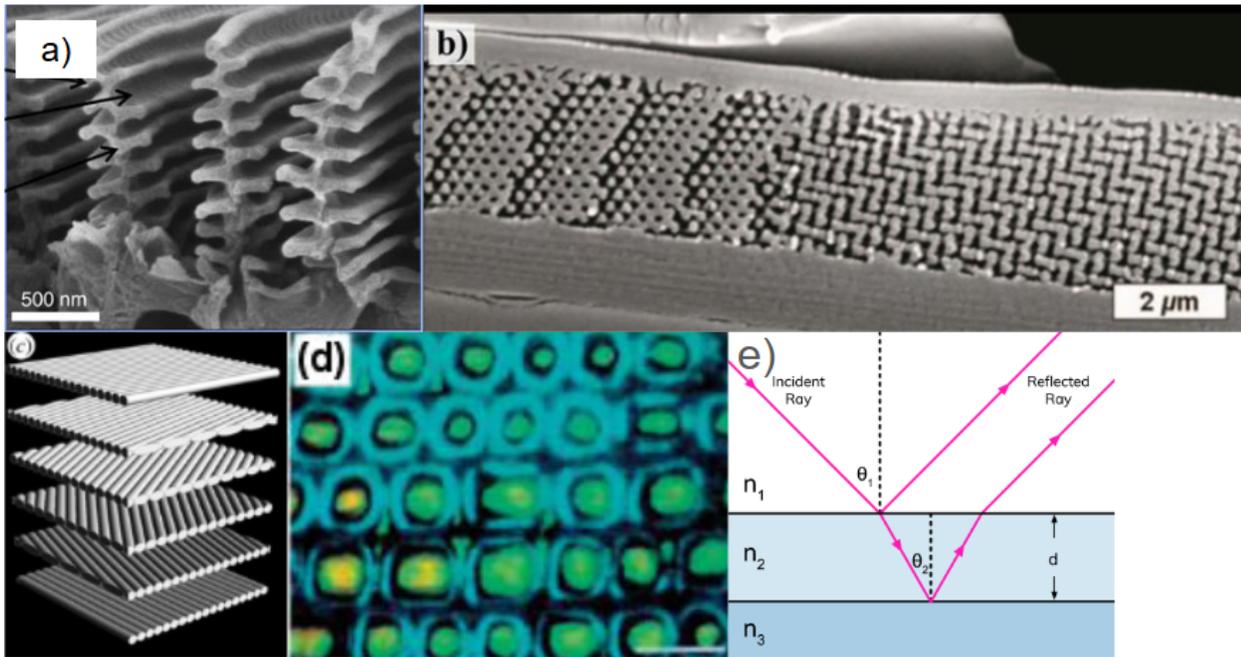
- A. 1**
- B. Up to 10, depending on ommatidium count
- C. Up to 100, depending on ommatidium count
- D. Up to 1000, depending on ommatidium count
- E. Up to 10000, depending on ommatidium count
- F. Up to 100000, depending on ommatidium count

175. (1 point) Why are apposition eyes more common in diurnal butterflies, while superposition eyes are more common in crepuscular and nocturnal moths?

**Solution:** Apposition eyes tend to have better spatial acuity in bright conditions. Superposition eyes are 100 to 1000 times more sensitive to light, since all of the light is concentrated from every ommatidium into a single image. (This tends to be true across insects in general.)

The following images will be used for the next ten questions.





176. ( $\frac{1}{2}$  point) Identify the family of insect 1.

**Solution: Nymphalidae**

177. ( $\frac{1}{2}$  point) Match insect 1 with the correct structural coloration diagram.

A. a B. b C. c D. d E. e

**Solution: Morpho butterflies get their color from a diffraction grating.  
Diagram from Potyrailo et al. (2015)**

178. ( $\frac{1}{2}$  point) Identify the family of insect 2.

**Solution: Drosophilidae**

179. ( $\frac{1}{2}$  point) Match insect 2 with the correct structural coloration diagram.

A. a B. b C. c D. d E. e

**Solution: The wings of various flies in Drosophilidae exhibit thin-film interference.  
Diagram from Shevtsova et al. (2011)**

180. ( $\frac{1}{2}$  point) Identify the family of insect 3.

**Solution: Papilionidae**

181. ( $\frac{1}{2}$  point) Match insect 3 with the correct structural coloration diagram.

A. a B. b C. c **D. d** E. e

**Solution: Papilio palinurus gains its color from selective mirrors.  
Diagram from Garg et al. (2017)**

182. ( $\frac{1}{2}$  point) Identify the family of insect 4.

**Solution: Scarabaeidae**

183. ( $\frac{1}{2}$  point) Match insect 4 with the correct structural coloration diagram.

A. a B. b **C. c** D. d E. e

**Solution: The chitin microfibrils of Chalcothea smaragdina work as a diffraction grating. Additionally, the successive rotation of the microfibrils in each layer makes the reflected light left-handed circular polarized.  
Diagram from McDonald et al. (2017)**

184. ( $\frac{1}{2}$  point) Identify the family of insect 5.

**Solution: Curculionidae**

185. ( $\frac{1}{2}$  point) Match insect 5 with the correct structural coloration diagram.

A. a **B. b** C. c D. d E. e

**Solution: Lamprocyphus augustus gains its coloration from a photonic crystal structure. This makes its color consistent regardless of angle.  
Diagram from Romano (2019)**

## Robot Tour

You're tired of all the bugs in Robot Tour, so you're making a bug (not a true bug; It's an ant) do it instead. Specifically:

1. The ant will (unsurprisingly) start on the start point.

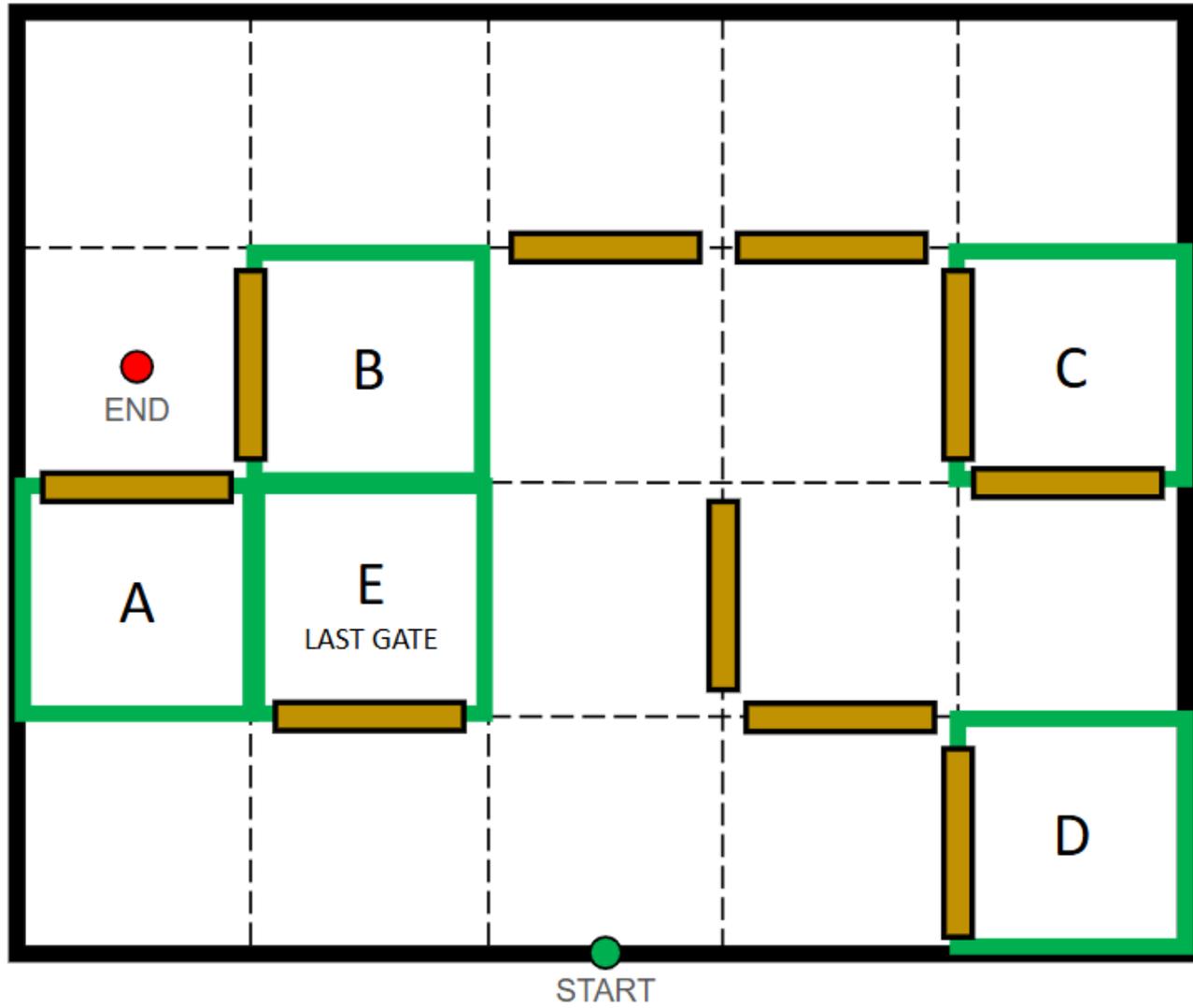
2. Next, the ant should enter squares A, B, C, and D, in any order.
3. Then, the ant should enter square E. E is the last square the ant should enter.
4. We only care about entering a square. After a square is entered for the first time, we don't care about any subsequent entries.
5. Last, the ant should navigate to the end point.
6. Each square is 50cm x 50cm. Some of the sides may have walls.
7. The ant should never come into contact with any of the walls. The walls are made of wood, and the ant is physically capable of climbing the walls.
8. No moving the walls, not even during setup.

You have one day to get things set up. You have the following supplies:

- 1x ant farm, with 3 ants in it. (They are all the same species as the ant you will guide. None of them are the same ant as the one you will guide.)
- 1x roll of tape
- 1x sugar cube
- 6x 30cm x 30cm glass panes treated with fluon. (This is what ant farm walls are made of.)
- 10x popsicle sticks
- 10x sheet of paper
- 10x Q-tip

(You do not have to use all supplies.)

After you set up your track, you will place one ant at the start point. You may not interfere with the movement of this ant.



The track. You may draw on this.



# Tower

You can't make a tower without glue! Let's look into how insects create adhesives.



187. (1/2 point) Identify the ORDER of insects that produced this structure.

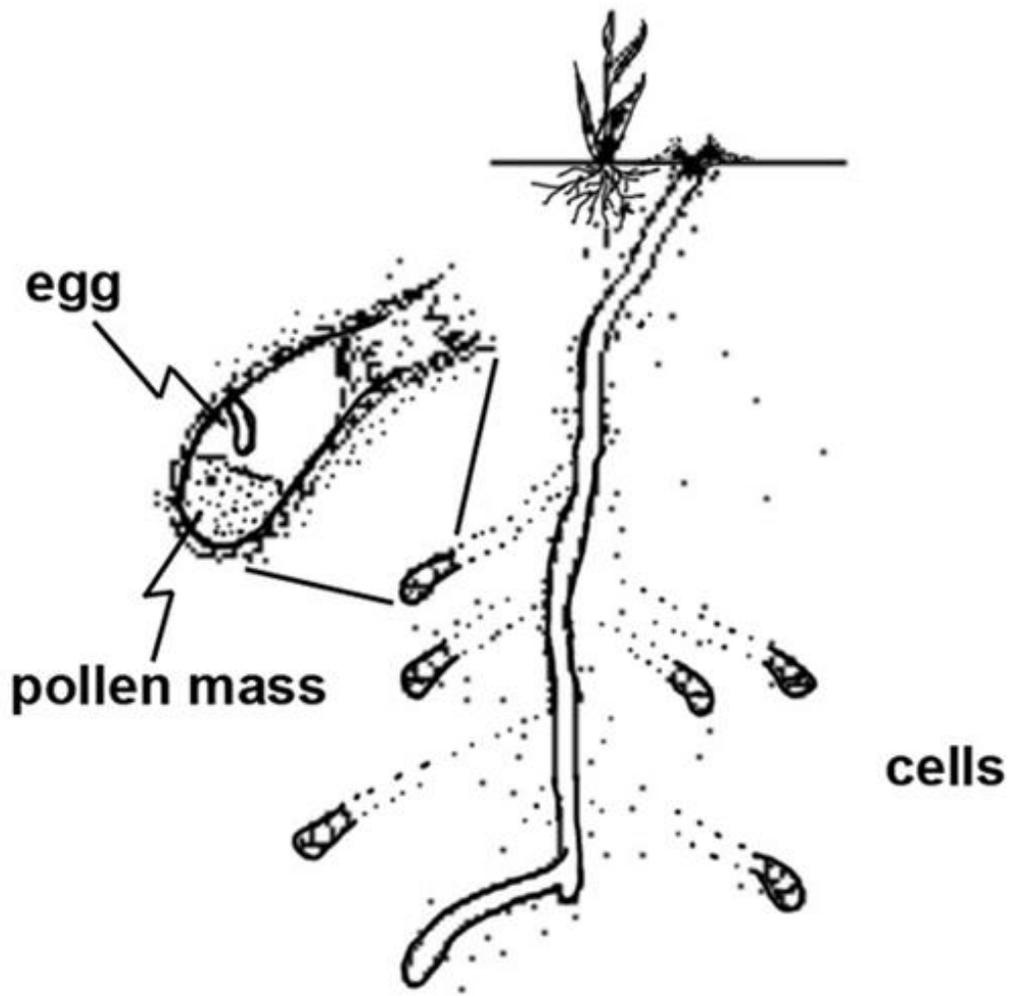
**Solution: Blattodea**

188. (1 point) What is the structure made of, and how is it held together?

**Solution: It is made of dirt and dung held together by saliva.**

189. (1 point) What is notable about the structures produced by this specific species?

**Solution: Its main axis is always aligned north to south.**



190. (1/2 point) Identify the family of insects that produced this structure.

**Solution: Colletidae**

191. (1 point) What type of chemical is this nest lined with?

**Solution: Polyester (1/2 point for "polymer")**

192. (1 point) What part of the body is this chemical produced from?

**Solution: Mouthparts, "presumably secreted by her salivary glands" (- NC State University)**



193. (1/2 point) Identify the family of insects that produced this structure.

**Solution: Drosophilidae**

194. (1/2 point) What is the name of this structure?

**Solution: Puparium**

195. (1/2 point) What part of the body produces the glue that attaches this structure to the substrate?

**Solution: Glue from the salivary glands**

196. (1 point) Where can you find this structure attached in the wild?

**Solution: Many different environments, including fruits, beer bottles, wood, rotting fruits, underground, and each other.**



197. ( $\frac{1}{2}$  point) Identify the family of insects that produced this structure.

**Solution: Gryllacrididae**

198. (1 point) Why does this insect create this structure?

**Solution: The structure is a shelter while it rests during the day.**

199. (1 point) Describe the molecular structure of the silk.

**Solution: It is made up of long, repetitive proteins with an extended beta-sheet structure, similar to the silk made by moths.**

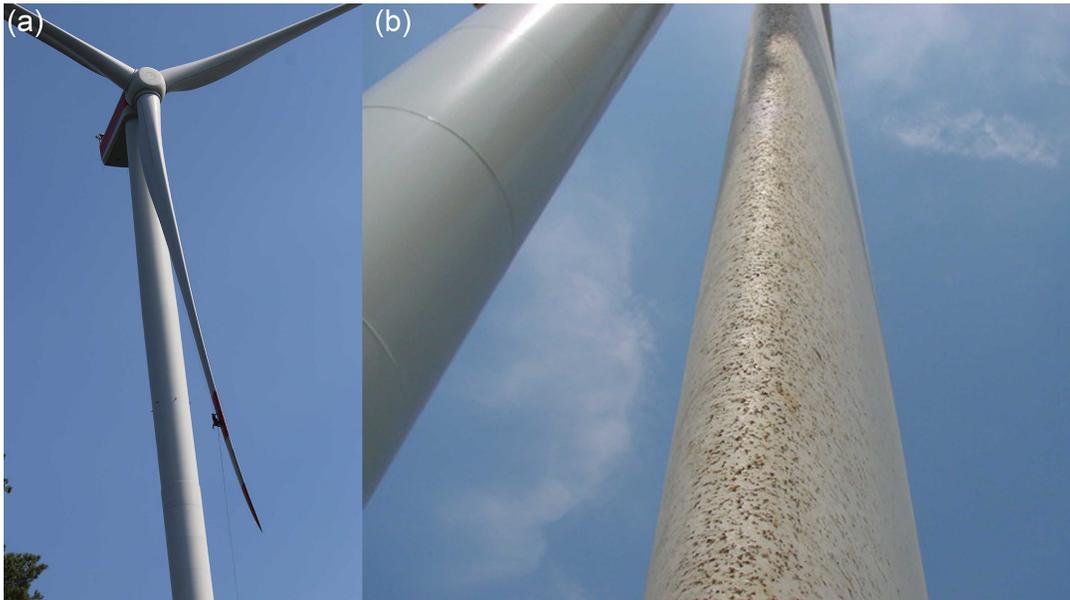
## Wind Power

In the 2023 paper "Is it safe for honey bee colonies to locate apiaries near wind turbines?", researchers Fourrier et al. looked into (unsurprisingly) whether or not it is safe for honey bee colonies to locate apiaries near wind turbines.

200. ( $\frac{1}{2}$  point) Did the researchers find a negative impact on worker bees?

A. Yes    **B. No**

201. ( $\frac{1}{2}$  point) Did the researchers find a negative impact on the reproductive castes?  
A. Yes B. No



**Solution:** From <https://doi.org/10.1111/csp2.366>

202. (1 point) How did insects form the layer of organic detritus on the wind turbine blade shown above?

**Solution:** The blade of the wind turbine smashed into them and they died, their pulverized corpses forming this layer of detritus.

203. (1 point) What is the economic impact of that?

**Solution:** The detritus layer disrupts the flow of air around the blade and makes the turbine less efficient. Thus, the turbine operators produce less energy and have to spend money cleaning the blades.

204. (2 points) What is the ecological impact of that? Provide two examples.

**Solution:** Reduced populations of pollinating insects (such as butterflies) decreases plant reproduction. Reduced populations of prey insects decreases populations of bats and birds.

205. (5 points) Complete the table. (Answers are not necessarily one per line. Lines were given for ample writing space.)

Stimuli produced or altered by turbines	Impacted sense organs	Potential effects
Light/color/shape	<u>Compound eyes and ocelli</u>	<u>Attraction to turbines;</u> <u>congregation around turbines</u>
Acoustic noise	<u>Tympanal ears;</u> <u>hairs; antennae</u>	<u>Alterations to calls;</u> <u>hindrance to mate location</u>
Vibration (seismic noise)	<u>Antennae;</u> <u>mechanoreceptors</u> <u>throughout body</u>	<u>Disruption of vibratory</u> <u>signals; increased stress;</u> <u>reduced offspring</u>
Temperature	<u>Thermoreceptors</u> <u>in antennae</u>	<u>Attraction to turbine towers;</u> <u>deterrence of some species</u>
Wind	<u>Antennae,</u> <u>mechanoreceptors</u>	<u>Increased abundance near</u> <u>nacelle; dispersal of kariomones;</u> <u>migration interference</u>

**Solution:** From <https://peerj.com/articles/18153/>, 1/2 points per box

## Write It, Do It

Large flat insect, facing up & right. Oval-shaped.

Big black eyes front of head.

6 legs splayed out.

Front legs reach in front of head, sort of like it's flexing. Innermost segment buff.

Other legs are broad and flat, pointing behind. Bristly on back of first segment.

Sticking out of

Unfortunately, the writer ran out of time and left the description unfinished.

206. (10 points) **TIEBREAKER #2** Draw the insect in its entirety, including the parts that the writer failed to describe.

**Solution: Lethocerus oculatus, from Belostomatidae. Can be differentiated from Nepidae as the back pair of legs are broad and paddlelike.**



**Solution:**

- $+1/2$  if insect faces up and right.
- $+1/2$  if insect is large, broad, flat, and oval-shaped.

- +1 if eyes have correct size and position. No ocelli.
- +1 if antennae are out of view.
- +1 if mouthparts are out of view or are sucking mouthparts.
- +1 if front pair of legs stick out from just behind eyes, stick out in front of head, and form a pincerlike shape.
- +1 if middle pair of legs stick out from roughly 1/5 along the body, splay out, are paddlelike (broad, bristly on back of first segment), and not longer than back pair of legs.
- +1 if back pair of legs stick out from roughly halfway along the body, splay out, are paddlelike, and not shorter than middle pair of legs.
- +1 for triangular pronotum starting roughly 1/5 along the body.
- +1 if wings are shown, and overlap over the thorax and abdomen.
- +1 if breathing tube is short. (Belostomatidae has a retractable breathing tube, but "sticking out of" the abdomen is this tube.)

## Fermi Questions

Give answers as the closest integer power of ten. (100 becomes 2; 900000 becomes 6; 0.03 becomes -2.)

These questions are worth such a small amount each that you get points only if you get them exactly correct.

207. ( $\frac{1}{2}$  point) How many named ant species are there? 4
208. ( $\frac{1}{2}$  point) How many named beetle species are there? 6
209. ( $\frac{1}{2}$  point) How many species are in Boreidae? 1
210. ( $\frac{1}{2}$  point) How many scales are there on the body of *Colias crocea* (in Pieridae)? 6
211. ( $\frac{1}{2}$  point) During the lifespan of the average worker in the family Vespidae, how many queen lifetimes pass? -1
212. ( $\frac{1}{2}$  point) How many times heavier is a filled replete than a non-replete worker ant? 3

**Solution: Replete mass came from *Camponotus inflatus*, though I had to use a general estimate for worker ant mass. *Camponotus* workers tend to be a bit bigger than average, but this shouldn't change the final answer.**

# Cake Bake

To distract myself from having lost the original draft of this test, I was attempting to bake a cake using this recipe:

- 200g white sugar
- 115g unsalted butter
- 120g chicken eggs
- 180g all-purpose flour
- 7g baking powder
- 110g 2% milk

Unfortunately, I had no chicken eggs! I *did*, however, have ant eggs. (Specifically, the eggs of the weaver ant *Oecophylla smaragdina*, which are eaten as food in Southeast Asian cuisine, though (to the best of my knowledge) never in cake.)

213. (2 points) Fill in the blanks for my new recipe:

- 200g white sugar
- 122.7 g unsalted butter
- 120g ant eggs
- 180g all-purpose flour
- 7g baking powder
- 108.3 g 2% milk

**Solution: 1 point will be given for each answer within 5% of the correct value.**

**Butter should be between 116.6g and 128.8g.**

**Milk should be between 102.9g and 113.7g.**

**Ant egg moisture and fat content found at <https://he01.tci-thaijo.org/index.php/IJPS/article/view/23170>**

**Chicken egg fat content found at <https://www.nutritionix.com/food/eggs/100-g> (We assume that all mass not accounted for is water.)**

**120g ant eggs contains 93.2g of water and 3.7g of fat.**

**120g chicken eggs contains 91.5g of water and 11.4g of fat.**

**We decrease the milk (slightly) to account for the fact that the ant eggs are more watery.**

**The fat content is reduced by 7.7 grams from the eggs and a negligible amount from the reduced amount of milk. We increase butter content accordingly.**

214. ( $\frac{1}{2}$  point) How would the cake taste compared to the original?

- A. Sweet
- B. Salty
- C. Sour**

- D. Bitter
- E. Umami

**Solution: Ant eggs taste sour due to their acetic acid content.**

215. (1/2 point) How would the texture of the cake compare to the original?

**Solution: Since it contains less protein, the cake would be crumblier and less puffy than the original.**

## Pokéthology



The Pokémon on the left is Caterpie, a Bug-type Pokémon. The Pokémon on the right is Butterfree, a dual-type Bug/Flying Pokémon. Butterfree is Caterpie's second evolution.

216. (1 point) What is the name and function of the orange structure on Caterpie's head?

**Solution: It is an osmeterium, used to intimidate predators.**

217. (1/2 point) What (non-Pokémon) family of insects has larvae with these structures?

**Solution: Papilionidae**

218. (1 1/2 points) Name 3 or more differences between Butterfree and adults of the family from the previous question.

**Solution:** Butterfree appears to have membranous wings, unlike the opaque scaly wings of Papilionidae. Butterfree appears to have mandibles and no proboscis, while Papilionids have a proboscis and no mandibles. Butterfree has 4 limbs, while Papilionids have 6.

**Solution:** DO NOT accept a lack of tails on the wings. Not all Papilionids have prominent tails.