Investigating Reproductive Strategies

Abstract

Students work in pairs to compare five aspects of an organism that reproduces sexually with one that reproduces asexually. As a class, students share their comparisons and generate a list of general characteristics for each mode of reproduction, and discuss the advantages and disadvantages of both.

Learning Objectives

- There are two modes of reproduction, sexual and asexual.
- There are advantages and disadvantages to both sexual and asexual reproduction.

Logistics

Time Required

- ***Class Time:***
  50 minutes
- ***Prep Time:***
  10 minutes to review activity and make copies of student pages

Materials

Copies of student pages

Prior Knowledge Needed

None

Appropriate For:

Primary Intermediate Secondary College

Special Features You'll Find Inside

- Illustrated information sheets for 12 organisms.
- A reference list for more information about the organisms used in this activity.
- A list of learning objectives and key ideas to help you guide classroom discussion during the activity.

Investigating Reproductive Strategies

Classroom Implementation

1. **Divide students into pairs.**

2. **Hand each pair:**
   - » **The** *Investigating Reproductive Strategies* **worksheet (page S-1)**
   - » **2 organism descriptions - one for an organism that reproduces sexually and one for an organism that reproduces either asexually or using both strategies - (see chart below).**

Reproductive strategies used by organisms described in this ac-

Sexual	Asexual	Both Sexual and Asexual
Blue-headed wrasse	Amoeba	Brittle star
Duck leech	Salmonella	Meadow garlic
Grizzly bear	Whiptail lizard	Spiny water fleas
Leafy sea dragon		
Red kangaroo		
Sand scorpion		

3. **Instruct each pair to read about their assigned organisms and complete the comparison table on the** *Investigating Reproductive Strategies* **worksheet.**

4. **When all pairs have completed the comparison table, have them post their tables around the room.**

5. **Ask students to walk around the room and read the comparison tables with the goal of creating a list of general characteristics for organisms that reproduce sexually and one for organisms that reproduce asexually.**

> ***Tip:*** **You may wish to have students record their ideas on a sheet of paper while they read the comparison tables**

6. **As a class, compile lists of general characteristics for organisms that reproduce sexually and asexually on the board. Learning objectives and discussion points for each category on the** *Investigating Reproductive Strategies* **worksheet are listed on pages 2-4 to help you guide the discussion.**

7. **Ask students to discuss the advantages and disadvantages of each mode of reproduction in their pairs. Have them prepared to support their reasoning.**

8. **Add advantages and disadvantages to the list of general characteristics for each mode of reproduction.**

9. **Lead a discussion on the types of situations or conditions in which each mode of reproduction would be most advantageous or disadvantageous. Do students think one reproductive mode is generally better? Why?**

Investigating Reproductive Strategies
Learning Objectives

What are the advantages and disadvantages of sexual and asexual reproduction?
Is one "better" than the other? You are an Ecologist who wants to find out. You decide to compare 5 aspects of organisms that reproduce sexually with ones that reproduce asexually. You will begin by looking at two organisms. Once you make your comparisons, you will share your information with all of the other ecologists in your class to draw general conclusions about each method of reproduction.

Fill in the table below with information for each organism you have been assigned.

	Sexual	Asexual
Relative complexity of organism (including size)	Learning Objectives/Discussion Points: • Complex organisms tend to reproduce sexually.	Learning Objectives/Discussion Points: • Simple organisms tend to reproduce asexually.
Number of parents who contribute genetic information to the offspring	Learning Objectives/Discussion Points: • Two parents contribute genetic information. • Offspring are unique from their parents and from each other.	Learning Objectives/Discussion Points: • One parent contributes genetic information. • Offspring are exact genetic copies (clones) of the parent.
Reproductive mechanism	Learning Objectives/Discussion Points: • Gametes from two parents join. • With sperm fertilize eggs inside the body, the chances of gametes meeting are increased. Each individual may produce fewer eggs and/or sperm. • When eggs and sperm are released to join outside the body, the gametes have a lower chance of meeting. Organisms that reproduce in this way must produce many gametes.	Learning Objectives/Discussion Points: • Asexual reproduction does not involve gametes. • Reproduction is by splitting in half, or forming new individuals that are released from the "parent."

Investigating Reproductive Strategies
Learning Objectives

	Sexual	Asexual
Relative amount of parental care	Learning Objectives/Discussion Points: • Offspring tend to have longer gestation periods, and developing offspring are protected. • Parents tend to care for their young, increasing the chances that offspring will survive. • Organisms that invest time and energy in caring for their young tend to have fewer offspring. • Some sexually reproducing organisms neither gestate nor care for their young. These offspring are vulnerable to predators or the environment. These organisms tend to produce large numbers of gametes and/or offspring. This increases the chances that some offspring will survive and reproduce.	Learning Objectives/Discussion Points: • Offspring receive little or no parental care. • Organisms that reproduce by forming new individuals that separate from the parent do provide a form of parental care before the offspring are released. • Organisms that do not care for their young tend to produce large numbers of offspring. • Organisms where few offspring survive to reproduce have large numbers of offspring. • Organisms that split to produce an "adult" offspring often can rapidly reproduce again.
Genetic variation in offspring	Learning Objectives/Discussion Points: • Genetic variation comes only from sexual reproduction, in which genetic information from two parents combines. • Genetic variation helps a species (as a whole) survive. In the event of a change in environment or increased competition for resources, some organisms may have slight trait variations (due to genetic variation) that allow them to survive. Over time, natural selection may favor these differences, resulting in new adaptations.	Learning Objectives/Discussion Points: • Offspring have little to no genetic variation. (note: variation does still arise through random mutation) • In the event of a change in environment or competition for resources, offspring may not have trait variations that will allow them to survive. • If a parent has traits that are well adapted to a particular environment, its offspring will have these same traits, which may provide them with a survival advantage.

Investigating Reproductive Strategies

Overall Learning Objectives/Discussion Points

- There are advantages and disadvantages to both sexual and asexual reproduction.
- For an individual it is "best" if the greatest number of its offspring survive to reproduce, carrying its genes into the next generation.
- Some species produce large numbers of offspring, but only a few may survive to reproduce. Other species produce few offspring, but parents provide extended care to improve each offspring's chance of survival.
- For a species it is "best" if individuals survive and reproduce so that the species does not go extinct.
- Genetic variation, through new combinations of alleles, results only from sexual reproduction. Certain variations may help individuals survival and reproduce, giving the population the potential to adapt to new and changing environments.
- Organisms that can use both sexual and asexual modes of reproduction may be most adaptable to different conditions.

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Investigating Reproductive Strategies

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	Sexual	Asexual
Relative complexity of organism (including size)		
Number of parents who contribute genetic information to the offspring		
Reproductive mechanism		
Relative amount of parental care		
Genetic variation in the offspring		

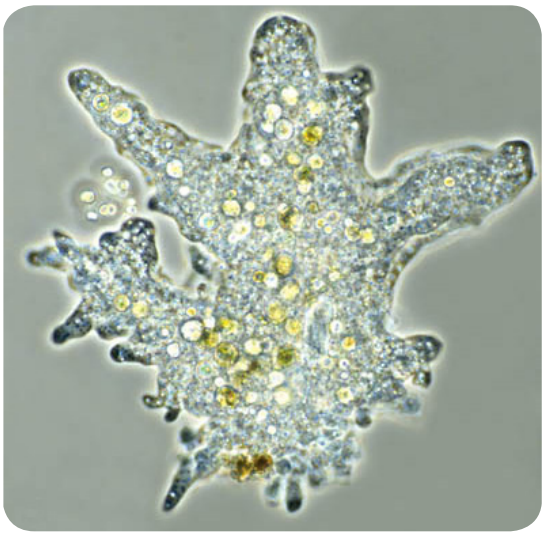
Name _____

Date _____

Reproductive Strategies

Animal Profile:

AMOEBA (*Amoeba proteus*)



Steve Durr

Amoeba proteus with several green algae trapped inside food vacuoles.

Take a look through a microscope at a drop of healthy pond water. You'll likely find a ton of one-celled organisms zooming about. Some of these cells move by fluttering tiny hair-like cilia. Others propel themselves with large whip-like flagella. You'll also come across blobby cells that creep about and engulf other cells with their bodies. These one-celled critters are amoebas, and they move and feed by extending pseudopodia (false feet). To move, an amoeba reaches pseudopodia away from its edges and anchors them at their tips. The cell's insides stream into the pseudopodia until the entire amoeba has slurped into a new place.

Amoebas live all over, from oceans to soil. They play an important ecological role by making meals of the huge numbers of bacteria, algae, and small protists found on this planet. One common amoeba is the giant amoeba, Amoeba proteus. Giant amoebas reproduce by binary fission, a fancy word that means splitting in two. When a giant amoeba begins to divide, it pulls its pseudopodia in to form a kind of ball. After its nucleus doubles, the amoeba constricts in the middle, as if a belt were being pulled tight around it. Finally, the two new cells pinch apart, send out pseudopodia, and slink away from each other. In this way, two identical "daughter" cells are made from one. When conditions are right, this amoeba can divide every 48 hours.

Name _____

Date _____

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Reproductive Strategies

Animal Profile:

BLUE-HEADED WRASSE
(*Thalassoma bifasciatum*)

Adult male Blue-Headed Wrasse

Many animals are born male or female and stay that way for the rest of their lives. Not so with the blue-headed wrasse, a tropical fish that darts about amongst the corals and sponges in shallow Caribbean waters. Females of this fish can completely transform into males when the conditions are right.

Blue-headed wrasses, like many reef fish, are small and brightly colored. Most of them—young males and females—are yellow with a greenish-black stripe on their sides. The others—the few, the proud, and the powerful—are older males. They have showy blue heads, green bodies, and thick black and white stripes around their collars.

Virginia O. Skinner

Adult female or young male Blue-Headed Wrasse

Big blue-headed males defend territories around the reefs. There, they strut their stuff until the smaller yellow females find them attractive. When this happens, the female swims with the male and spawns (releases her eggs). The male quickly fertilizes them with his sperm before they float away into the ocean. Blue-headed males can mate with as many as 100 females per day!

Of course, these big males can lose their territories because of nasty little things like death and rivalry. When that happens, the largest yellow female in the area may morph into a blue-headed male. So, some of the blue-headed males were born male, while others were born female.

Virginia O. Skinner

Juvenile Blue-Headed Wrasse

For the females that transform into males, this is a great deal. They can get a lot of their genes into the next generation. First they lay eggs when they are younger, then they fertilize eggs as males when they're older.

Name _____

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Reproductive Strategies

Animal Profile:

BRITTLE STAR (*Ophiactis savignyi*)

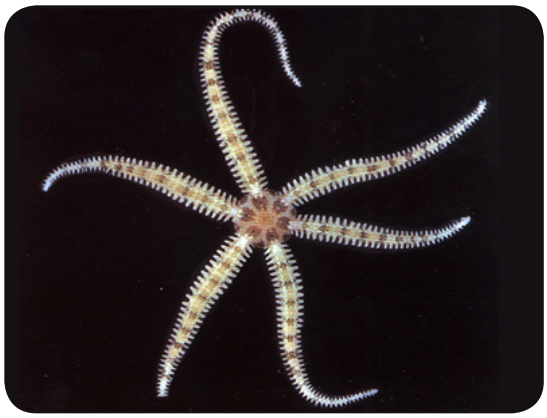
Peer into the hole of a sea sponge and you may catch a glimpse of the brittle star *Ophiactis savignyi*. These creatures are tiny: only an inch or two across with arms stretched. They inhabit virtually all of the world's tropical and sub-tropical ocean habitats.

Brittle stars are related to starfish. They have a similar body structure. The central disk holds all the important stuff like the mouth, stomach and reproductive organs. Then there are the arms—long, slender, wavy and edged with short spines. These arms are what give brittle stars their name. They can break off and regenerate.

O. savignyi takes regeneration a step further. It actually splits in half to reproduce. When fission happens, the brittle star breaks down the middle of its disk to make two identical 3-armed halves. These half-stars then grow three new arms.

But this isn't the only way *O. savignyi* reproduces. Like all brittle stars, they also reproduce sexually. At certain times of the year, large females and males raise their disks off the surface, balance on their legs, and release sperm and eggs into the ocean. When the sperm and eggs meet, they make larvae that float away to new habitats.

Fission is the main way that *Ophiocomella* reproduce. But since they don't move far or fast, large groups of brittle star clones build up in one area. Scientists think sexual reproduction might help brittle stars move into new areas far from their clone-filled sponge homes.



Michael Roy

Ophiactis savignyi

Tamara McGovern

A recently divided Ophiactis savignyi. Three tiny arms are beginning to regenerate.

Ellen Muller - www.pbase.com/imagine

Brittle star spawning.

Name _____

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Reproductive Strategies

Animal Profile:

DUCK LEECH (*Theromyzon tessulatum*)

Biopix.dk

Leeches are the stuff of horror movies and doomed journeys into infested waters. This leech is no exception. It has the disgusting habit of attaching itself to nostrils, eyes, throats, and even brains. Thankfully for humans, it only does this to ducks and other waterfowl. This has earned it the common name "duck leech."

The duck leech does a good job getting around. It probably gets spread as ducks fly from pond to pond. Like all leeches, this leech is a hermaphrodite: it has both male and female reproductive parts. But that doesn't mean it can move into a pond all alone, reproduce with itself, and start a new leech population. It still takes two to tango, as they say. A leech requires sperm from another leech to fertilize its eggs.

When the duck leech reproduces, two leeches rub together and give each other their sperm. Each leech will use the other's sperm to fertilize its eggs. They they place as many as 400 fertilized eggs into gooey cocoons for protection. A leech attaches its cocoons to a rock or other sheltered place, then waves its body over them. This delivers fresh, oxygen-rich water.

Biopix.dk

Young attached to the underside of a parent leech.

After 21 days, all 400 of the developing young leeches attach to their parent's belly. They remain attached until the parent finds a suitable bird for a meal. When that happens, the young bloodsuckers leave their parent behind and attach to the host for their first blood meal. The parent dies shortly thereafter, but not before giving hundreds of new eyeball-suckers a shot at the game of life.

Name _____

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Reproductive Strategies

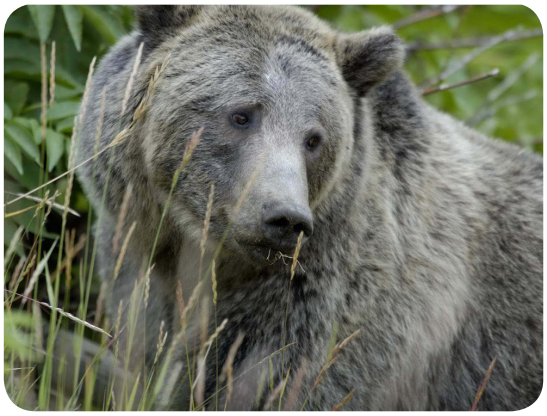
Animal Profile:

GRIZZLY BEAR (*Ursus arctos horribilis*)

US Fish and Wildlife Service/Larry Aumiller

Grizzly bears used to roam throughout the Great Plains of North America. They hunted elk and moose, and nibbled on berries and grasses. Grizzly bears still do these things, of course. But habitat loss and hunting have left the bears only in rough, mountainous areas.

Grizzly bears are enormous animals. They need large territories, especially when food is hard to find. Males can weigh as much as 453.6 kg (1000 pounds). Females can clock in around 317.5 kg (700 pounds). A grizzly bear's territory can be as large as 906.5 square kilometers (350 square miles). Though grizzlies spend most of their days wandering alone, they come together in early summer to mate.



US Fish and Wildlife Service/ Terry Tollefsbol

During mating, the male deposits his sperm into the female, where they fertilize her eggs. Females delay implantation of the fertilized eggs until late fall. This way, the embryos don't begin developing until the females are nestled into their warm dens. Mothers give birth 8 weeks later to between 1 and 4 cubs. Until they leave the den in late spring, the cubs live off their mom's milk. This means mom has to eat enough in the summer and fall to survive hibernation and to feed her cubs, too! Cubs stay with their mother for about 3 years. She won't reproduce again until they leave her side.

Bears grow and reproduce slowly. This, and their need for large territories with a lot of food, makes grizzlies sensitive to over-hunting and habitat loss. Thankfully, they're protected by the Endangered Species Act. And many conservation and wildlife biologists

Name _____

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Reproductive Strategies

Animal Profile:

LEAFY SEA DRAGON (*Phycodurus eques*)

Dragons lurk in the cool waters off the southwestern Australian coast. But they aren't the mythical beasts that devour huge ships before slipping away into the deep. These dragons are calm, graceful fish known as leafy sea dragons (*Phycodurus eques*).

Jeff Jeffords - divegallery.com

Though smaller than mythical dragons, leafy sea dragons can be pretty big. They grow up to 51 cm (1.7 feet) long, and they have long leaf-like appendages sprouting from their bodies. This leafiness helps them blend in with their seaweed habitat. It hides them from predators and helps them hunt for food. Like their cousins the seahorses, leafy sea dragons have long snouts they use to suck up tiny shrimp. To hunt, they drift around camouflaged as a piece of seaweed and ambush their small, crunchy prey.

Leafy sea dragons and their relatives reproduce in a way that's rare in the fish world. The males carry and hatch the young instead of the females! When sea dragons mate, the female finds a potential dad and deposits her eggs underneath his tail. There, his sperm fertilize them. Pregnant dads can carry as many as 200 incubating eggs. It pays to have a dad that looks like seaweed, because the eggs are protected from predators there. The eggs cling for 4–5 weeks, then they hatch.

www.stuarthutchison.com.au

Eggs attached under a male sea dragon's tail.

The young are less than 2.5 cm (1 inch) long at hatching. Sadly, many will become little fishy snacks for larger fish. But the lucky ones who survive will grow up to be beautiful adults. Having protection from dad during development likely gave leafy sea dragons a fin up in the big ocean world.

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Reproductive Strategies

Plant Profile:

MEADOW GARLIC

(Liliaceae*: Allium canadense*)

Larry Allain @ USGS National Wetlands Research Center

Before Europeans brought their garlic and onions to North America, Native Americans were likely spicing up their cooking with a native plant known as meadow garlic. This garlic, *Allium canadense*, grows wild from Florida to Canada. Surprisingly, it belongs to the same family as garden lilies—those big, bright flowers that sit in vases and gardens around the world. Even though it's called meadow garlic, it really smells and tastes more like an onion. Rubbing the leaves and stems releases a pungent onion smell.

Meadow garlic, also known as wild garlic, grows from bulbs like other lilies in its family. The bulbs lie dormant underground over winter, storing energy. Spring and early summer bring a burst of growth and reproduction. Bees don't mind the onion smell, and they buzz around pollinating the small, pink or white flowers. Although each flower has both male and female reproductive parts, it can't mate with itself. The bees are needed to move pollen from one plant to another. Gametes join to form fertile seeds that will spread and grow into new plants. The offspring have a mix of genes from the two parent plants.

But meadow garlic doesn't rely only on bees or other pollinators to spread itself around. Perched underneath the flowers are clusters of little, nubby growths called bulblets. The bulblets are outgrowths of the plan. When they drop off, they sprout into new plants identical to their parent. The bublets provide enough start-up energy for the new plants to grow. Eventually, they produce flowers and bulblets of their own.

Since plants in the lily family reproduce both with and without fertilization, they can spread easily. Some lilies have actually become pests by taking over pastures, gardens, and roadsides across the country.

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Animal Profile:

RED KANGAROO (*Macropus rufus*)

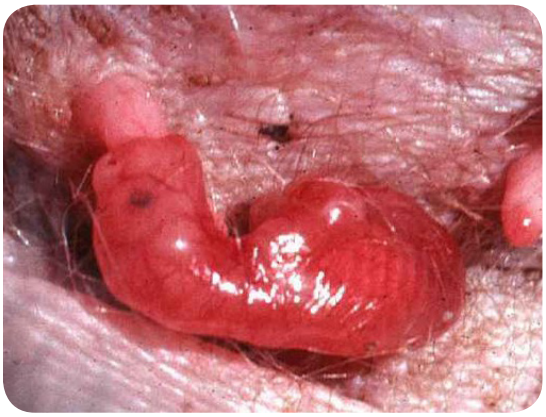
In the remote, dry plains of central Australia, mobs roam the countryside. But these aren't mobs to be feared. Mobs are the official name for groups of red kangaroos, *Macropus rufus*. And unlike angry mobs of people, red kangaroos are skittish and will scatter when frightened. When they're really moving, red kangaroos can leap as far as 3.7 meters (12 feet) in one jump and reach speeds of 56 kph (34.8 mph)!

Chris Willis

A mother red kangaroo with a joey in her pouch.

Red kangaroos are one of the largest marsupials. Herbivorous mobs of them bounce about eating grasses and other vegetation. Mobs are usually led by the most mature female and include lots of other females and young kangaroos, called joeys. When it's mating time, males will sometimes box each other for females with their powerful legs. The winning male deposits his sperm in the female, where it fertilizes an egg.

After mating, females gestate for about 33 days, then give birth to one baby kangaroo. Young red kangaroos are born very undeveloped. Like most marsupials, they will spend a lot of time growing in their mom's pouches. Though tiny, pink, hairless, and blind, the newborn knows to head straight for the pouch. It swims through mom's fur to get there, then attaches to a nipple and finishes developing.



Geoff Shaw - http://kangaroo.genome.org.

A newborn kangaroo in its mother's pouch.

After about 7 months, a joey outgrows mom's pouch and leaves to bounce around next to her. Once this happens, the mom gives birth to another tiny pink baby. Females can continuously give birth. They usually have about 3 joeys every two years.

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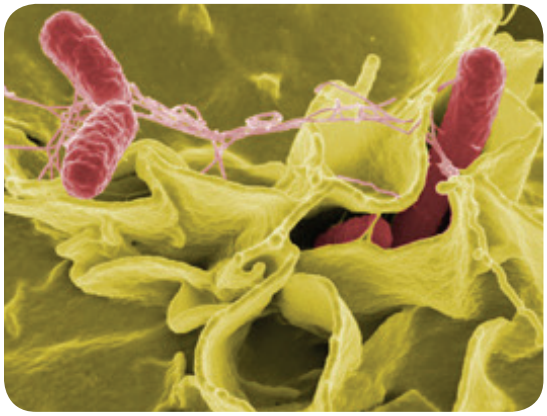
Reproductive Strategies

Bacteria Profile:
SALMONELLA (*Salmonella typhimurium*)

There are times when we eat something and our stomachs hurt. And then there are times when it hurts REALLY badly. When it hurts dreadfully bad and includes fever, nausea and diarrhea, it could be food poisoning. Yick. And that's a mild case of food poisoning! Some of the more life-threatening cases can send a person to the hospital.



Rocky Mountain Laboratories, NIAID,

Salmonella (rod-shaped) invading human cells.

The interesting thing is, it's not poisoning at all. It is the result of a sinister bacteria known as Salmonella. This one-celled, rod-shaped bacteria is fairly common. It can be found naturally in raw eggs, raw meats, on the bodies of some reptiles, and in animal feces. It's when Salmonella finds itself in the warm growth chambers of our bodies that it hits pay dirt.

When Salmonella reaches our small intestine, it begins to make copies of itself through simple division. These bacteria continue to rapidly divide, increasing in number and infecting other cells. It takes about 12–72 hours to feel the effects of a Salmonella invasion. Our immune system responds, but Salmonella does a good job of fending it off. Our bodies can fight off some Salmonella infections, but we often need antibiotics to overcome them.

Thankfully, Salmonella is not one of those extreme bacteria that can survive the freezing temperatures of the Arctic or the boiling heat of volcanic thermal vents. We can kill Salmonella by cooking, pasteurizing, and freezing our foods and drinks. Still, Salmonella infection is common enough. It usually turns up where people aren't washing their hands or cooking meat thoroughly.

Name _____

Date _____

Reproductive Strategies

Animal Profile:

SAND SCORPION (*Paruroctonus mesaensis*)

When the sun goes down in the Mojave Desert, sinister beasts lurk underfoot. The sand scorpion spends its days in a burrow underground, then comes out at night to sting, kill, and munch its prey. Shine an ultraviolet light and the ground will come alive with glowing scorpions. They hunt beetles, crickets, other scorpions, and even cannibalize their own kind. If it's the right time of year, glowing scorpions might also be dancing the night away.

Philip H. Brownell, Ph.D.

Sand scorpion (Paruroctonus mesaensis) capturing a burrowing cockroadh. Photo taken under UV illumination..

Yep, that's right—sand scorpions dance during courtship. Males grasp the females by their pinchers and move them around in circles. After a while, the male deposits a packet of sperm onto a stick or other surface. Then he moves the female until she is on top of the sperm. She takes it in and fertilizes her eggs internally. The dance ends here, and the male usually skitters off to find more mates. But every now and then, the female rears back, stings the male, and eats him for her next meal!

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Scorpions (Tityus trinitatis) engaged in courtship dance.

Young sand scorpions spend about 12 months developing inside their mother, then they are born alive. They quickly crawl onto their mom's back, where they stay until they're big enough to leave the burrow. On average, a sand scorpion mom has about 33 newborns. But things aren't always easy for them. Sometimes the young eat each other or the mom eats the young. Clearly, stingers don't make life trouble-free for the sand scorpion. But they're still very successful in their dry, sandy habitats.

http://scorpion.amnh.

Mother scorpion (syntropis) carrying babies on her back.

http://scorpion.amnh.

Spermatophor from a male scorpion.

Name _____

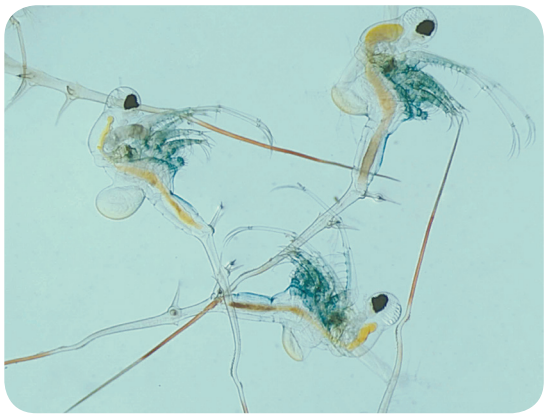
Date _____

Reproductive Strategies

Animal Profile:

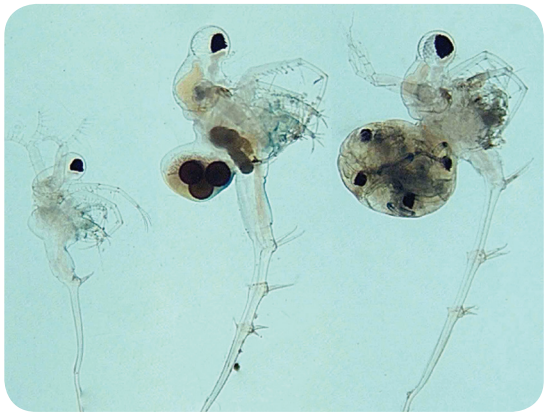
SPINY WATER FLEA (*Bythotrephes longimanus*)

There's a tiny, transparent crustacean that swims jerkily around in the Great Lakes. It spikes fish in the mouth with its long tail and gobbles up microscopic aquatic animals (zooplankton). It's called the spiny water flea, but it's more related to crabs and lobsters than to insects.



Pieter Johnson, University of Colo-

Though other kinds of water fleas are common in ponds and streams, the spiny water flea is not a welcome visitor. It's an invader from European waters, and it competes with local fish and water fleas for food. Its defense is its nasty barbed tail, which makes up 70% of its 2 cm long body.



Pieter Johnson, University of Colo-

Different reproductive forms of spiny water fleas. Male (left), female with asexual eggs (center), and female with sexual eggs (right).

Spiny water fleas are a threat to ecosystems in part because they reproduce rapidly. Like all water fleas, this one alternates between asexual and sexual phases. Most of the time, a female produces eggs without fertilization. She releases about 10 eggs into the brood chamber on her back. They develop over several days, then the young clones hatch. In the warm days of summer, females can make a batch of clones every 2 weeks.

When food is scarce or temperatures drop, some females produce spiny little males. The males mate with females that have produced special eggs used for fertilization. Once fertilized, these so-called "resting eggs" leave the mom and stay dormant until conditions improve. Resting eggs can survive drying or being eaten by fish.

Spiny water fleas seem to have a lot on their side, and they're in the Great Lakes to stay. Still, biologists are working hard to keep them from spreading into more lakes.

Name _____

Date _____

Reproductive Strategies

Animal Profile:

DESERT GRASSLANDS WHIPTAIL LIZARD (*Aspidoscelis uniparens*)

NPS - Sally King

Things are often not what they seem in the world of reproduction. Take the example of the desert grassland whiptail, a lizard that lives in the southwestern United States. These lizards have long sleek bodies with lines from nose to tail. They race around in the dry leaves and branches eating termites, grasshoppers, beetles, and other insects. Like other lizards, the whiptails perform courtship, mate, and lay eggs.

Sounds pretty ordinary, right? But if we took a closer look, we'd find that not a single one of these lizards is a male! This all-female whiptail species can reproduce without fertilization—a process called parthenogenesis.

© David Crews, Ph.D., University of Texas at Austin

Two female desert grasslands whiptail lizards engaged in pseudocopulation.

Pairs of females take turns playing male during courtship and mating. If the female is interested, the "male" will wrap around her and grip "his" jaws around her body. The couple will stay like this for 5 to 10 minutes. This is called pseudocopulation, or false mating. No actual males or sperm are involved.

The "female" from this mating pair lays 2 to 3 eggs, which all hatch into copies of their mom. Females will "mate" and lay eggs about 3 times over the breeding season. It turns out that females who lay eggs after "mating" with another female lay more eggs than females who don't mate. Laying a few more eggs is definitely an advantage in the harsh desert where survival is difficult.