Questions 38-47 are based on the following passage and supplementary material.

This passage is adapted from Elizabeth Pennisi, "Seagrasses Partner with Clams to Stay Healthy." ©2012 by American Association for the Advancement of Science.

Not much to look at and sometimes quite mucky, seagrass beds have been called the ugly ducklings of marine conservation. They lack the charisma of coral reefs, yet like reefs, these beds form a highly productive and diverse ecosystem, acting as the nursery for many kinds of fish as well as a home to sea turtles, manatees, and a host of other sea creatures. Seagrasses help cycle nutrients, and experts estimate they provide $1.9 trillion in ecosystem services per year worldwide. At the heart of seagrasses' success may be a small clam.

Seagrasses are saltwater flowering plants that grow along coasts and make up 0.2% of the ocean's ecosystems. They produce an amount of biomass that beats that of the Amazonian rain forest and is on par with that of corn and sugarcane crops. Their roots and stems trap organic matter and sediment, causing buildups of rich mud that can be waist deep.

This muck is a potential threat to the grass: Decaying organic matter produces a lot of sulfide, creating what could be an unhealthy environment for plant roots. Researchers had assumed that the oxygen released from seagrass roots combined with enough of the surrounding sulfide to neutralize this toxic element. Not so. "We found that in most seagrass beds, it's much more complex," marine ecologist Tjisse van der Heide says. "They have a trick to speed up oxidation" that relies on a symbiotic relationship with bacteria that consume sulfides.

Van der Heide first began to suspect that seagrass depended on bacteria while doing fieldwork in Mauritania. He and his colleagues found thousands of 1-centimeter lucinid clams living among the seagrass roots. Gills make up much of the clam's innards: That's where sulfide-oxidizing bacteria live. They sustain the clam by providing nutrients in much the way that zooxanthellae sustain coral.

Following up on their clam observation, the researchers took 110 samples of seagrass beds with a 15-centimeter-wide tube that cut cores 20 centimeters deep into the sediment. They filtered out and weighed all the organisms in the sediment and dried and weighed the seagrass in each core. "The more bivalves we found in the core, the more seagrass we found in the core," suggesting a beneficial partnership, Van der Heide says.

Wondering if this cohabitation was unique to Mauritania, the researchers combed the literature for studies describing the communities inside other seagrass beds, finding 84 covering tropic, subtropic, and temperate sites on six continents. Lucinid clams were found associated with 11 of 12 seagrass genera, the one exception being a seagrass that grew on bare rock.

Next, Van der Heide explored the potential of this relationship in the lab. He grew seagrass alone, clams alone, and the two organisms together under different conditions, including one in which he and his colleagues injected sulfide into the sediment semiweekly. On its own, the seagrass was able to process some of the sulfide, but sulfide gradually increased in concentration and interfered with seagrass growth. The clams alone got rid of the introduced sulfide but didn't get any bigger. But both the clams and the seagrass thrived when together, getting rid of the sulfide and growing as well, Van der Heide's team reports. The roots seemed to provide the clams with more ready access to oxygen, which "was necessary for the bivalves to consume that sulfide in an efficient manner," Van der Heide explains.

"The elegant experimental design provides compelling evidence for the benefits of the interaction between seagrasses and the associated bivalve," says Carlos Duarte, a marine ecologist at the University of Western Australia in Perth.

CONTINUE

Figure 1

Effect of Sulfide and Lucinid Clams on Seagrass Root Biomass

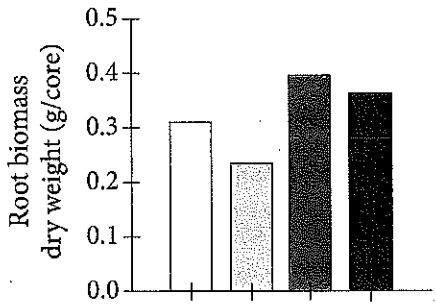
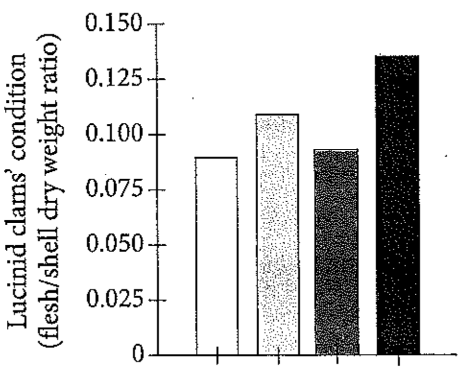


Figure 2

Effect of Sulfide and Seagrass on Lucinid Clams' Condition



Adapted from Tjisse van der Heide et al., "A Three-Stage Symbiosis Forms the Foundation of Seagrass Ecosystems." ©2012 by American Association for the Advancement of Science.

38

The main purpose of the passage is to

A) describe a study showing how one species helps to limit the spread of another species.
B) present research that reveals a mutually beneficial relationship between different species.
C) explain how changing environmental conditions pose a threat to multiple species in an ecosystem.
D) analyze the process by which one species can take over the ecological niche of another species.

39

As used in line 15, "beats" most nearly means

A) exceeds.
B) subdues.
C) strikes.
D) counteracts.

40

It can reasonably be inferred from the passage that sulfide accumulates around seagrass roots due to

A) an overabundance of lucinid clams.
B) the presence of sulfide-oxidizing bacteria.
C) an excess of key root nutrients.
D) the physical characteristics of the seagrass.

41

Which choice provides the best evidence for the answer to the previous question?

A) Lines 14-16 ("They . . . crops")
B) Lines 17-19 ("Their . . . deep")
C) Lines 28-30 ("They . . . sulfides")
D) Lines 33-35 ("He and . . . roots")

42

As used in lines 37 and 38, "sustain" most nearly means

A) withstand.

B) affirm.

C) prolong.

D) nourish.

43

Which choice provides the best evidence that Van der Heide was trying to determine whether seagrass and lucinid clams together respond differently to additional sulfide in the sediment than does either seagrass alone or lucinid clams alone?

A) Lines 42-44 ("They . . . each core")

B) Lines 45-47 ("The more bivalves . . . says")

C) Lines 52-55 ("Lucinid . . . rock")

D) Lines 57-61 ("He grew . . . semiweekly")

44

Which statement about the oxygen released by seagrass roots is best supported by information in the passage?

A) It impedes the growth of sulfide-oxidizing bacteria in the gills of lucinid clams.

B) It serves the same role for lucinid clams that zooxanthellae serve for coral.

C) It is not sufficient to eliminate sulfide accumulation in the absence of lucinid clams.

D) It becomes more concentrated as sediment builds up around seagrass roots.

45

Which choice provides the best evidence for the answer to the previous question?

A) Lines 35-36 ("Gills . . . live")

B) Lines 37-38 ("They . . . coral")

C) Lines 61-64 ("On its . . . growth")

D) Lines 64-65 ("The clams . . . bigger")

46

Which conclusion is best supported by the experimental results shown in figure 1?

A) Sulfide had a positive effect on the root biomass of seagrass when lucinid clams were absent.

B) Seagrass had a greater root biomass in the absence of lucinid clams and injected sulfide than when exposed to both lucinid clams and injected sulfide.

C) The presence of lucinid clams had a positive effect on the root biomass of seagrass regardless of whether sulfide was present.

D) Lucinid clams had a positive effect on the root biomass of seagrass in direct proportion to the concentration of sulfide in the sediment.

47

Regarding the claim that clams and seagrass "thrived when together" (line 66) in the experiment, which statement is best supported by the information in the two figures?

A) The clams thrived more when seagrass was present than in any condition without seagrass.

B) Increasing the quantity of sulfide when clams were present helped seagrass thrive.

C) Decreasing the quantity of sulfide when seagrass was present helped clams thrive.

D) The introduction of sulfide when both clams and seagrass were present benefited clams but not seagrass.

STOP

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Do not turn to any other section.