PHILIPPINE SCIENCE HIGH SCHOOL WESTERN VISAYAS
Doña Lawaan H. Lopez Campus
Iloilo City

# LARVAL DEVELOPMENT OF MUD CRAB (*Scylla serrata*) AS AFFECTED BY FOUR DIFFERENT KINDS OF FEEDS

A Research Paper Presented to the
Faculty of Philippine Science High School Western Visayas
Iloilo City

In Partial Fulfillment
of the Requirements in
Technology Research II

By

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Kristoffer T. Panes
Michael Angelo G. Salvo

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APPROVAL SHEET

A Research Paper Requirement

For Technology Science II

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## Abstract

This study aimed to determine the effect of four different types of feed, namely, mussel, fish, *Artemia*, and Acetes, on the larval development of mudcrabs. It specifically determined which feed would be the most efficient feed for the development of the mud crab larvae, focusing on the carapace width, carapace length, body weight, and the mortality rate. The independent variables in this study is the type of feed used on mudcrabs during their larval development, while the dependent variables includes the mortality rate, the final weight and length of mudcrabs fed with the different kinds of feed. This study, employing the Completely Randomized Design, was done at the Southeast Asian Fisheries Development Center (SEAFDEC), Tigbauan, Iloilo, during the summer of 2002 for nine consecutive days. Each feeding group replicated in four 1-gallon plastic containers. The mean and standard deviation were used for descriptive statistics while the One-Way ANOVA was used for inferential statistics to determine

significant difference in the mortality rate, final weight, and final length of the mudcrabs fed with mussel, fish, artemia, and acetes.

The results show that mud crabs fed with mussels registered the highest body weight while those fed with fish had the lowest, but it was noted that no significant difference existed between and among the feed type as far as their effect on body weight of mudcrabs is concerned. For carapace width, those fed with acetes had the highest carapace width, while those fed with fish had the lowest of the four groups. However, no significant difference in the carapace width was noted among mudcrabs fed with different feed types. Among the four groups, those fed with acetes registered the longest carapace. It was also noted that those fed with acetes differed significantly from other groups in terms of carapace length. Also, those fed with acetes showed the lowest mortality rate among the four groups. Their difference in terms of mortality was significantly higher than any other group fed with different feed type. Acetes proved to be the best feed among the four to be used to maximize the growth and development of the mud crab in their larval stage.

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# LARVAL DEVELOPMENT OF MUD CRAB (*Scylla serrata*) AS AFFECTED BY FOUR DIFFERENT KINDS OF FEEDS

## Chapter 1

## Introduction to the Study

### Background of the Study

Crabs are an important food source. Some are canned and others are sold fresh to restaurants. In the United States three main kinds of crabs are caught for their meat. Blue crabs are caught commercially in open water by trawls or are removed from the mud with dredges. The "soft-shell crabs" served in restaurants are freshly molted adults whose carapaces have not hardened. Dungeness crabs (*Cancer magister*) are native to the Pacific coastlines of North America. The king crabs (*Paralithodes camtschatica*) come from the North Pacific Ocean and the Bering Sea. A single king crab can provide as much as 5 pounds (2.3 kilograms) of meat. Various kinds of stone, rock, and sand crabs are gathered along coasts for food, but they are not commercially important (Compton's Encyclopedia, 2000).

This research about mud crabs is conducted because of two reasons. One is to identify the type of feed which would be most

recommended to use during larval development of mudcrabs. And another is to determine what type feed would make mud crab growth faster.

This study was conducted during the summer of 2002 at the Southeast Asian Fisheries Development Center (SEAFDEC). SEAFDEC, provides a very comprehensive laboratory facility for this research, aside from the facts that there are numerous other researcher related to that study are being conducted there.

The independent variables in this study is the type of feed used on mudcrabs during their larval development, while the dependent variables includes the mortality rate, the final weight and length of mudcrabs fed with the different kinds of feed.

The relationship between the independent variable and the dependent variables is presented in Figure 1.

## Statement of the Problem and the Hypothesis

This study aimed to determine the effect of four different types of feed on the larval development of mudcrabs.

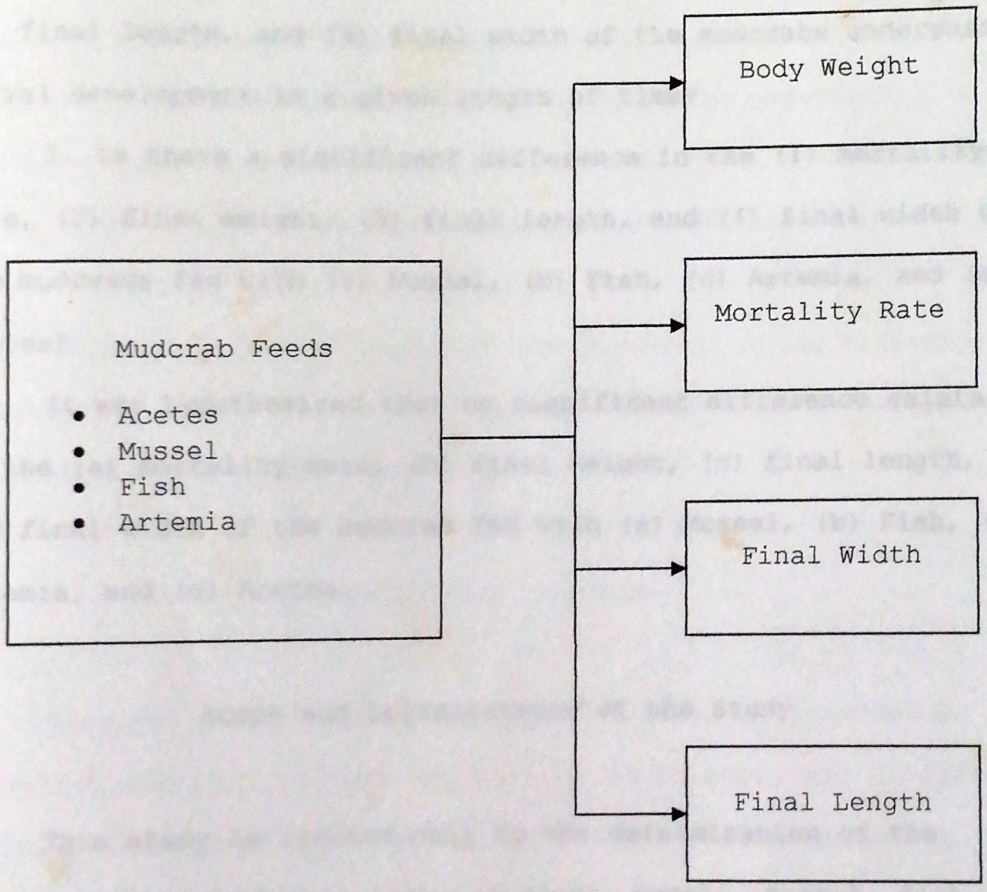


Figure 1. The effect of the kind of feed on the body weight, mortality rate, carapace width, and carapace length of mudcrab.

It specifically sought answers to the following questions:

1. What is the effect of (a) Mussel, (b) Fish, (c) Artemia, and (d) Acetes on the (1) mortality rate, (2) final weight, (3) final length, and (4) final width of the mudcrabs undergoing larval development in a given length of time?

2. Is there a significant difference in the (1) mortality rate, (2) final weight, (3) final length, and (4) final width of the mudcrabs fed with (a) Mussel, (b) Fish, (c) Artemia, and (d) Acetes?

It was hypothesized that no significant difference exists in the (a) mortality rate, (b) final weight, (c) final length, and final width of the mudcrab fed with (a) Mussel, (b) Fish, (c) Artemia, and (d) Acetes.

## Scope and Delimitations of the Study

This study is limited only to the determination of the effect of four different types of feeds, namely, mussel, fish, artemia and acetes on the body weight, carapace length, carapace width and mortality rate of mud crabs.

This study used mudcrabs, *Scylla serrata*, cultured at SEAFDEC and randomly selected with the assistance of SEAFDEC scientist.

The mean and standard deviation were used for descriptive statistics while the One-Way ANOVA was used for inferential statistics to determine significant difference in the mortality rate, final weight, and final length of the mudcrabs fed with mussel, fish, artemia, and acetes.

This study was conducted at the Southeast Asian Fisheries Development Center located at Tigbauan, Iloilo during the summer of 2002 for nine consecutive days.

## Definition of Terms

Mudcrab- a common name for any of a group of crustaceans characterized by a reduced abdomen and an enlarged and broadened anterior portion of the body; although most common as bottom dwellers in the sea, crabs also occur in fresh water, and some venture onto land (Microsoft® Encarta® Reference Library 2003, 2003).

In this study, "mudcrab" refers to the test animal, *Scylla serrata*, in larval stage, cultured at and obtained from SEAFDEC.

Larva- is the early form of an animal (as a frog or sea urchin) that at birth or hatching is fundamentally unlike its parent and must metamorphose before assuming the adult characteristics (Merriam-Webster Online).

In this study "larva" refers to the mudcrab organism in its larval stage.

Development- means to go through a process of natural growth, differentiation, or evolution by successive changes (Merriam-Webster Online).

In this study, the term "development" refers to the three physical attributes of the test organisms, namely, body weight, carapace length, and carapace width. This term also include mortality rate.

Feeds- is food for livestock; specifically, a mixture or preparation for feeding livestock (Merriam-Webster Online).

In this study, "feeds" refers to four feeding treatments given to mud crab larvae, namely, mussel, fish, *Artemia* and acetes.

Mussel- is a marine bivalve mollusk, especially of genus *Mytilus*, usually having a dark elongated shell.

In this study, "mussel" is the prepared feed for mudcrabs composed mainly of mussel meat.

Fish- is any of numerous cold-blooded strictly aquatic craniate vertebrates that include the bony fishes and usually the cartilaginous and jawless fishes and that have typically an elongated somewhat spindle-shaped body terminating in a broad caudal fin, limbs in the form of fins when present at all, and a 2-chambered heart by which blood is sent through thoracic gills to be oxygenated (Merriam-Webster Online).

In this study, "fish" is the prepared feed for mudcrabs composed mainly of fish meat.

*Artemia*- also known as brine shrimp, it is a commonly name for any of a group of small crustaceans found in the evaporating pools of saltworks and in briny lakes throughout the world, such as Great Salt Lake, where virtually no other higher forms of life can exist; the typical full-grown brine shrimp is about 13 mm (about 0.5 in) long, with flat, leaflike legs and a long "tail" consisting of the last eight segments of the body (Microsoft® Encarta® Reference Library 2003).

In this study, "*Artemia*" is the prepared feed for mudcrabs composed mainly of brine shrimp.

Acetes- is one of the 2000 species of crustacean, the size of which is comparable to that of small insects (Microsoft® Encarta® Reference Library, 2003).

In this study, "acetes" is the prepared feed for mudcrabs composed mainly of small shrimp.

Weight- means relative heaviness; the force with which a body is attracted toward the earth or a celestial body by gravitation and which is equal to the product of the mass and the local gravitational acceleration (Merriam-Webster Online).

In this study, "weight" refers to one of the dependent variables in this study, i.e., the obtained data after weighing the individual mud crabs using the sensitive weighing scale.

Length- is a measured distance or dimension (Merriam-Webster Online).

In this study, "length" refers to one of the dependent variables in this study, i.e., the distance from one point of the carapace to another of the test organism's carapace measured cephalocaudally using a microscope with a ruler attachment.

Width- is the horizontal measurement taken at right angles to the length (Merriam-Webster Online).

In this study, "width" refers to one of the dependent variables in this study, i.e., the distance from one side of the carapace to another using a microscope with a ruler attachment.

## Chapter 2

## Review of Related Literature

A crab is a typically marine crustacean with a front pair of legs specialized as pincers (chelipeds) and used for food capture, signaling, and fighting. It usually walks sideways, using four pairs of walking legs, also capable of swimming. Its body is broad, flattened, with a hard outer covering (carapace), abdomen permanently tucked up beneath body, and eyes usually movable on stalks. Some species terrestrial and some found in fresh water. Its eggs are carried by females, usually hatching into a planktonic larval stage (zoea). Many species are exploited commercially for food (Webster's World Encyclopedia, 2001 Edition).

Crabs have flatter, broader bodies than lobsters, crayfish, and shrimps. The small abdomen is folded into a groove under the cephalothorax and does not extend behind the carapace. The first pair of legs has large pinching claws. In crabs that swim, the last pair of legs is broad and flattened, serving as paddles. Crabs' eyes are mounted on movable stalks that can be drawn into the carapace. Crabs that live in water breathe by means of gills. Land crabs have modified gills that function as lungs. Some crabs feed on vegetable matter. Others eat small living

animals. Most crabs, however, are scavengers, eating dead or decaying material.

Many different kinds of crabs live throughout the world. Pea crabs (family Pinnotheridae) are among the smallest, some species living on the sea urchins called sand dollars. Other pea crabs live within the shells of oysters or mussels. Japanese spider crabs (*Macrocheira kaempferi*) are the largest crustaceans and may measure up to 12 feet (3.7 meters) from tip to tip of their outstretched claws. Their bodies may measure up to 18 inches (46 centimeters) long and 12 inches (30 centimeters) wide.

Most crabs live in the sea, on or near the bottom. One family (Potomonidae), found in southern Europe and many tropical areas, lives in fresh water. Some crabs live on land, sometimes several miles from water. To lay their eggs, the females must return to the water. Ghost crabs (genus *Ocypode*) stay on the ocean shore above the high-water line. Fiddler crabs (genus *Uca*) are common along the Atlantic coast in areas of salt and brackish water. The male fiddler has an enlarged right claw that it waves back and forth as a signal to available females and to competing males. Fiddlers live in burrows in the sand or mud, where they stay during winter and high tides.

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Kinds of Crabs

Pea crabs (family *Pinnotheridae*)

Pea crabs are among the smallest, some species living on the sea urchins called sand dollars. Other pea crabs live within the shells of oysters or mussels.

Japanese spider crabs (*Macrocheira kaempferi*)

Japanese spider crabs are the largest crustaceans and may measure up to 12 feet (3.7 meters) from tip to tip of their outstretched claws. Their bodies may measure up to 18 inches (46 centimeters) long and 12 inches (30 centimeters) wide.

Ghost crabs (genus *Ocypode quadrata*)

Ghost crabs stay on the ocean shore above the high-water line. They live in burrows along the sandy beaches of the Eastern United States. The crabs can reach relatively large sizes of over 50-mm carapace width. They are omnivorous and will eat other crabs, clams, insects, vegetation, and detritus. Feeding activity takes place at night, while burrowing occurs during the day. Burrows show zonation with young crabs found closer to shore, near water. Older crabs tend to burrow farther

from water. The large eyes of the crab are sensitive to changes in light intensity. The crab can produce 3 sounds: a rapping of the claw on the substrate, a rasping stridulation of the legs, and a bubbling sound presumably produced from the gill chamber. Combat between males is highly ritualized and rarely ends with contact.

Fiddler crabs (genus *Uca*)

Fiddler crabs are common along the Atlantic coast in areas of salt and brackish water. The male fiddler has an enlarged right claw that it waves back and forth as a signal to available females and to competing males. Fiddlers live in burrows in the sand or mud, where they stay during winter and high tides.

Hermit crabs (superfamily Paguroidea)

Hermit crabs have long, soft abdomens that are spirally coiled. They occupy abandoned snail shells by thrusting the abdomen into the shell and holding onto it with the hooks on a pair of leglike organs. They do not kill the original owner of the shell, though they will fight other hermit crabs to determine occupancy of a shell. The hermit crab drags the shell behind as

it walks about. As the crab grows larger, it seeks a larger shell.

Blue crab (*Callinectes sapidus*)

A common crab along the Atlantic and Gulf coasts of the United States. Blue crabs are swimming crabs that live in marine waters but also enter shallow brackish areas. The female blue crab lays eggs that are carried on her back until they hatch. Each egg hatches into a zoea, a larva that has several long spines, a long narrow abdomen, and large fringed antennae. After molting several times, the zoea ultimately emerges with the appearance of an adult crab. Blue crabs are caught commercially in open water by trawls or are removed from the mud with dredges.

Horseshoe crab (*Limulus polyphemus*)

The horseshoe crab, sometimes called king crab, is unrelated to the true crabs. It is an arthropod in the subphylum Chelicerata, but it is not considered to be a crustacean.

Stone Crabs

The stone crab has gained in popularity as a seafood delicacy in Texas and the commercial harvest has increased since 1984. This crab lives around rocky areas or oyster reefs and burrows into the sand. It is dark brownish-red with gray interspersed. Claws are hinged, very dark, and banded with red and yellow. All its legs are used for walking, and it has very strong pinchers used to crush oysters.

Stone crabs are fished near jetties, oyster reefs or other rocky areas just as for blue crabs. Stone crabs have small bodies and only the claws are eaten. To be kept, claws must be two and one-half inches long, measured from the tips of the immovable finger to the first joint. Only one legal size claw may be removed and then the crab must be returned immediately to the water. The claws are prepared in the same manner as blue crab claws.

Helmet Crab (*Telmessus cheiragonus*)

The helmet crab, in the family Cheiragonidae range from the Chukchi Sea (Sparks and Pereyra, 1966) and Norton Sound, Alaska to Monterey, California; however they are rare south of the Puget

Sound, Washington. They also are found from Siberia to Japan in the Western Pacific. Their yellowish coloring and bristles distinguish them easily. Their preferred habitat is eelgrass beds and rocky areas with algal cover from low intertidal to 110 m. During the spring their molted carapaces can be seen on the beaches in large numbers. A similar species, *Erimacrus isenbeckii*, is caught commercially around the Pribilof Islands, Alaska.

Green Crab *(Carcinus maenas)*

The European green crab is a small shore crab (adults measure about 3'' across) whose native distribution is along the coasts of the North and Baltic Seas. Although known by the common name of green crab, color is not its distinguishing feature. The shell (carapace) color can vary widely. Juveniles can change color to match their surroundings. Adults are generally dark greenish with yellow markings. The underside is often bright red or yellow. The crab is an effective forager, adept at opening bivalve shells. In California, it has caused losses as high as 50% in Manila clam stocks. It preys on numerous other organisms, making these crabs potential competitors for the food sources of native fish and bird species.

The recent arrival of the green crab on the U.S. West Coast is cause for concern. The green crab has already invaded numerous coastal communities outside of its native range, including South Africa, Australia, and both coasts of North America. An able colonizer and efficient predator, this small shore crab has the potential to significantly alter any ecosystem it invades. It has been blamed for the collapse of the soft-shell clam industry in Maine. The green crab could threaten Dungeness crab, oyster and clam fisheries and aquaculture operations in the Pacific Northwest and British Columbia.

First seen in San Francisco Bay in 1989, the green crab moved southward to Monterey Bay and northward to Humboldt Bay, California; Coos Bay, Oregon and into many Oregon estuaries. Green crab were sighted in Willapa Bay and Grays Harbor, Washington, and on the west coast of Vancouver Island, in 1998 and 1999.

## Life Cycle

In the Chesapeake Bay, crab larvae-called *zoea*-are released by mature females in high salinity waters near the mouth of the Bay. The zoea are transported to the continental shelf, where

they develop for a period of 30 to 45 days, through seven or eight distinct stages. The shrimplike zoea feed on zooplankton and plant material.

Zoea changes to the postlarval-*megalopae*-stage on the near-shore Atlantic shelf. Once they have been swept into the Bay by wind and currents, megalopae migrate vertically in response to light and tide. They use nocturnal flood tides to assist their movement up the estuary to shallow estuarine nursery habitats.

Megalopae settle in the lower Bay and use SAV beds as nursery beds. After six to 20 days, depending on salinity and temperature, the megalopae molt producing the true first crab stage. It is at this time that they become recognizable as miniature crabs. Crabs mature at approximately 12 to 18 months of age. Under current levels of fishing pressure, most crabs live from one to two years beyond maturity and the typical lifespan of a crab is up to three years. The maximum age may be as long as five to eight years.

The sexually mature crab is approximately five inches wide-the legal size for harvesting. Before mating, the male "cradles" the female in its legs and carries her for up to several days while searching for suitable cover, where he guards her during her final molt. Mating takes place while the female is in her

soft-shell phase. After mating, the male resumes cradling the female for several more days until the new shell have hardened. The male departs to search for another receptive female; the female migrates to the higher salinities of the lower Bay, where she develops an orange external egg mass beneath her apron that may contain between 750,000 and 8 million eggs, depending on her size.

The egg mass darkens over a two-week period as the orange yolk is consumed by the developing larvae. Larvae develop large black eye spots as hatching approaches.

Spawning is protracted and occurs over a period of one to two weeks. Spawning occurs from May to September, with a minor peak in June and major peaks in July and August. Individual females may spawn more than once, depending on the amount of sperm transferred during mating. Successive spawns may occur during the same year, or females may overwinter before spawning again the following spring.

Feeding activities

In its native range, the feeding activity of the European crab greatly impacts populations of mussels (*Mytilus* spp.),

dogwhelks (*Nucella lapillus*), and cockles (*Cerastoderma edule*). In Scotland, the crab acts as an intermediate host of the acanthocephalan worm, *Profilicollis botulus*, which causes heavy mortalities in common eiders (*Somateria mollissima*). Along the east coast of North America, the European crab preys on quahogs (*Mercenaria mercenaria*), a hard shell clam, and has been implicated in the demise of the Atlantic soft-shell clam fisheries of the 1950s. In Bodega Bay, California, there has been a significant reduction in the populations of native clams (*Transennella* spp.) and a shore crab (*Hemigrapsus oregonensis*) since the arrival of the European crab in 1993. Furthermore, laboratory studies show that European crabs readily prey on Dungeness crabs (*Cancer magister*) of equal or smaller size. Dungeness crabs spend part of their juvenile life in the intertidal zone, and may therefore be at risk from European crab predation.

The European crab is capable of learning and can improve prey-handling skills while foraging. The crab is quicker, more dexterous, and can open shells in more ways than other species of crabs. Two color varieties exist: red and green. Red-colored European crabs prefer larger bivalves and usually dominate green-colored European crabs in aggressive disputes over prey. The

crusher claws (the larger of the two claws) of red European crabs exert more force, on average, than those of green European crabs. In Denmark, the foraging activity of the European crab is about 20 times higher in summer and fall than in winter and spring. In summer, large numbers of European crabs move up and down the shore with the tides. European crab usually forage during high tide, whereas females are active primarily at night, independent of the tidal phase.

Studies conducted on the European crab in Europe indicate that when preying on bivalves, feeding rates generally decrease with increasing bivalve size and with decreasing crab size. Oysters are typically "crab-proof" at around 60-mm shell length, whereas mussels are free of predation at around 45-mm shell length. European green crabs, with a 25-75 mm carapace width, are capable of eating three oysters up to 60 mm shell length daily; a relatively low number compared to the nearly three-dozen mussels (up to 45 mm shell length) it is able to eat in the same period! Mussel populations located high in the intertidal zone tend to survive predation better than those lower in the intertidal zone.

# Chapter 3

## Research Design and Methodology

This study aimed to determine the effect of four different types of feed on the larval development of mudcrabs.

It specifically determined the effect of mussel, fish, *Artemia*, and Acetes on the mortality rate, final weight, final length, and final width of the mudcrabs undergoing larval development in a given length of time. It also determined the significant difference in the mortality rate, final weight, final length, and final width of the mudcrabs fed with mussel, fish, *Artemia*, and Acetes.

It was hypothesized that no significant difference exists in the mortality rate, final weight, final length, and final width of the mudcrab fed with mussel, fish, *Artemia*, and Acetes.

## Research Design

This study, employing the Completely Randomized Design, was done at the Southeast Asian Fisheries Development Center (SEAFDEC), Tigbauan, Iloilo. It determined the effect of types of feed used on mud crab larvae for nine days. Four feeds were used by the researchers, namely, acetes, *Artemia*, mussel and

fish. Each feeding group was replicated in four 1-gallon plastic containers.

## Materials and Equipment

The materials used for this experiment are 16 plastic containers, 16 aerators, a thermometer, a sensitive weighing scale, a microscope with ruler attachments, and a refractometer.

## General Procedure

### Preparing the Container Set-up

Each sixteen plastic containers, four for each type of feed, were filled with 3 liters of seawater with a salinity of 7. Then, 12 mud crab larvae were placed in each container. The containers were labeled appropriately for each feed type with four replicates for each feed type.

### Feeding and Feeding Schedule

The mud crab larvae were fed with the mussel, fish, *Artemia* and acetes depending on the label of the container. This was done twice a day for nine days at 10 a.m. and 3 p.m.

The temperature and salinity were monitored twice each day during the duration of the experiment.

## Gathering of Data

Starting Day 2, the larval development in terms of body weight, carapace length and width as well as mortality rate was noted and recorded.

### Determining the Body Weight, Carapace Length, and Carapace Width

The weight of each larva was measured in mg using the sensitive weighing scale. The data, expressed as mean weight, were then recorded for each replicate and for each feed type.

The carapace length of each larva was measured from the tip at the head section going to the caudal section using the microscope with attachment. The data, expressed as mean carapace length in mm, were recorded for each replicate and for each feed type.

The carapace width of each larva was measured using the microscope with ruler attachment at the midsection of the larvae where the carapace is noted the widest. The data,

expressed as mean carapace width in mm, were then recorded for each replicate and for each feed type.

The body weight of each larva in each container was measured using a sensitive weighing scale. The data, expressed as mean body weight in mg, were recorded for each replicate and for each feed type.

The mortality rate of each larva was determined by counting the number of live larvae starting day 2 for each replicate and for each feed type.

This process of determining the body weight, carapace length and carapace width and mortality rate was done until day 9.

## Statistical Techniques

### Descriptive Statistics

The mean and standard deviation were employed as descriptive statistical tools.

The mean was employed to express the average final body weight, carapace length, carapace width and mortality rate of the mudcrabs in each feeding treatment.

Inferential Statistics

The One-Way ANOVA, set at .05 level of significance, was used to determine whether the larval development in terms of body weight, carapace length, carapace width and mortality rate showed significant difference in mudcrabs fed with four types of feeds.

# Chapter 4

## Results and Discussion

This study aimed to determine the effect of four different types of feed on the larval development of mudcrabs.

It specifically determined the effect of mussel, fish, *Artemia*, and Acetes on the mortality rate, final weight, and final length of the mudcrabs undergoing larval development in a given length of time. It also determined the significant difference in the mortality rate, final weight, final length, and final width of the mudcrabs fed with mussel, fish, *Artemia*, and Acetes.

It was hypothesized that no significant difference exists in the mortality rate, final weight, final length, and final width of the mudcrabs fed with mussel, fish, *Artemia*, and Acetes.

### Final body weight of *Scylla serrata*

Results of the study showed that the body weight was observed the highest with mussel feed with a mean of 15.83 mg. Acetes was second at 14.529 mg while Artemia was 12.67 mg. Fish meal registered 10.25 mg.

Table 1 shows the data.

Carapace Width of *Scylla serrata*

The carapace width of *Scylla serrata* was 3.877 mm for mussel, 3.289 mm for fish, 3.538 mm for *Artemia* and 3.898 mm for Acetes.

Table 2 shows the data.

As indicated in the table, acetes registered the highest carapace width with a mean of 3.898 mm followed by museel with 3.877 mm. Artemia and fish had 3.538 mm and 3.289 mm respectively in that order.

Carapace Length of *Scylla serrata*

The carapace length of *Scylla serrata* was 2.965 mm for mussel, 2.632 mm for fish, 2.660 mm for Artemia and 3.272 mm for Acetes.

Table 3 shows the data.

Table 1

Mean body weight of *Scylla serrata*(in mg) after 9 feeding days

| Feed Type | N | Mean Body Weight (mg) | Standard Deviation |
|---|---|---|---|
| Mussel | 6 | 15.83 | 2.71 |
| Fish | 4 | 10.25 | 1.71 |
| *Artemia* | 9 | 12.67 | 3.87 |
| Acetes | 17 | 14.53 | 4.36 |

Table 2

Carapace width of *Scylla serrata*(in mm) after 9 feeding days

| Feed Type | N | Mean carapace width (mm) | Standard Deviation |
|---|---|---|---|
| Mussel | 6 | 3.877 | 0.53 |
| Fish | 4 | 3.289 | 0.24 |
| *Artemia* | 9 | 3.538 | 0.47 |
| Acetes | 17 | 3.898 | 0.76 |

Table 3

Carapace Length of *Scylla serrata* (in mm) after 9 feeding days

| Feed Type | N | Mean carapace length (mm) | Standard Deviation |
|---|---|---|---|
| Mussel | 6 | 2.965 | 0.37 |
| Fish | 4 | 2.632 | 0.12 |
| Artemia | 9 | 2.660 | 0.24 |
| Acetes | 17 | 3.272 | 0.46 |

As the results show, Acetes yielded the longest carapace length at 3.272 mm followed by mussel with 2.965 mm. Artemia and fish had 2.660 mm and 2.632 mm respectively in that order.

Mortality Rate of *Scylla serrata after 9 feeding days*

*Scylla serrata* mortality rate was 87.5% for mussel, 92% for fish, 81.25% for artemia and 64.5% for acetes.

Table 4 shows the data.

Table 4

Mortality Rate of *Scylla serrata after 9 feeding days*

| Feed Type | Mean Mortality | % Mortality | Standard Deviation |
|---|---|---|---|
| Mussel | 9.75 | 87.5% | 87.5 |
| Fish | 10.5 | 92.0% | 0 |
| Artemia | 11 | 81.25% | 4.00 |
| Acetes | 7.75 | 64.5% | 8.19 |

Results of the study showed that fish meal had the highest mortality rate of 92% with 10.5 mean mortality. It was followed by mussel meal with 88% mortality rate with 9.75 mean mortality while artemia had 81% mortality rate with 11 mean mortality. Acetes registered the lowest mortality rate of 65% with 7.75 mean mortality.

Significant Difference in body weight of *Scylla serrata* after 9 feeding days

The One-Way Analysis of Variance, set at .05 alpha level of significance, showed that there was no significant difference in the body weight of *Scylla serrata*, as reflected by $F(4) = 0.110$, $p < 0.05$

Table 5 shows the data.

This means that although differences were noted in the mean body weight of the mudcrabs, the different feeds did not differ significantly in their effects upon the mudcrabs in terms of the mean weight of the mud crab.

Significant Difference in carapace width of *Scylla serrata* after 9 feeding days

The One-Way Analysis of Variance, set at .05 alpha level of significance, showed that there is no significant difference in the carapace width of *Scylla serrata* as reflected by $F(4) = 0.247$, $p < 0.05$.

Table 6 shows the data.

This means that the different feed types had the same effect on the carapace width of *Scylla serrata*.

Table 5

One-Way ANOVA Summary table for the values of body weight

| Source of Variation | Sum of Squares (SS) | df | Mean Squares | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 95.82 | 3 | 31.940 | 2.175 | 0.110 |
| Within Groups | 469.819 | 32 | 14.682 | | |
| Total | 565.639 | 35 | | | |

Table 6

One-Way ANOVA Summary table for the values of carapace width

| Source of Variation | Sum of Squares (SS) | Df | Mean Squares | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 1.715 | 3 | .572 | 1.448 | .247 |
| Within Groups | 12.638 | 32 | .395 | | |
| Total | 14.353 | 35 | | | |

Significant Difference in carapace length of *Scylla serrata* after 9 feeding days

The One-Way Analysis of Variance, set at .05 alpha level of significance, showed that there is significant difference in the carapace length of *Scylla serrata* as reflected by $F(4) = .022$, $p > 0.05$

Table 7 shows the data.

This means that certain feed type had greater effect on the carapace length of mud crab *Scylla serrata* compared with other feeds after feeding.

When the data were subjected to post-hoc treatment for multiple comparisons using the Scheffe test, significant difference was noted in the length of the carapace between those fed with fish and those with acetes.

The data showed, however, that the carapace length of mud crab *Scylla serrata* fed with acetes did not differ significantly with those fed with mussel and artemia.

Table 9 shows the data.

In terms of carapace width, acetes feed is better than fish feed.

Table 7
One-Way ANOVA Summary table for the values of carapace length

| Source of Variation | Sum of Squares (SS) | Df | Mean Squares | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 1.581 | 3 | .527 | 3.673 | .022 |
| Within Groups | 4.590 | 32 | .143 | | |
| Total | 6.171 | 35 | | | |

Significant Difference in mortality rate of *Scylla serrata* after 9 feeding days

The One-Way Analysis of Variance, set at .05 alpha level of significance, showed that there is significant difference in the mortality rate of Scylla serrata as reflected by $F(2) = .000$, $p > .05$.

Table 8 shows the data

This means that a certain group of mud crabs given a particular feed type registered significantly higher mortality rate than others.

Table 8

One-Way ANOVA Summary table for the values of mortality rate

| Source of Variation | Sum of Squares (SS) | Df | Mean Squares | F | Sig |
|---|---|---|---|---|---|
| Between Groups | 1741 | 3 | 580.33 | 21.103 | .000 |
| Within Groups | 330 | 12 | 26.500 | | |
| Total | 2071 | 15 | | | |

When the data were subjected to post hoc treatment for multiple comparisons using the Scheffe test, significant differences were noted between mussel and acetes, fish and acetes, and *Artemia* and acetes.

Table 10 shows the data.

These statistics simply showed that the difference in the mortality rate (survival rate) between acetes and any other feeds is significant, establishing the fact that acetes feed is better than fish; acetes is also a better feed than mussel and *Artemia*.

Table 9

Scheffe test for One-Way ANOVA in Table 7

| Variables | Mean Differences | Standard Error | Significance |
|---|---|---|---|
| Mussel vs. Fish | 0.333 | 0.244 | 0.607 |
| Mussel vs. Artemia | -0.029 | 0.200 | 0.999 |
| Mussel vs. Acetes | -0.30770 | 0.180 | 0.416 |
| Fish vs. Artemia | -0.36261 | 0.228 | 0.479 |
| Fish vs. Acetes | -0.64103 | 0.210 | 0.041 |
| Artemia vs. Acetes | 0.27842 | 0.156 | 0.380 |

Table 10

Scheffe test for One-Way ANOVA in Table 8

| Variables | Mean Differences | Standard Error | Significance |
|---|---|---|---|
| Mussel vs. Fish | -4.50 | 3.708 | 0.695 |
| Mussel vs. Artemia | 6.50 | 3.708 | 0.416 |
| Mussel vs. Acetes | 23.00* | 3.708 | 0.000 |
| Fish vs. Artemia | 11.00 | 3.708 | 0.077 |
| Fish vs. Acetes | 27.50* | 3.708 | 0.000 |
| Artemia vs. Acetes | 16.50* | 3.708 | 0.007 |

# Chapter 5

## Summary, Conclusion and Recommendations

This study aimed to determine the effect of four different types of feed on the larval development of mudcrabs.

It specifically sought answers to the following questions:

1. What is the effect of (a) Mussel, (b) Fish, (c) Artemia, and (d) Acetes on the (1) mortality rate, (2) final weight, (3) final length, and (4) final width of the mudcrabs undergoing larval development in a given length of time?

2. Is there a significant difference in the (1) mortality rate, (2) final weight, (3) final length, and (4) final width of the mudcrabs fed with (a) Mussel, (b) Fish, (c) Artemia, and (d) Acetes?

It was hypothesized that no significant difference exists in the (a) mortality rate, (b) final weight, (c) final length, and final width of the mudcrab fed with (a) Mussel, (b) Fish, (c) Artemia, and (d) Acetes.

## Summary

Mudcrabs fed with mussels registered the highest body weight while those fed with fish had the lowest, but it was noted that no significant difference existed between and among the feed type as far as their effect on body weight of mudcrabs is concerned.

For carapace width, those fed with acetes had the highest carapace width, while those fed with fish had the lowest of the four groups. However, no significant difference in the carapace width was noted among mudcrabs fed with different feed types.

Among the four groups, those fed with acetes registered the longest carapace. It was also noted that those fed with acetes differed significantly from other groups in terms of carapace length.

Also, those fed with acetes showed the lowest mortality rate among the four groups. Their difference in terms of mortality was significantly higher than any other group fed with different feed type.

## Conclusions

Based on the results of the study, the following conclusions may be drawn:

1. That acetes has shown high potential as feed for mudcrabs *Scylla serrata* during their larval stage. This maybe explained by the fact that in the two physical attributes of the mudcrabs, namely carapace width and length, those given acetes as feeds registered the highest figure. It ranked second only in the body weight aspect. More significantly, acetes registered the lowest mortality rate and this rate differed significantly from the mortality rate of the three other groups.

2. That the other feeds may also be potential as feeds for mudcrabs *Scylla serrata* except that fish meal somewhat yielded the poorest result. It was noted during the experiment that the fish bits given to the mudcrabs were hard resulting to low consumption. Also, the mudcrabs turned on each other when the fish meal was difficult to take.

## Recommendations

Based on the results of the study, it is recommended that acetes would be the best natural feed to use to optimize the growth of the mudcrab.

It is also recommended that different types of feeds be tried to determine the best feed for the mudcrabs. Likewise, various feeding times should be tried, in order to determine their best feeding time. Fish feed should be made softer, to make it more edible for the mudcrabs. Feed quantity should be increased proportionate to their growth.

Since the study did not include synthetic feed against which the natural feeds can be compared, it is also recommended that laboratory prepared feeds be also included in order to really find out whether the feeds as treatment are as effective as the synthetic ones.

It is further recommended that there be a study which uses more species of crab to be reared to find out the fastest growing species as affected by the feed treatments. Also, parallel studies can extend the investigation to the adult stage. This will determine whether the same feeds can still be effective at any given stage of mud crab development.

Lastly, duplicating this study is encouraged to establish the validity of the effects of the given feeds.

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