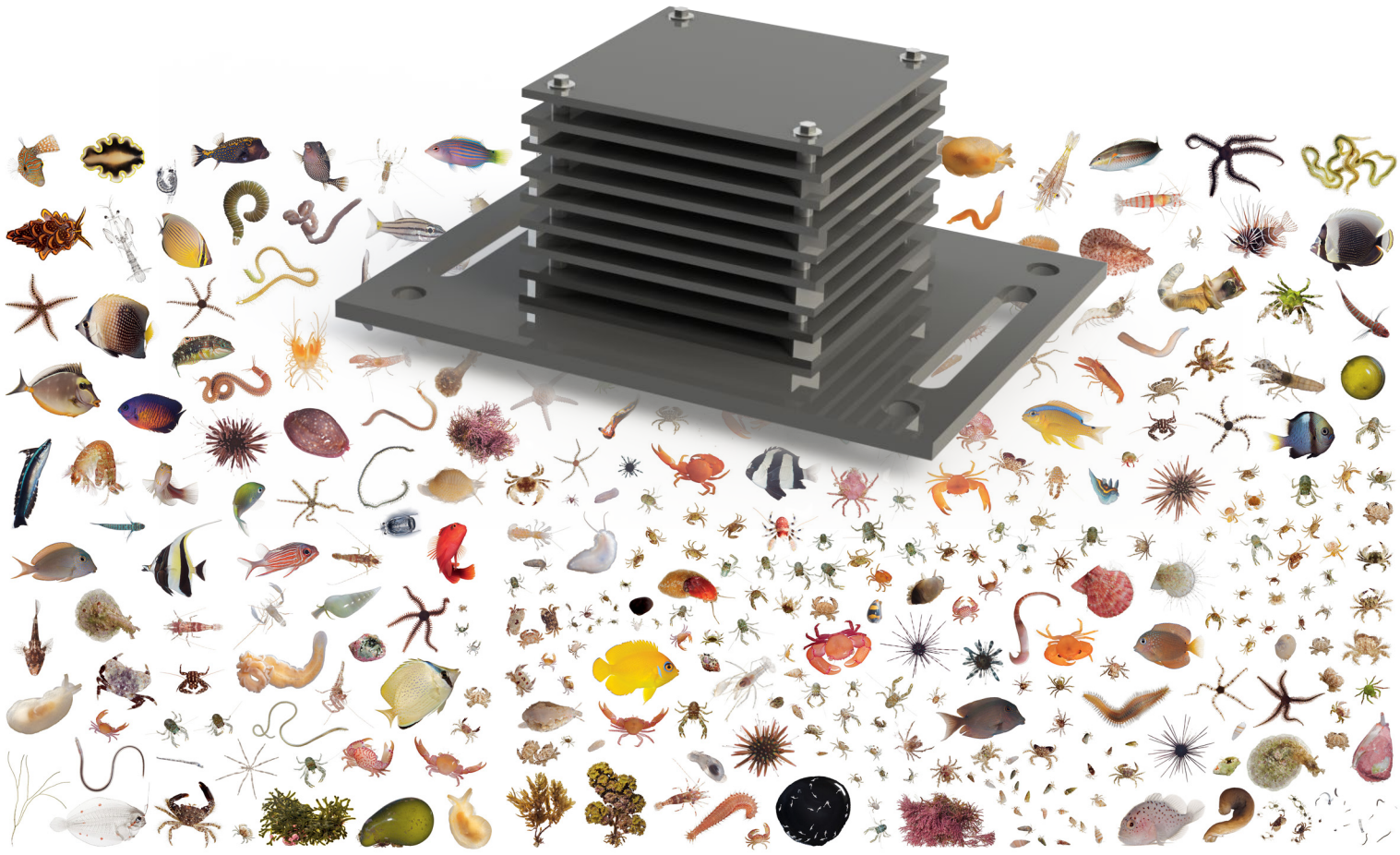
FIELD GUIDE
to
CRYPTIC MARINE INVERTEBRATES
OF THE PHILIPPINES

A Sample of Biodiversity
from
Autonomous Reef Monitoring Structures



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Field Guide to Cryptic Marine Invertebrates of the Philippines: A Sample of Biodiversity from Autonomous Reef Monitoring Structures

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Quezon City 1100 Philippines

ARMS image by NOAA; "A World in One Cubic Foot: Portraits of Biodiversity" image by David Liittschwager (Liittschwager, 2012).

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Front cover images: *ARMS image by NOAA; "A World in One Cubic Foot: Portraits of Biodiversity" image by David Liittschwager (Liittschwager, 2012).*

Back cover image: *Nudibranch, Moalboal, Philippines, 2016, by Megan Moews-Asher, NOAA Fisheries.*

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FOREWORD

The Philippines is renowned as the global epicenter of marine biodiversity, and it has been the government's top priority to find solutions to abate impacts of threats related to climate change and increase awareness of the Filipino citizens on the importance of a healthy marine ecosystem.

Too little is known about marine cryptic invertebrates or cryptobiota. They are the minute organisms that are usually unnoticed but serve as building blocks of the coral reefs. Marine cryptobiota serve an integral part of our food chain and support our fisheries. However, these organisms are much likely to be affected by climate related disturbances such as anomalous increases in sea surface temperature. We might possibly lose these precious organisms even before we have the chance to know them. This is the reason why we need to further improve our management policies and interventions which is anchored on good science and research.

We have a great pleasure to share with you the "Field Guide to Cryptic Marine Invertebrates of the Philippines: A sample of biodiversity from Autonomous Reef Monitoring Structures (ARMS)". This document is a product of the collaborative research between the Philippines and the United States of America on understanding marine biodiversity along geographic and anthropogenic gradients. Photos used are from the specimens collected in Verde Island Passage using the ARMS.

The Field Guide is intended for use of the general public, especially those who are involved in biodiversity researches, protected area management, and community empowerment. We believe that engaging all sectors, especially the academe and the community, is one of the most effective strategies in making our environment resilient from the effects of climate change. With this in mind, we always find ways to reach out, capacitate, and support them in every possible way we can.

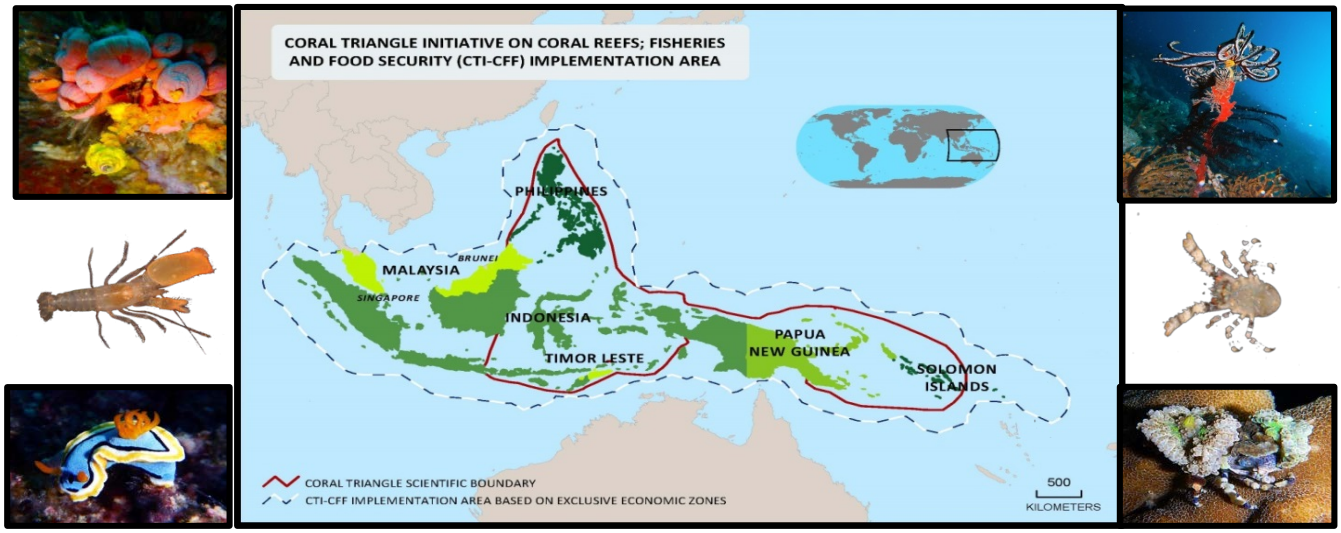
We thank the Philippine and U.S. research collaborators and all those who are involved in the development of this Field Guide. We take pride in this document and we do hope that this will help us achieve our goal of empowering the community for the conservation and protection of our oceans!

DR. THERESA MUNDITA S. LIM

Director, Biodiversity Management Bureau

Philippine Coral Reefs and Biodiversity

Located within the Coral Triangle, the world's epicenter for marine biological diversity or "biodiversity," the Philippines coral reef ecosystems host some of the greatest diversity of marine life on the planet! Its coral reefs are made up of thousands of species.

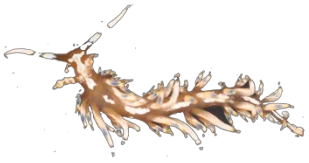


Coral Triangle Map: dashed line represents Exclusive Economic Zones (Flanders Marine Institute VLIZ); solid line shows scientific boundary (Veron et al., 2009), courtesy of Coral Triangle Secretariat. Biodiversity images: Cut outs from ARMS by NOAA Fisheries; All other images Moalboal, Philippines 2016, by Megan Moews-Asher, NOAA Fisheries

Coral reefs occupy less than 0.1% of the Earth's surface and less than 0.2% percent of the ocean bottom (Reaka-Kudla, 1997), and yet they provide a unique set of ecosystem goods and services to the people. As an archipelagic country, more than half of the Philippine population depend on coral reef ecosystems and other marine resources for food, income related to fisheries and tourism, coastal protection, climate moderation, and raw materials including ornamental fish and medicinal resources, among others.

Philippine Coral Reefs and Biodiversity





Biodiversity is one of the most important factors supporting marine ecosystem health and recovery (Borja, 2012). Because of their incredible biodiversity, coral reef ecosystems are called "the rainforests of the sea" (Knowlton et al., 2010). Like the trees and birds of a rainforest, the coral and fish in a coral reef represent but a SMALL portion of the overall diversity (life). In a rainforest, it's the insects that make up most of the biodiversity! So what organisms make up most of the life on a reef?

Invertebrates!

In this guide, we focus primarily on the small motile (moving) invertebrates that live in the holes and crevices of the reef or are camouflaged and thus blend into the reef making them hard to see. These organisms are known as the "cryptofauna" and are important to nutrient cycling and to the reef fish that feed on them! Therefore the health of coral reef ecosystems, including fisheries, relies heavily on the health of these organisms. Despite their importance, cryptofauna are poorly understood in part because they are small, diverse, and challenging to identify.



Biodiversity image cut outs courtesy NOAA Fisheries

Philippine Coral Reefs and Biodiversity

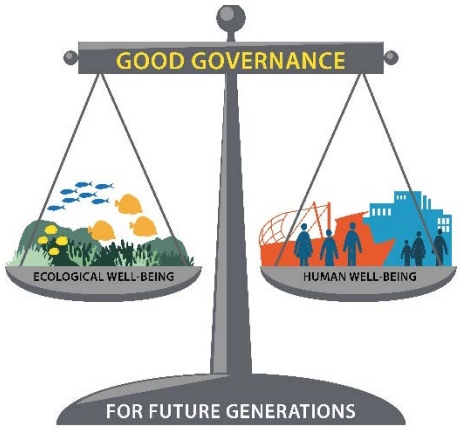


Image showing balance between ecological and human well-being through good governance (Staples et al., 2014)

Interactions between the biotic (living) and abiotic (non-living--such as temperature and nutrients) parts of the ecosystem are important to how the ecosystem functions and the ability of its life to survive and thrive. From the smallest organisms in the food chain to the largest, including us who use, impact, and rely on the health of the ecosystem, there is a fine line in achieving the balance between ecological and human well-being. The scale can easily be tipped as these systems are impacted by human or natural stressors.

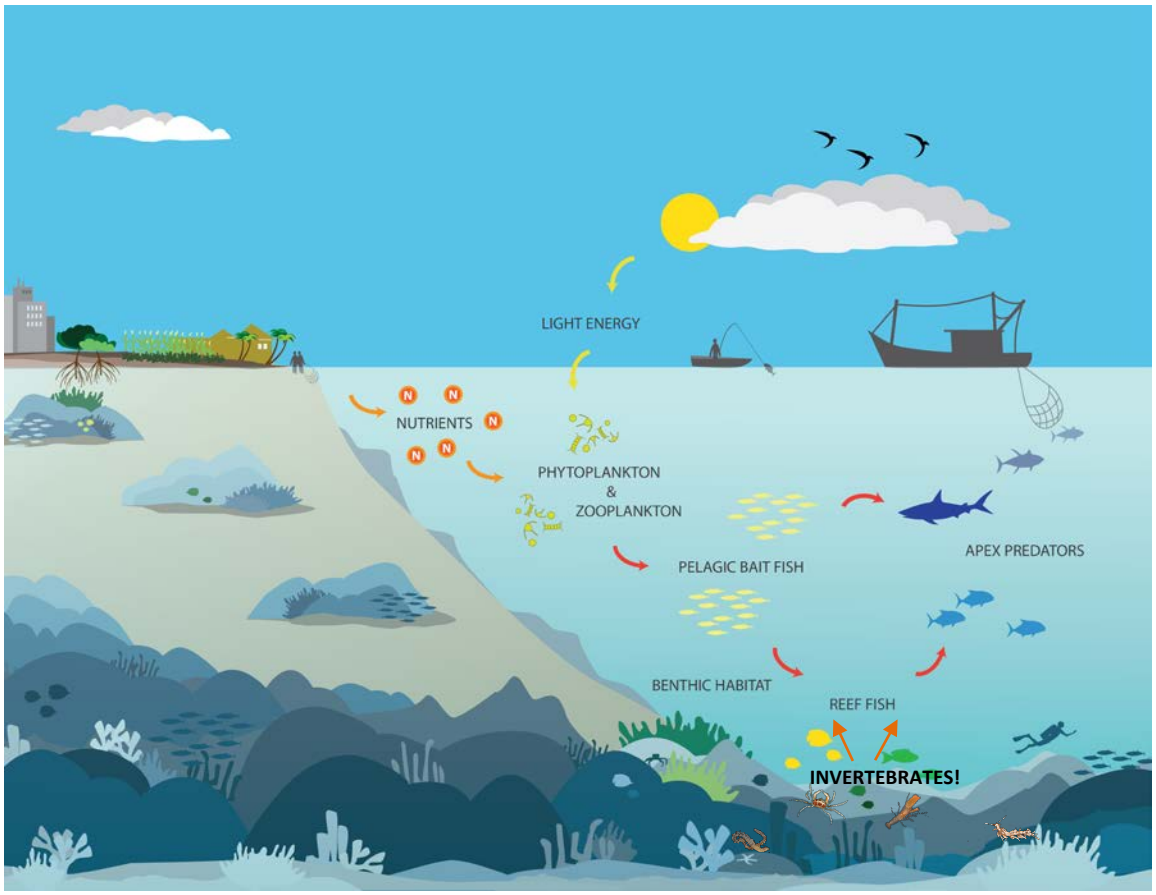


Image depicting connections within an ecosystem and its trophic levels (food chain) courtesy NOAA Fisheries

Threats and Impacts on Coral Reefs

Coral reef ecosystems are deteriorating at alarming rates due to human and environmental stressors that often have combined impacts!

Threats and impacts to these systems can include (but are not limited to):

Over-harvesting & Overfishing

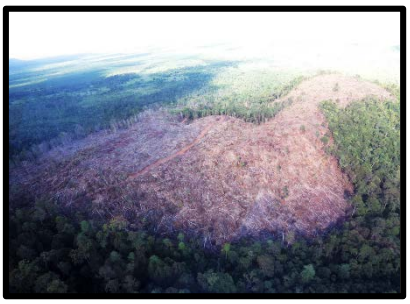
Resulting in impacts to food sources and changes in the ecosystem dynamics

Image of fish, Bohol, Philippines 2018, courtesy Rizza Sacra UNDP

Land-based Sources of Pollution

-Deforestation
-Agriculture
-Mining
-See also Coastal Development (next page)

These result in increased sediments, nutrients, chemicals and other pollutants impacting the marine ecosystem.



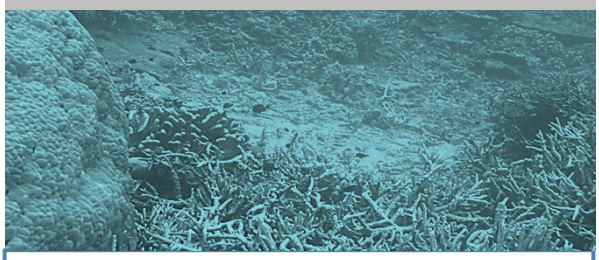
Images of deforestation, Palawan 2017 and mining Manicani, Guiuan, Eastern Samar 2016, Philippines, courtesy DENR

Threats and Impacts on Coral Reefs

Coastal Development

-Sewage
-Coastal erosion
-Marine debris (both land and sea)
-See also to Land-based Sources of Pollution (previous page)

Habitat Destruction



-Destructive fishing gear
-Blast fishing
-Poison
-Pollution
-Anchoring
-Vessel groundings

Climate Change and Ocean Acidification

For more information see next page

These threats decrease the health of coral reefs and an "injured" coral reef impacts ALL of us, because we rely on coral reefs for food, jobs, coastal protection from storm related hazards, tourism, and personal enjoyment.

Images: (left) blast fishing impacted coral reef courtesy Megan Moews-Asher, NOAA Fisheries; coral bleaching, Snake Island, Honda Bay Puerto Princesa, Palawan Philippines 2016 courtesy Patrie Cianne Gelveson, DENR; (right) marine debris, Manila, Philippines 2011 courtesy DENR; dead fish from blast fishing courtesy Moews-Asher, NOAA Fisheries

Climate Change and Ocean Acidification

Climate change—Increased greenhouse gasses caused by human activities create abnormal variations in the atmosphere affecting Earth's climate. This can lead to ocean warming, a serious threat to coral reef ecosystems. Ocean warming can result in:

Coral Bleaching

Coral Disease

Sea level rise

Increased frequency and intensity of storms

Ocean acidification– Oceans naturally absorb carbon dioxide (CO_2). However, with the increase of CO_2 into our atmosphere from human activities, the ocean is absorbing more than a healthy level. As a result, ocean pH levels (acidity) are reduced. This change in ocean chemistry:

- Decreases the ability of corals to grow (calcify) thereby weakening their "skeletons."
- Causes increased erosion of these reef builders due to more fragile coral "skeletons," indirectly impacting all of the organisms that rely on them for habitat.
- Impacts the larval ("infant") growth stages of many marine organisms thereby reducing their ability to survive to adulthood.

All of the above will result in major ecosystem shifts affecting goods and services to humans (National Research Council, 2010).

Images: Coral bleaching, Snake Island, Honda Bay, Palawan Philippines 2016 courtesy Patrie Cianne Gelveson, DENR; Coral disease, Acute tissue loss/White Syndrome, Kingman Reef 2008, courtesy Bernardo Vargas-Angel, NOAA Fisheries

What Can You Do to Help?

Start by understanding that managing and conserving biodiversity is key to maintaining and improving the health of your rich marine resources in the Philippines. What else?

Learn:

1. Increase your understanding of the various species of animals living in the coral reef and other marine ecosystems.
2. Learn about/practice good reef etiquette (e.g. don't walk or anchor on living corals).
3. Learn about an Ecosystem Approach to Fisheries Management (EAFM):
   a) Philippines focused "Mainstreaming EAFM" (led by Department of Agriculture's Bureau of Fisheries and Aquatic Resources): https://www.bfar.da.gov.ph/PUBLICATIONCAPTUREDIVISION.jsp
   b) Additional EAFM tools: www.eafmlearn.org
4. Learn more about and choose to eat sustainable seafood.

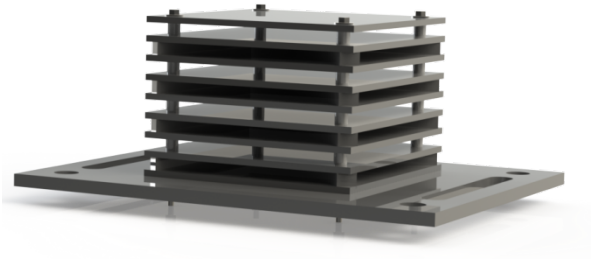
Do:

1. Get actively involved in beach and waterway clean ups, collecting data, managing resources, and/or influencing leaders, managers and policy-makers.
2. Reduce pollution/run off from such pollutants as household, garden and agricultural chemicals, sewage, trash, mining, deforestation, etc.
3. Do not engage in blast fishing, using poison or destructive fishing gear.
4. Shrink your carbon footprint to reduce greenhouse gases (e.g., drive less, use cleaner energy if possible, use energy-efficient appliances and light bulbs).
5. Reduce, reuse, recycle!
6. Use less paper--go digital!
7. Raise awareness and understanding by sharing your knowledge with others.

Images: Top left "Mainstreaming EAFM" courtesy NOAA Fisheries; Bottom left/right "Hands-on-ARMS" courtesy BMB

Autonomous Reef Monitoring Structures

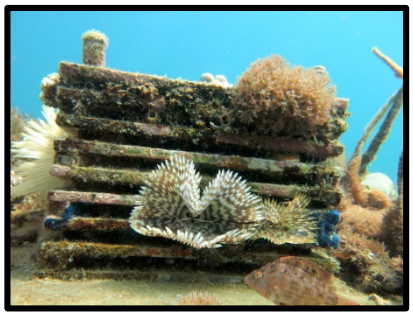
(ARMS)

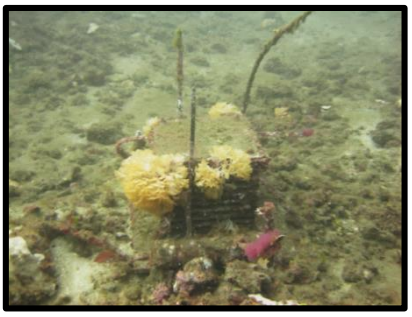


These small long-term collection devices:

- Were designed to mimic the structural complexity of a coral reef and attract invertebrate cryptofauna (both motile and sessile (stationary)).
- Were developed to better understand the diversity, distribution, abundance, and community structure of these cryptofauna through systematic sampling.
- Were deployed at sites around the Philippines including Verde Island Passage, Cebu and Cavite.

This **Field Guide** has been created using images of cryptofauna collected off of **ARMS** recovered in the Verde Island Passage.



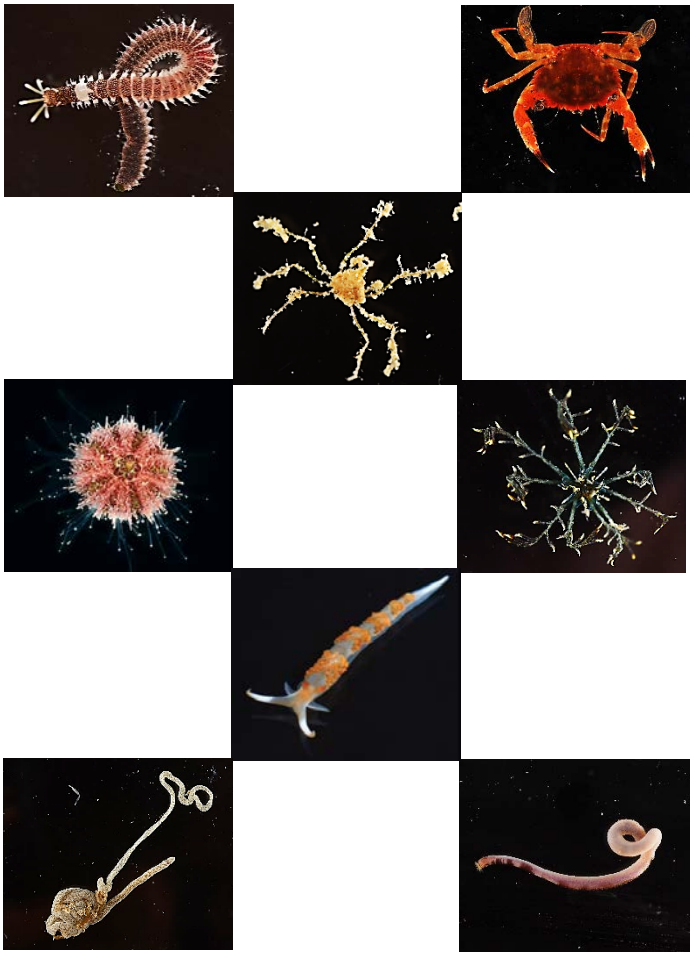


Images: Biological recruitment on ARMS and ARMS plate, courtesy NOAA Fisheries
NOAA ARMS overview: www.pifsc.noaa.gov/cred/survey_methods/arms/overview.php

ARMS Invertebrate Field Guide

The goal of this outreach field guide is to help non-taxonomists and citizen scientists learn about and make basic identifications of motile cryptofauna using example images from organisms >2 mm in size collected from ARMS at Verde Island Passage. Therefore, the identifications within the guide are presented at the Phylum to Family levels (a few exceptions go to lowest level identification above Family) and include the common names of representative organisms collected and imaged from these ARMS.

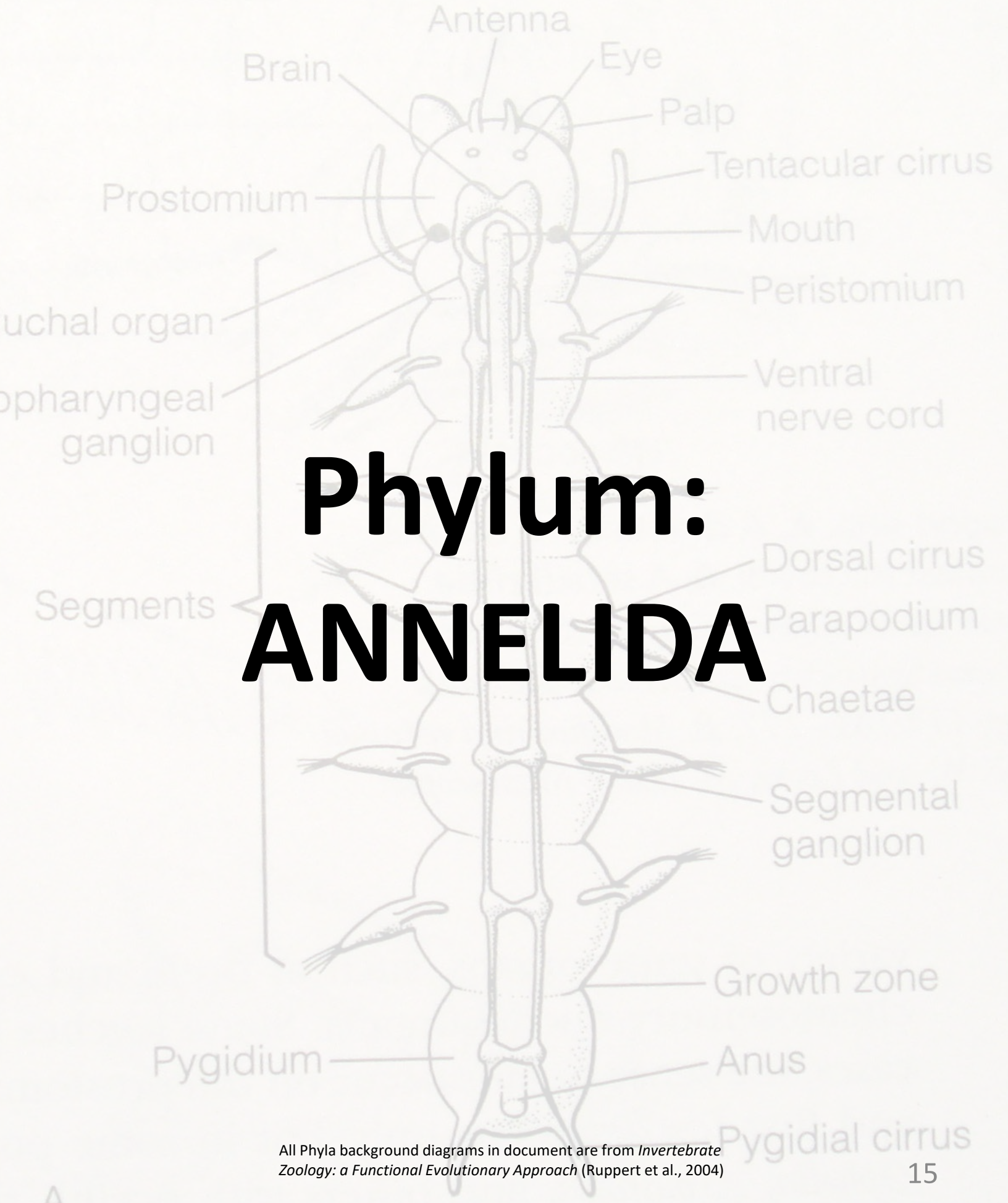
ANNELIDA
ARTHROPODA
ECHINODERMATA
MOLLUSCA
NEMERTEA
PLATYHELMINTHES
SIPUNCULA



The guide is in alphabetical order by Phylum, followed alphabetically by common name within each sub-group. Each Phylum begins with a description of key features for that Phylum, including example images. Thereafter, the top of each page identifies the common name of the animal group and the bottom of each page lists the taxonomic hierarchy to the degree in which the group has been identified. Below is an example of the taxonomic hierarchical information. We pulled out the Family name where available and put it directly under the images to highlight it.

PHYLUM, CLASS, ORDER, FAMILY

All crytofauna images from here on are from Verde Island Passage ARMS and were taken by BMB, NOAA, and partners.



Phylum: ANNELIDA

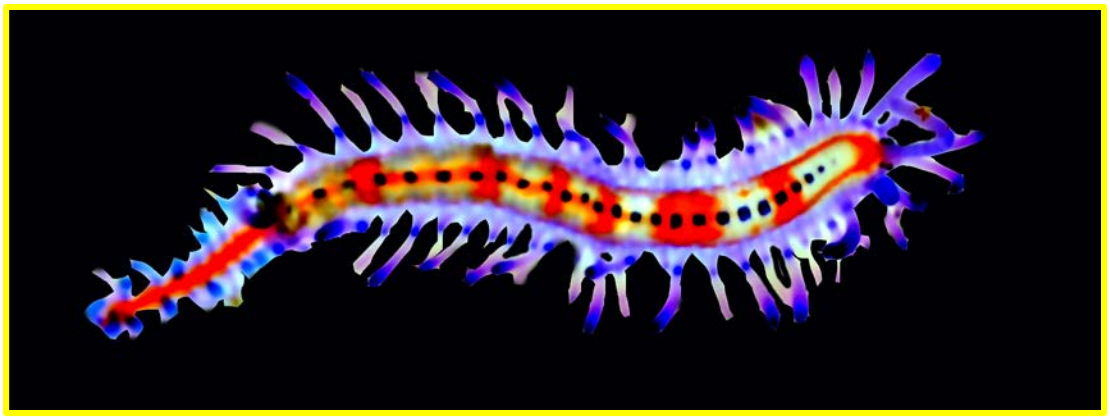
All Phyla background diagrams in document are from *Invertebrate Zoology: a Functional Evolutionary Approach* (Ruppert et al., 2004)

Phylum Annelida

* Common name “segmented worm”
* Long, symmetrical, segmented body (all segments look the same)
* Flexible; no hard covering
* Have parapodia—legs extending out from segments (used for motion)
* Have “stiff bristles” setae on their parapodia

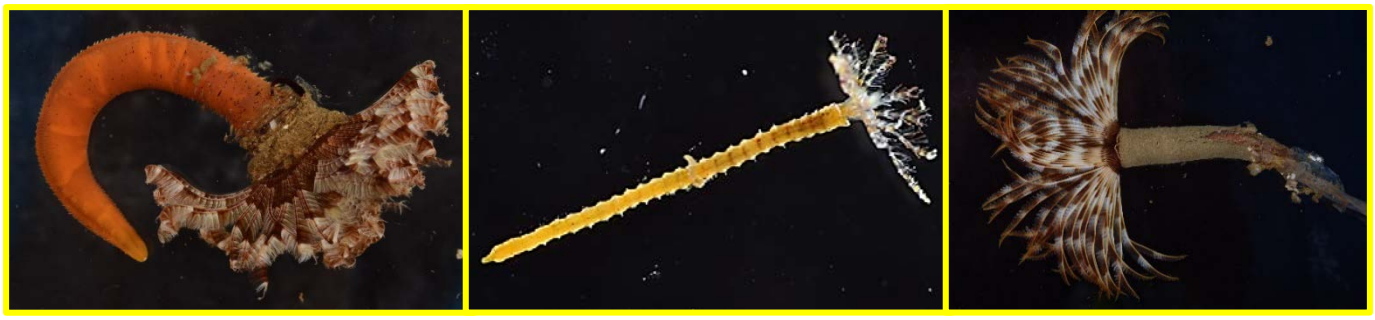
Feather Duster Worm

Parchment Tube Worm



Bristle Worm

FEATHER DUSTER WORM



Family

SABELLIDA

Phylum Class Order

ANNELIDA, POLYCHAETA, SABELLIDA

MARINE WORM

Family

EUNICIDAE

Phylum Class Order

ANNELIDA, POLYCHAETA, EUNICIDA

PARCHMENT TUBE WORM

Family

CHAETOPTERIDAE

Phylum Class Order

ANNELIDA, POLYCHAETA, CANALIPALPATA

SCALE WORM





Family

POLYNOIDAE

Phylum Class Order

ANNELIDA, POLYCHAETA, PHYLLODOCIDA

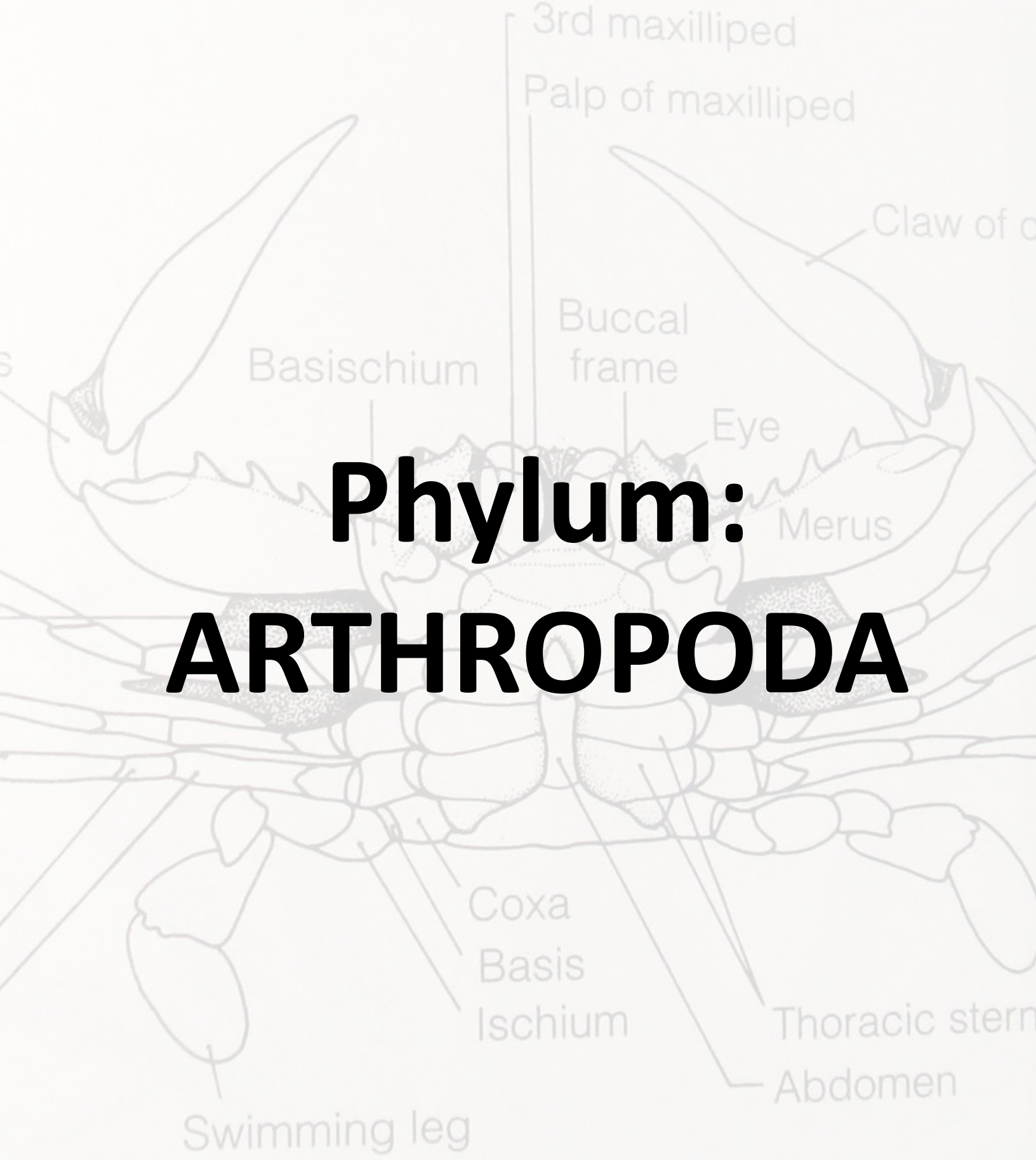
SPAGHETTI WORM

Family

TEREBELLIDAE

Phylum Class Order

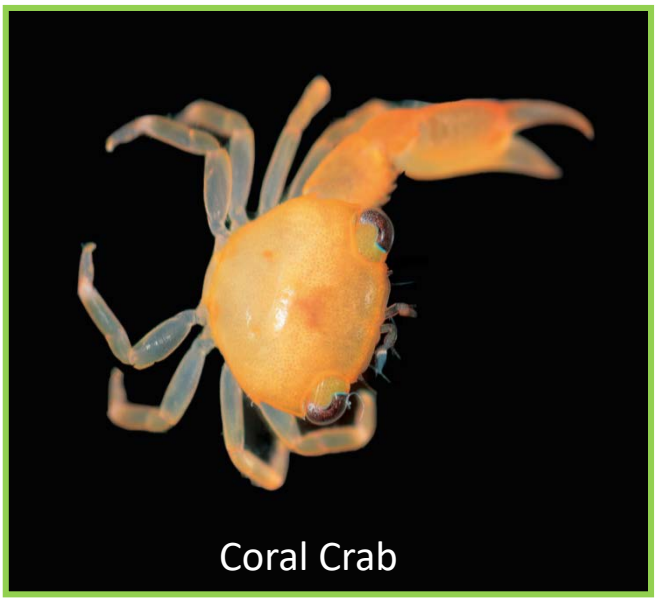
ANNELIDA, POLYCHAETA, TEREBELLIDA

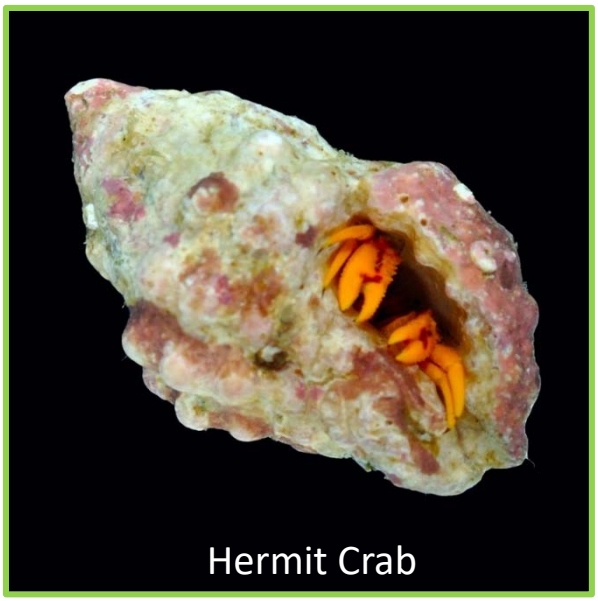


Phylum: ARTHROPODA

Phylum Arthropoda

* Distinct head & compound eyes
* Segmented, regular body shape (not all segments look the same)
* Exoskeleton (external skeleton/shell)
* Multiple jointed/paired appendages
* May have claws
* Molt as they grow


Coral Crab


Hermit Crab

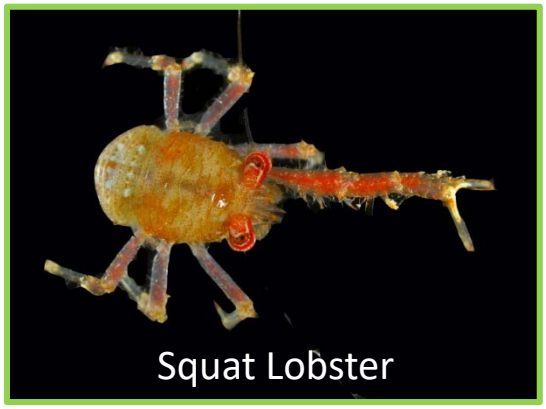

Hermit Crab


Shrimp

Phylum Arthropoda continued…

* Distinct head & compound eyes
* Segmented, regular body shape (not all segments look the same)
* Exoskeleton (external skeleton/shell)
* Multiple jointed/paired appendages
* May have claws
* Molt as they grow

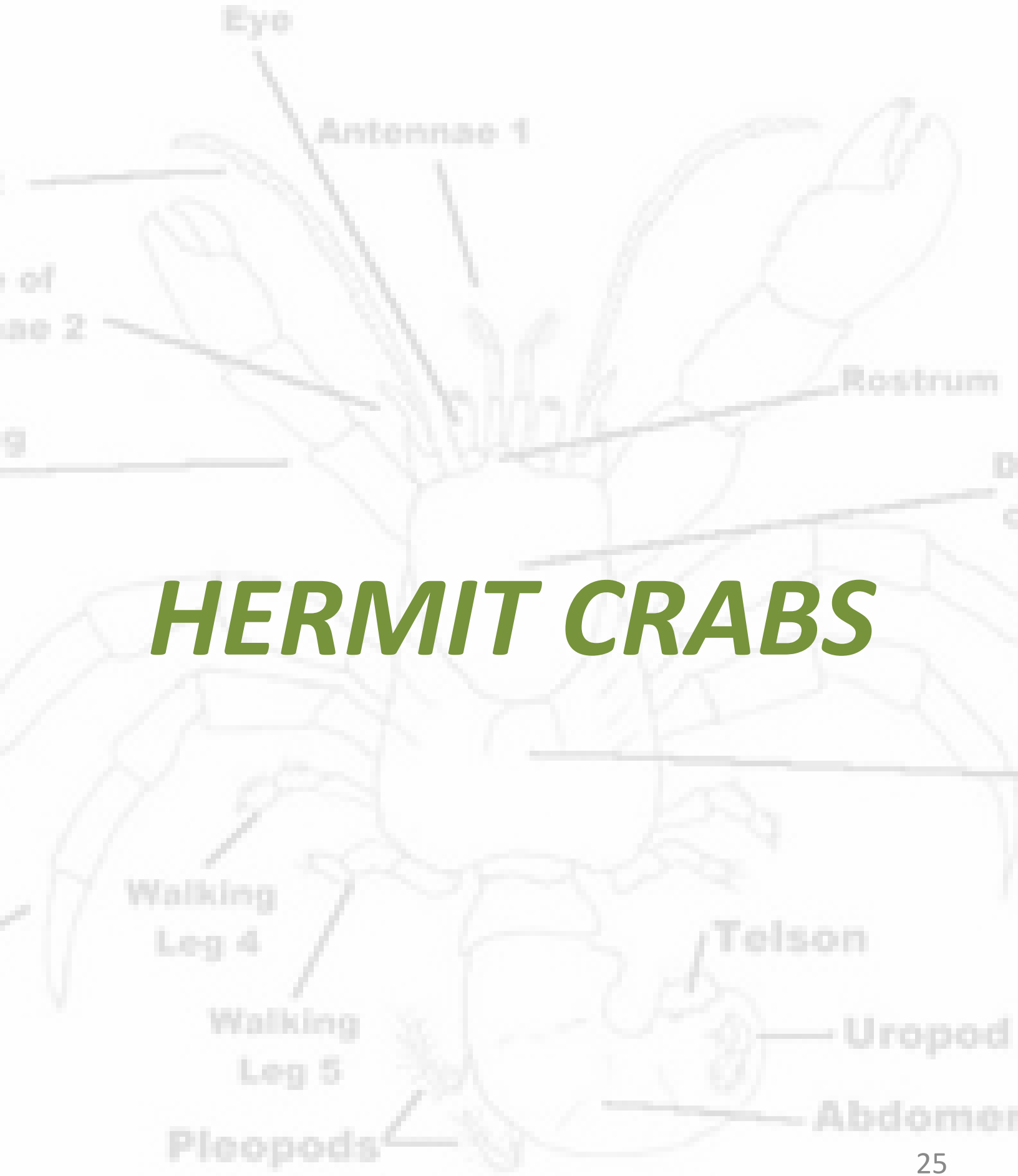

Snapping Shrimp


Squat Lobster


Mantis Shrimp

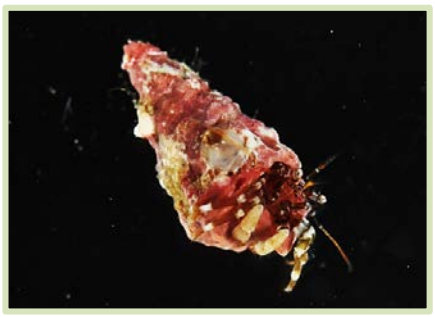

Shrimp


Crab



HERMIT CRABS

HERMIT CRAB






Family

DIOGENIDAE and PAGURIDAE

Phylum Class Order

ARTHROPODA, MALACOSTRACA, DECAPODA

PORCELAIN CRAB






Family

PORCELLANIDAE

Phylum	Class	Order
ARTHROPODA,	MALACOSTRACA,	DECAPODA

SQUAT LOBSTER

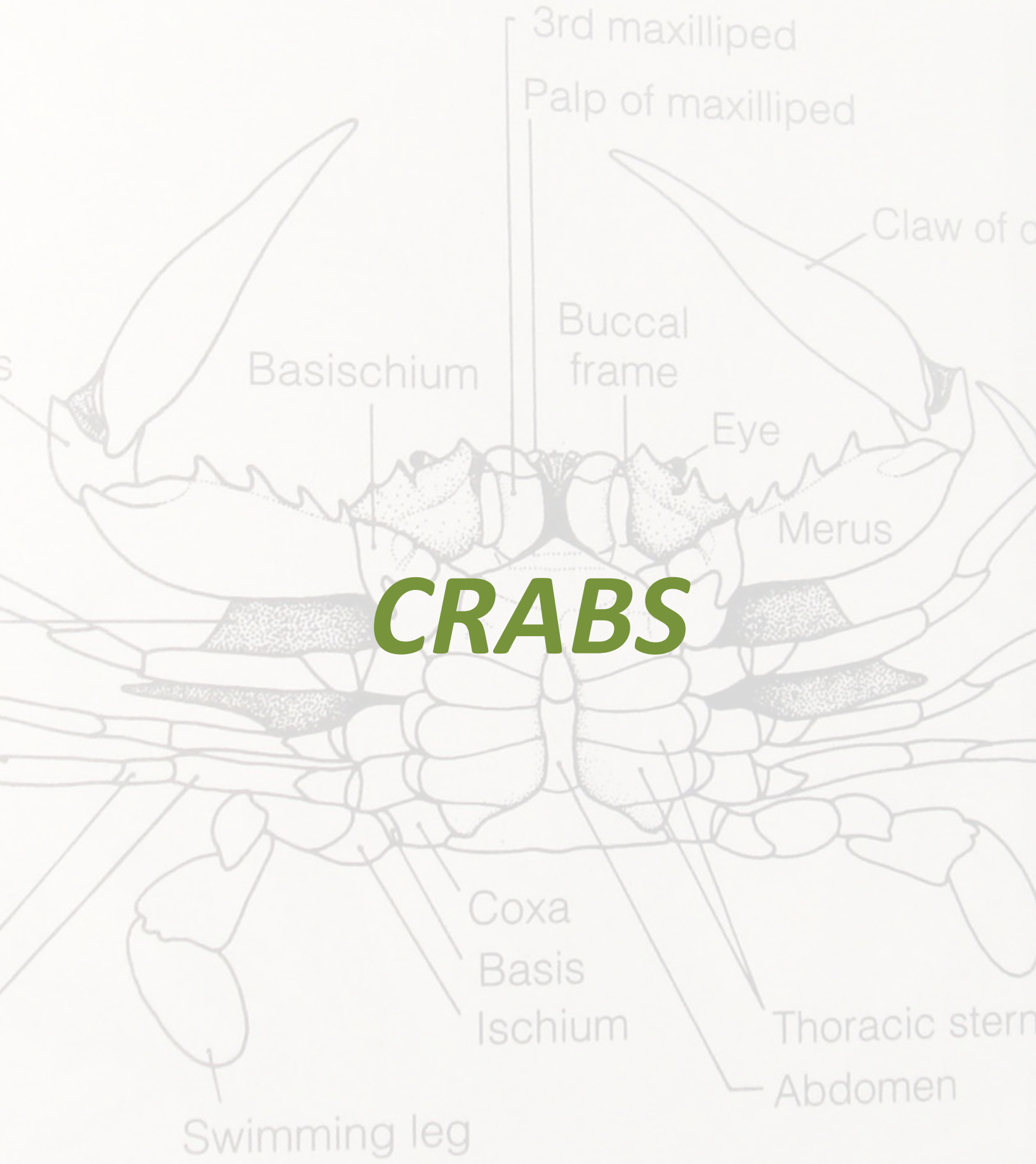





Family

GALATHEIDAE

Phylum ARTHROPODA, Class MALACOSTRACA, Order DECAPODA


3rd maxilliped
Palp of maxilliped
Claw of c
Buccal frame
Basischium
Eye
Merus
Coxa
Basis
Ischium
Thoracic stern
Abdomen
Swimming leg

CRABS

CORAL CRABS

Family

Trapeziidae

Phylum Class Order

ARTHROPODA, MALACOSTRACA, DECAPODA

DECORATOR CRAB






Family

EPIALTIDAE and MAJIDAE

Phylum	Class	Order
ARTHROPODA,	MALACOSTRACA,	DECAPODA

PEBBLE CRABS





Family

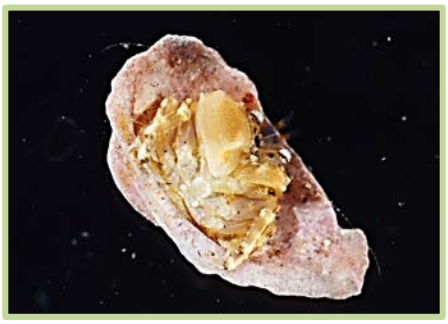
XANTHIDAE

Phylum Class Order

ARTHROPODA, MALACOSTRACA, DECAPODA

SPONGE CRABS




Family

DROMIIDAE

Phylum	Class	Order
ARTHROPODA,	MALACOSTRACA,	DECAPODA

SWIMMING CRABS

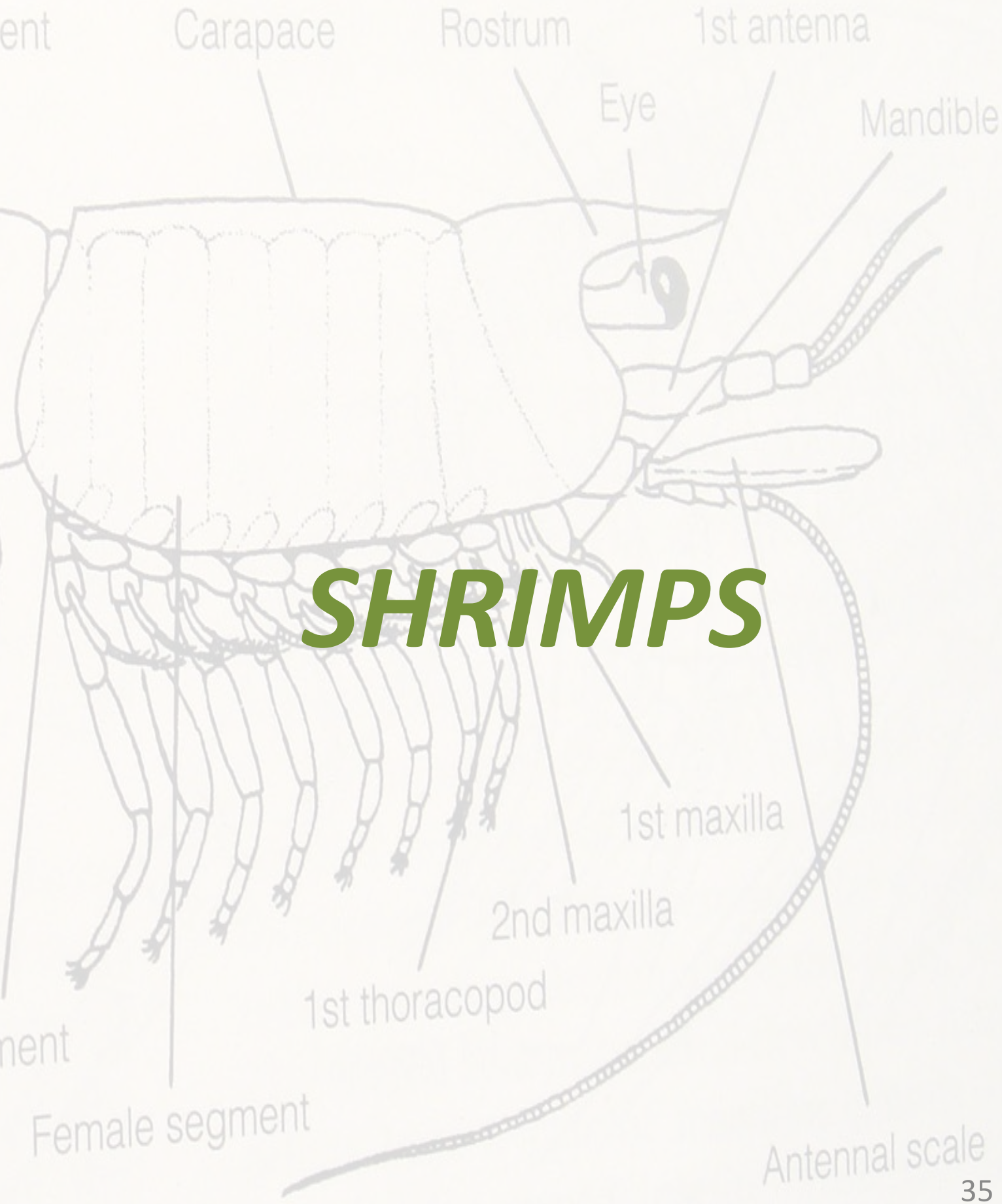





Family

PORTUNIDAE

Phylum ARTHROPODA, Class MALACOSTRACA, Order DECAPODA


ent
Carapace
Rostrum
1st antenna
Eye
Mandible
1st maxilla
2nd maxilla
1st thoracopod
nent
Female segment
Antennal scale

SHRIMPS

BROKEN-BACK SHRIMP





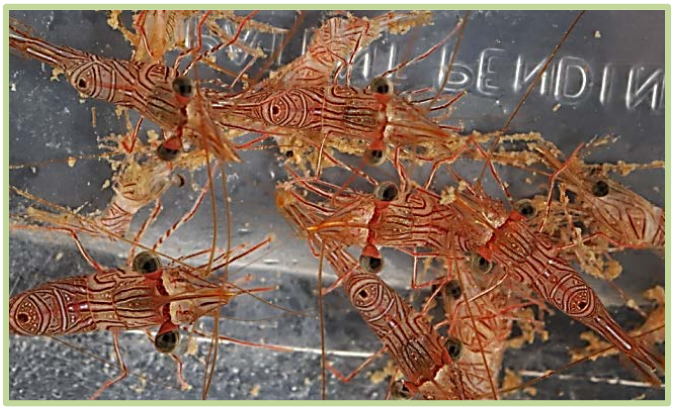
Family

HIPPOLYTIDAE

Phylum Class Order

ARTHROPODA, MALACOSTRACA, DECAPODA

HINGEBEAK SHRIMP



Family

RHYNCHOCINETIDAE

Phylum	Class	Order
ARTHROPODA,	MALACOSTRACA,	DECAPODA

SHRIMP





Family

PALAEMONIDAE

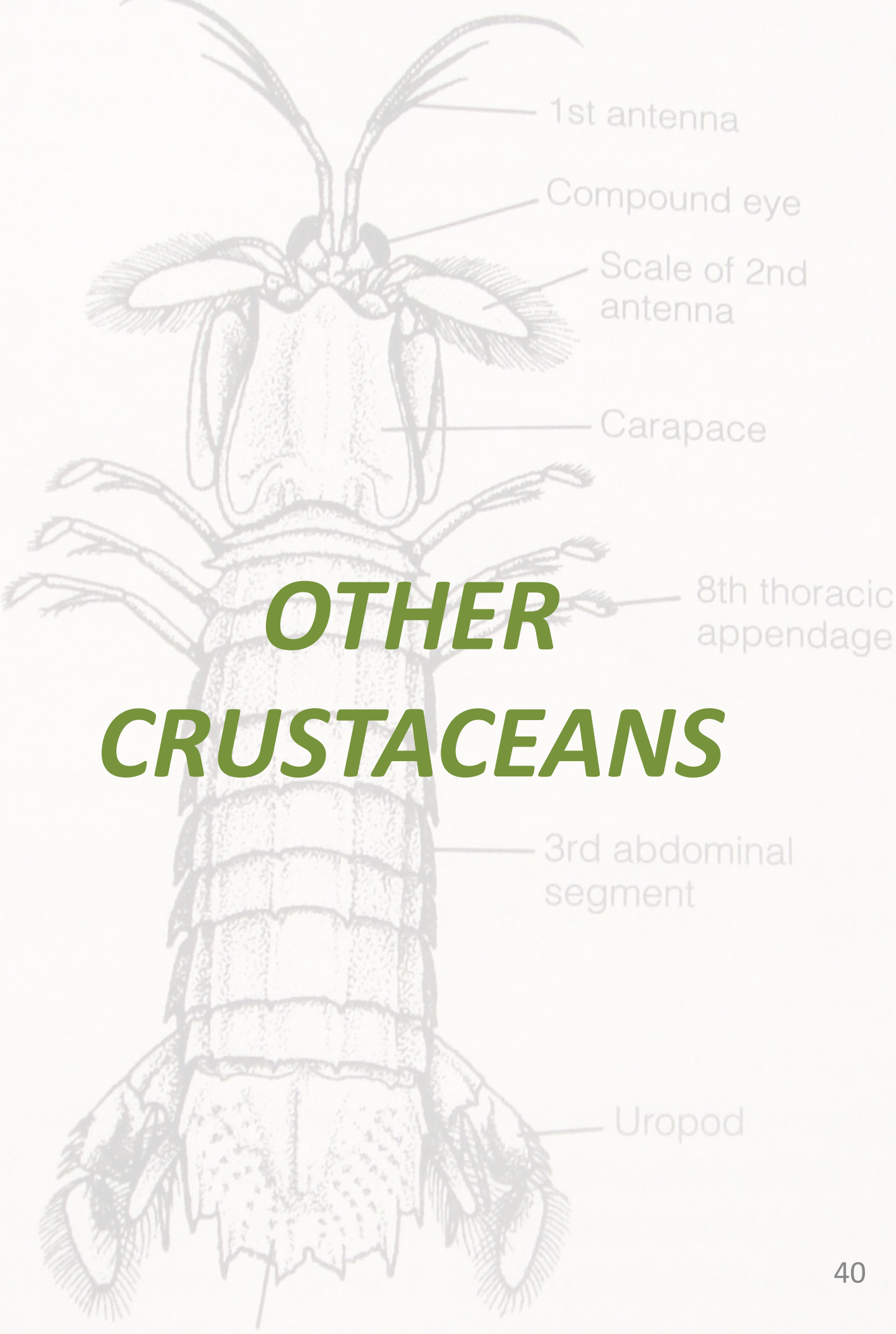
Phylum	Class	Order
ARTHROPODA,	MALACOSTRACA,	DECAPODA

SNAPPING SHRIMP

Family

ALPHEIDAE

Phylum ARTHROPODA, Class MALACOSTRACA, Order DECAPODA



OTHER CRUSTACEANS

ISOPODS

Phylum Class Order

ARTHROPODA, MALACOSTRACA, ISOPODA

MANTIS SHRIMP

Phylum Class Order

ARTHROPODA, MALACOSTRACA, STOMATOPODA

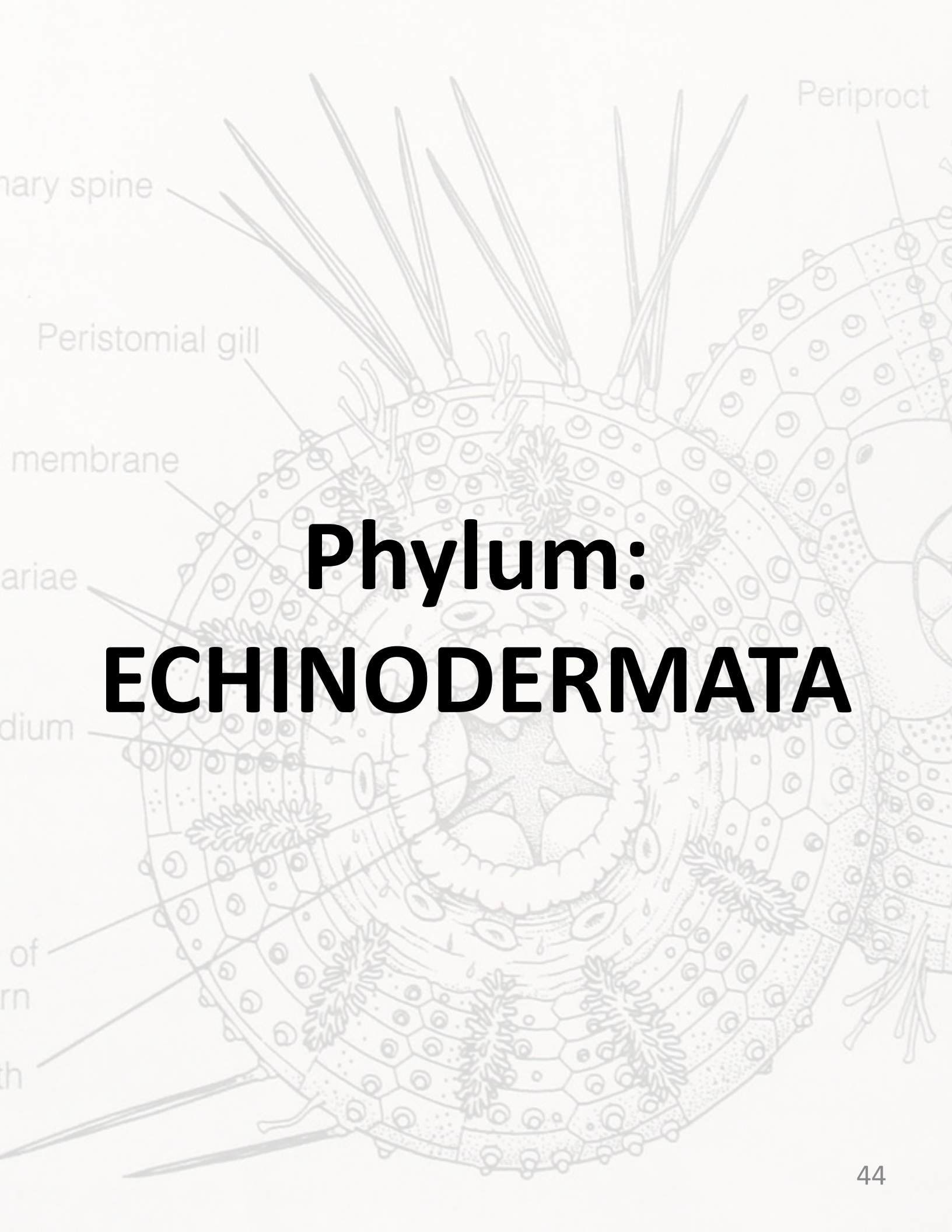
SKELETON SHRIMP

Family

CAPRELLIDAE

Phylum Class Order

ARTHROPODA, MALACOSTRA, AMPHIPODA



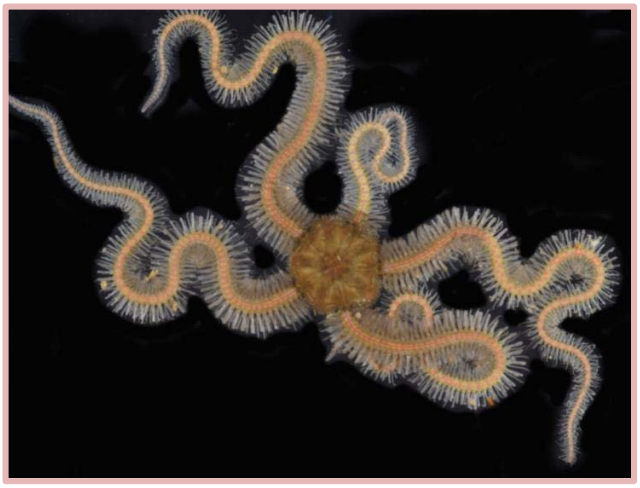
Phylum: ECHINODERMATA

Phylum Echinodermata

* No distinct head; adults often have 5-sided radial symmetry
* May be long and cylindrical
* May have spines
* May have multiple arms
* Have mutable connective tissue (skin can soften and harden)
* Have water vascular system (no skeleton or exoskeleton)
* Have tube feet for motion
* Oral surface (mouth) faces down

Sea Urchin

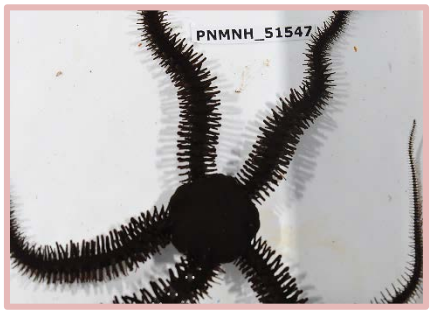
Sea Cucumber

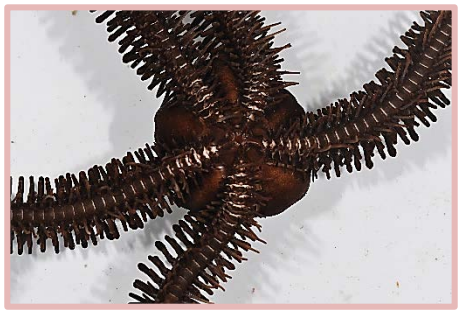


Brittle Star

Basket Star

BRITTLE STAR






Family

OPHIOCOMIDAE

Phylum Class Order

ECHINODERMATA, OPHIUROIDEA, OPHIURIDA

CRINOID





Phylum Class

ECHINODERMATA, CRINOIDEA

SEA CUCUMBER




Family

HOLOTHURIIDAE

Phylum Class Order

ECHINODERMATA, HOLOTHUROIDEA, ASPIDOCHIROTIDA

SEA CUCUMBER

Family

STICHOPODIDAE

Phylum	Class	Order
ECHINODERMATA,	HOLOTHUROIDEA,	ASPIDOCHIROTIDA

SEA CUCUMBER

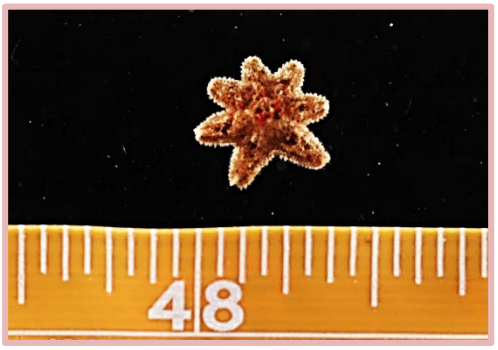
Family

SYNAPTIDAE

Phylum Class Order

ECHINODERMATA, HOLOTHUROIDEA, APODIDA

SEA STAR



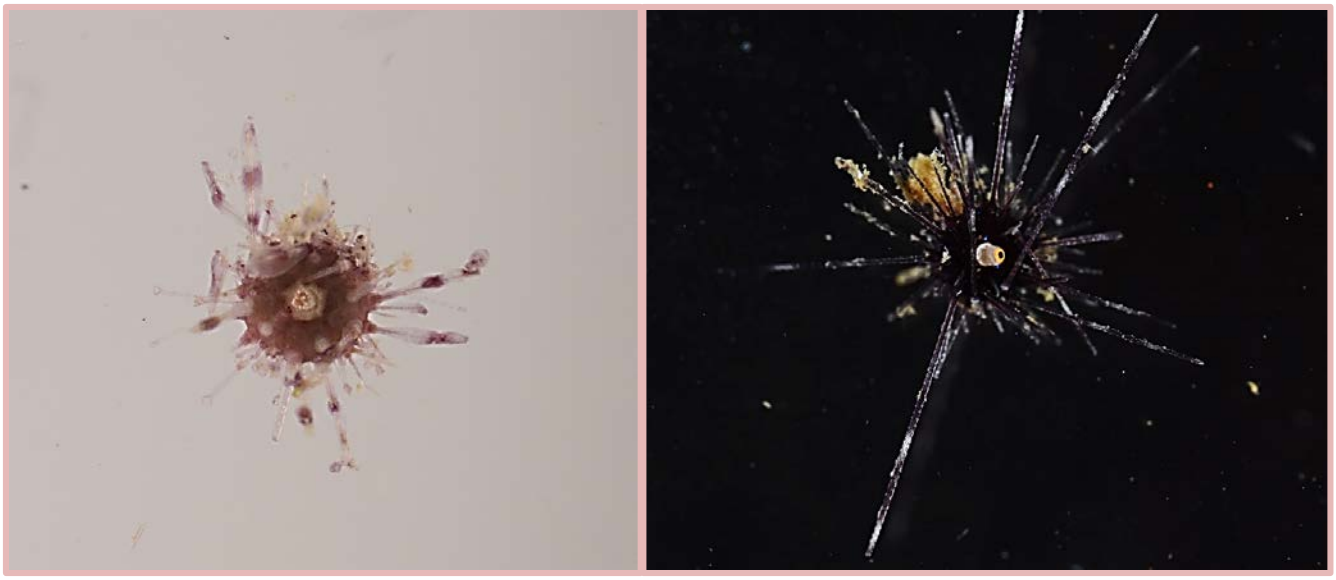
Family

ASTERINIDAE

Phylum Class Order

ECHINODERMATA, ASTEROIDEA, VALVATIDA

SEA URCHIN



Family

DIADEMATIDAE

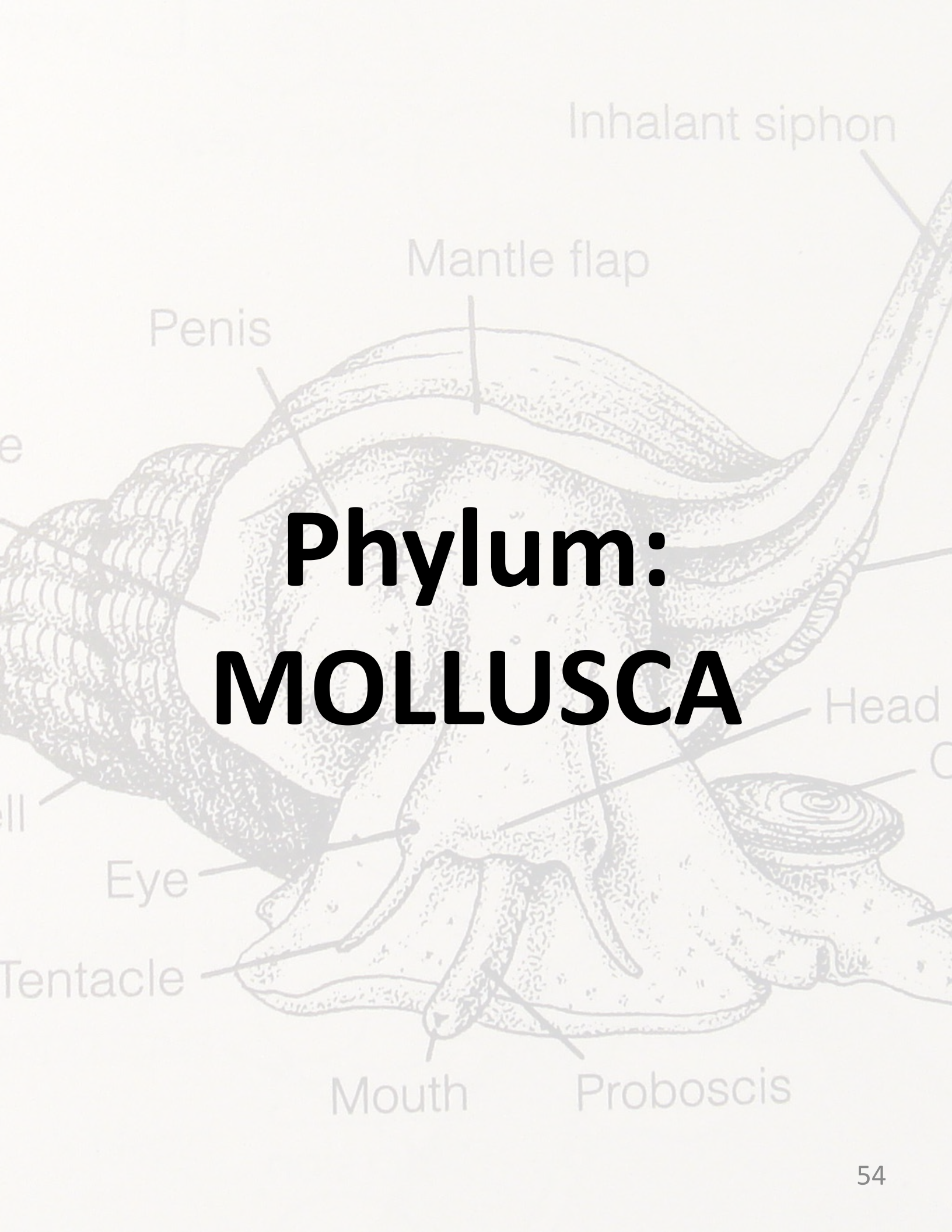
Phylum	Class	Order
ECHINODERMATA,	ECHINOIDEA,	DIADEMATOIDA

SEA URCHIN

Family

TOXOPNEUSTIDAE

Phylum	Class	Order
ECHINODERMATA,	ECHINOIDEA,	CAMARODONTA



Phylum: MOLLUSCA

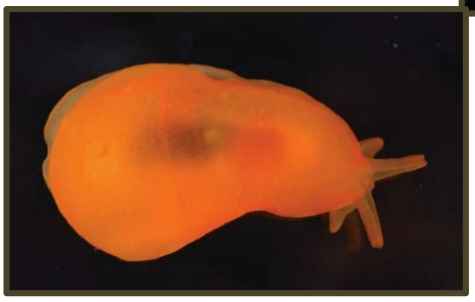
Phylum Mollusca

* Soft body (unsegmented)
* Distinct head and body
* May have shell (some have two shells hinged)
* May have gills or rhinophores (like horns) sticking out (if shell-less)
* May be colorful (if shell-less)
* May have 8 - 10 arms
* No segmented legs

Fragile File Clam

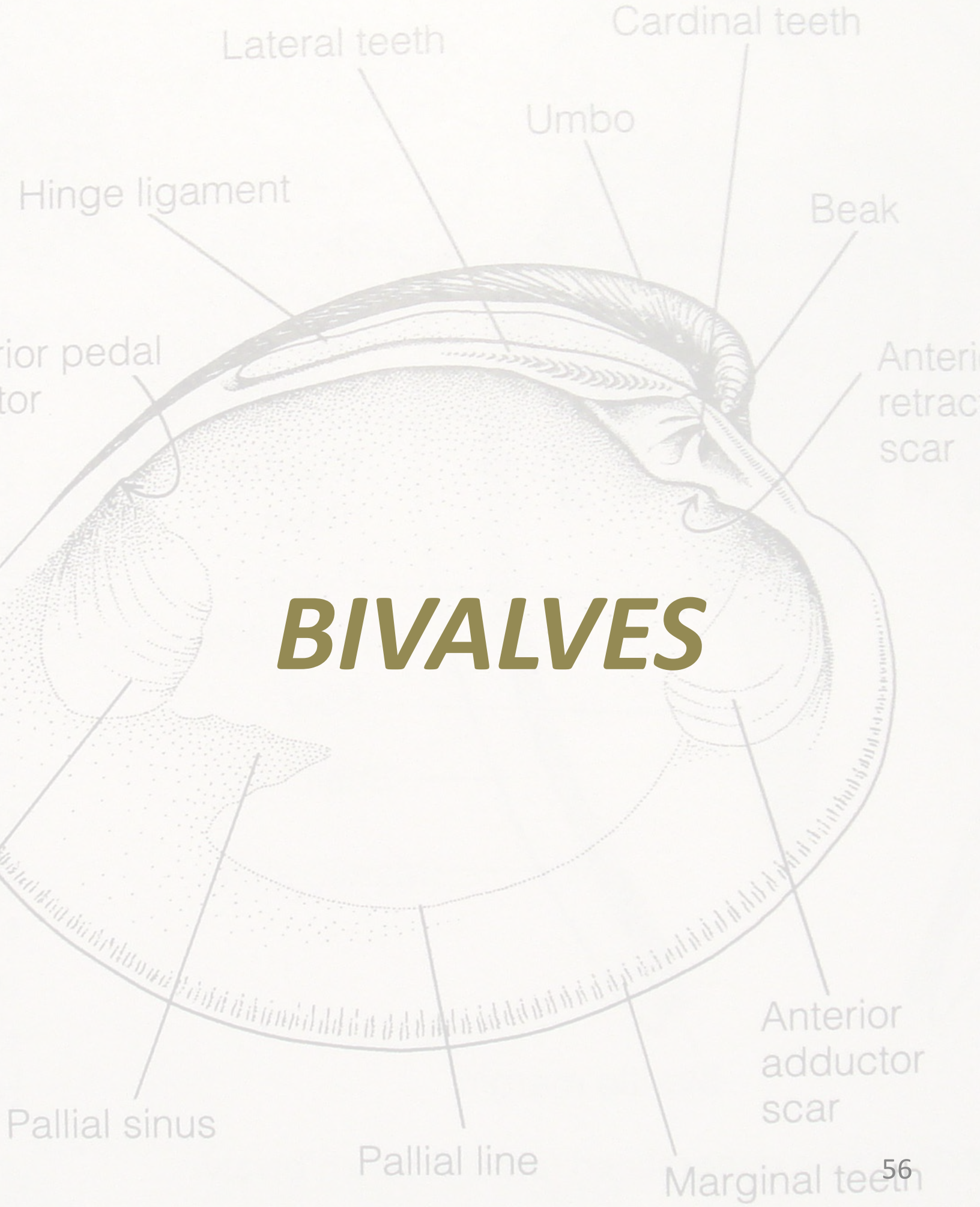
Nudibranch

Whelk



Side-gilled Sea Slug

Cowrie


Lateral teeth
Cardinal teeth
Umbo
Hinge ligament
Beak
Anterior pedal retractor
Anterior retractor scar
Anterior adductor scar
Pallial sinus
Pallial line
Marginal teeth

BIVALVES

ARK CLAM

Family

ARCIDAE

Phylum Class Order

MOLLUSCA, BIVALVIA, ARCIDA

FILE CLAMS

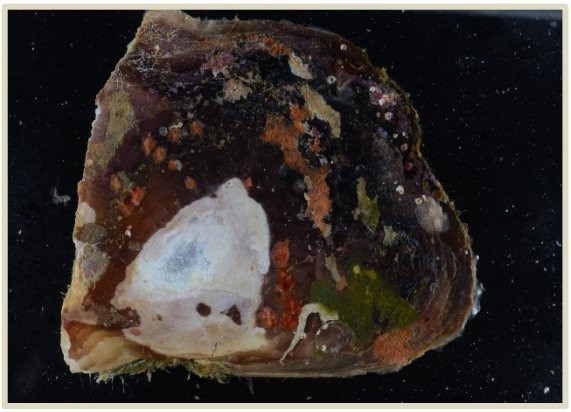
Family

LIMIDAE

Phylum Class Order

MOLLUSCA, BIVALVIA, LIMIDA

OYSTERS



Phylum Class Order

MOLLUSCA, BIVALVIA, OSTREIDA

SCALLOPS






Family

PECTINIDAE

Phylum Class Order

MOLLUSCA, BIVALVIA, PECTINIDA

MARINE SNAILS

ABALONE

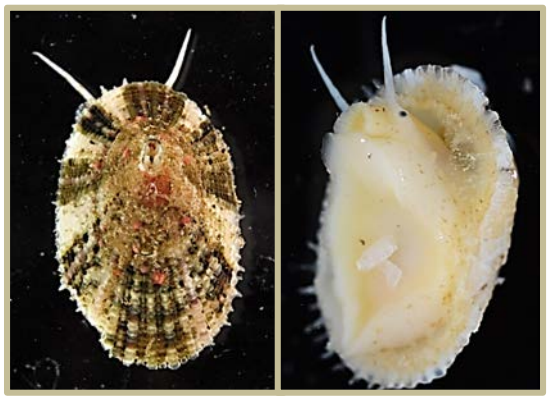
Family

HALIOTIDAE

Phylum Class Order

MOLLUSCA, GASTROPODA, Lepetellida

LIMPET



Family

FISSURELLIDAE

Phylum Class Order

MOLLUSCA, GASTROPODA, LEPETELLIDA

WHELKS






Family

BUCCINIDAE

Phylum Class Order

MOLLUSCA, GASTROPODA, NEOGRASTROPODA

SEA SLUGS

NUDIBRANCH





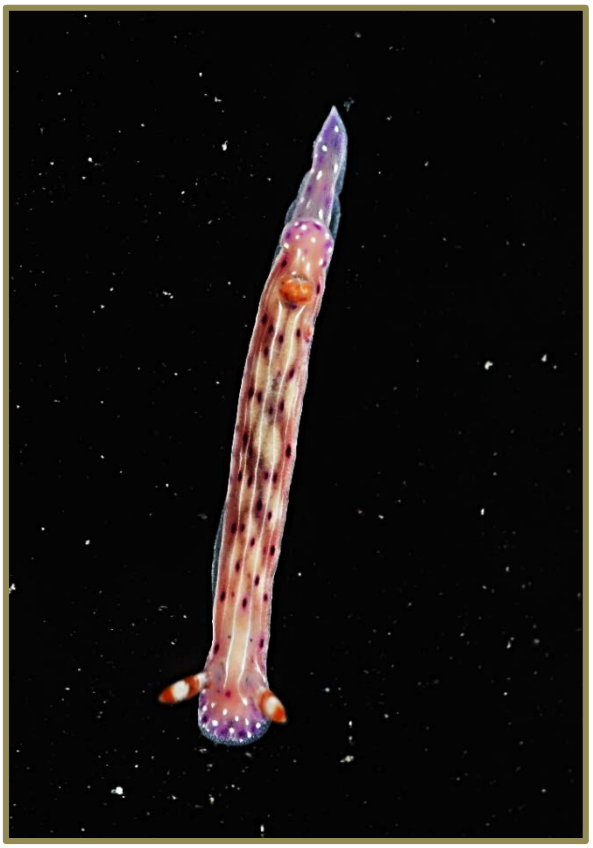

Family

AEOLIDIIDAE

Phylum Class Order

MOLLUSCA, GASTROPODA, NUDIBRANCHIA

NUDIBRANCH



Family

CHROMODORIDIDAE

Phylum Class Order

MOLLUSCA, GASTROPODA, NUDIBRANCHIA

NUDIBRANCH

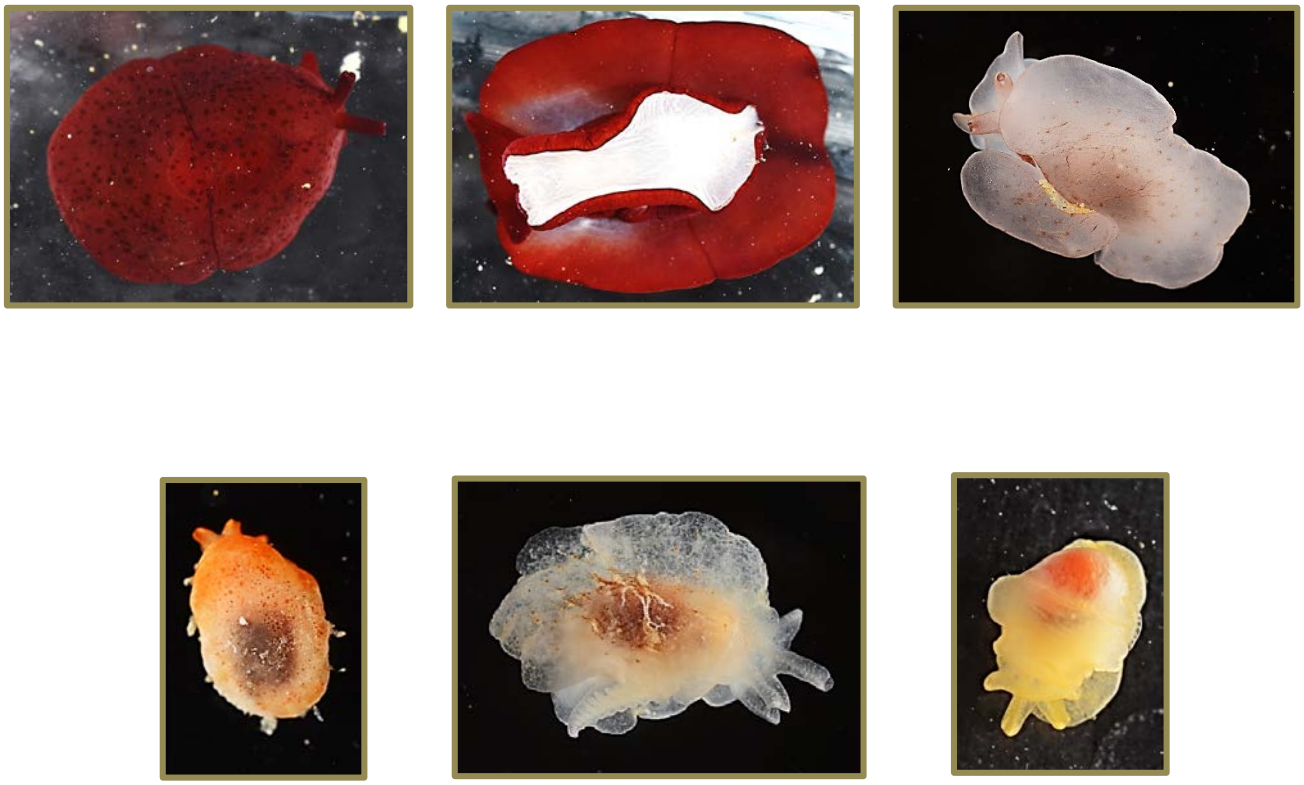
Family

DISCODORIDIDAE

Phylum Class Order

MOLLUSCA, GASTROPODA, NUDIBRANCHIA

SIDE-GILLED SEA SLUG



Family

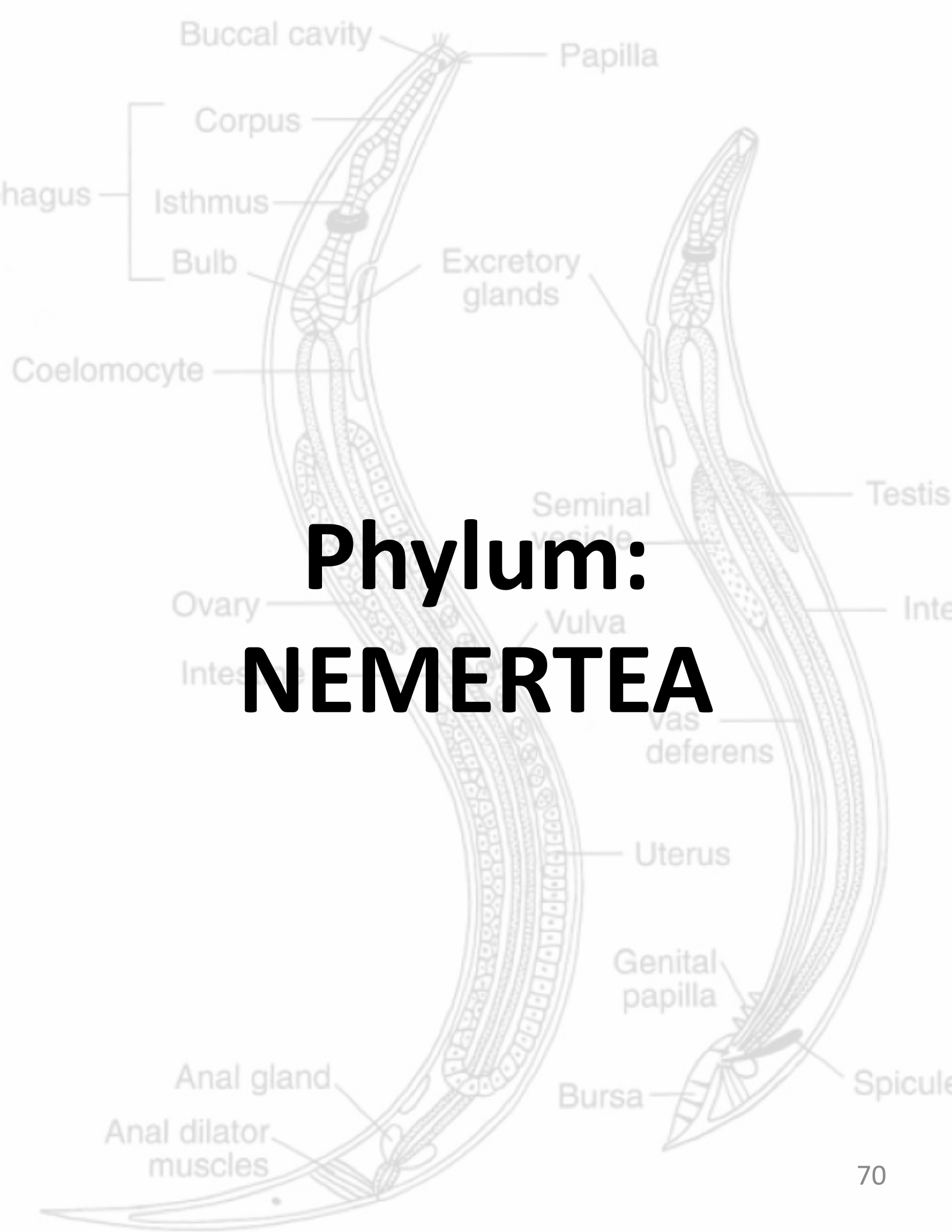
PLEUROBRANCHIDAE

Phylum Class

MOLLUSCA, GASTROPODA,

Order

PLEUROBRANCHOMORPHA



Phylum: NEMERTEA

Phylum Nemertea

* Common name “ribbon worm”
* No distinct head
* Long, thin, unsegmented body
* Has proboscis (long flexible tubular mouth for feeding) that moves in & out of body cavity (when not in use, can be completely everted into cavity)
* Can contract & expand body
* Use cilia/mucus for movement
* Many have patterns

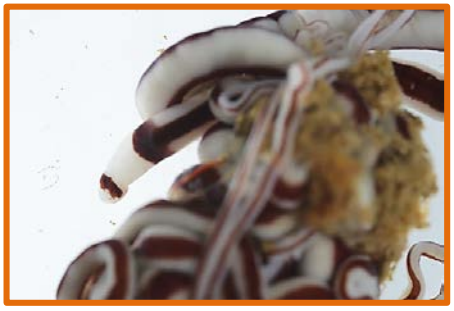
Ribbon Worm

Ribbon Worm

RIBBON WORM







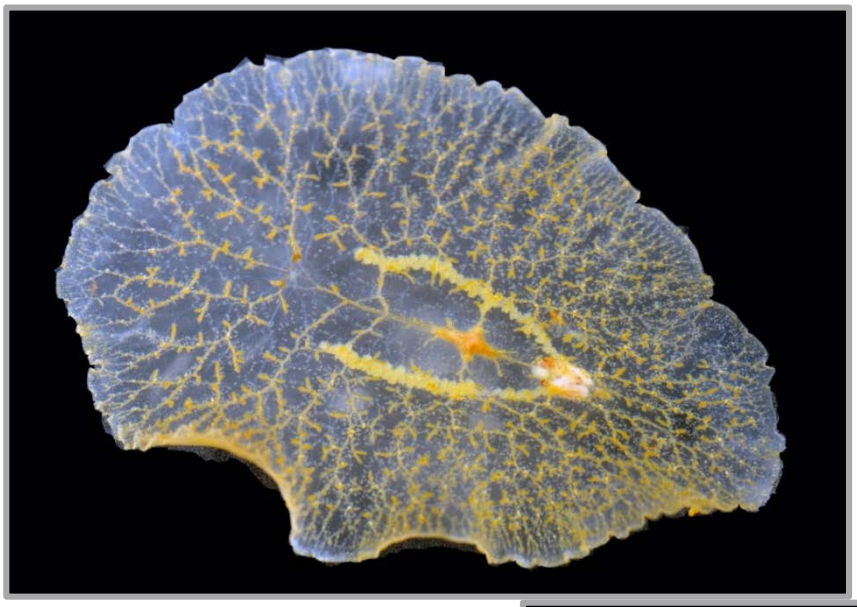
Phylum

NEMERTEA

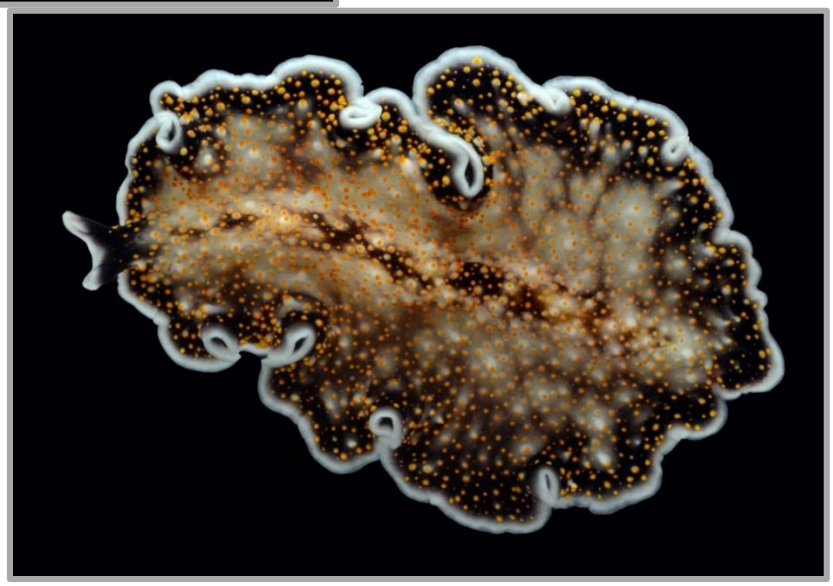
Phylum: PLATYHELMINTHES

Phylum Platyhelminthes

* Common name “flatworm”
* Defined head and tail (with central nervous system with brain/nerves)
* Eye spots (light-sensitive clusters)
* Bilaterally symmetrical
* Three tissue layers
* No body cavity
* No circulatory system
* No hard skeleton



Flatworm



Flatworm

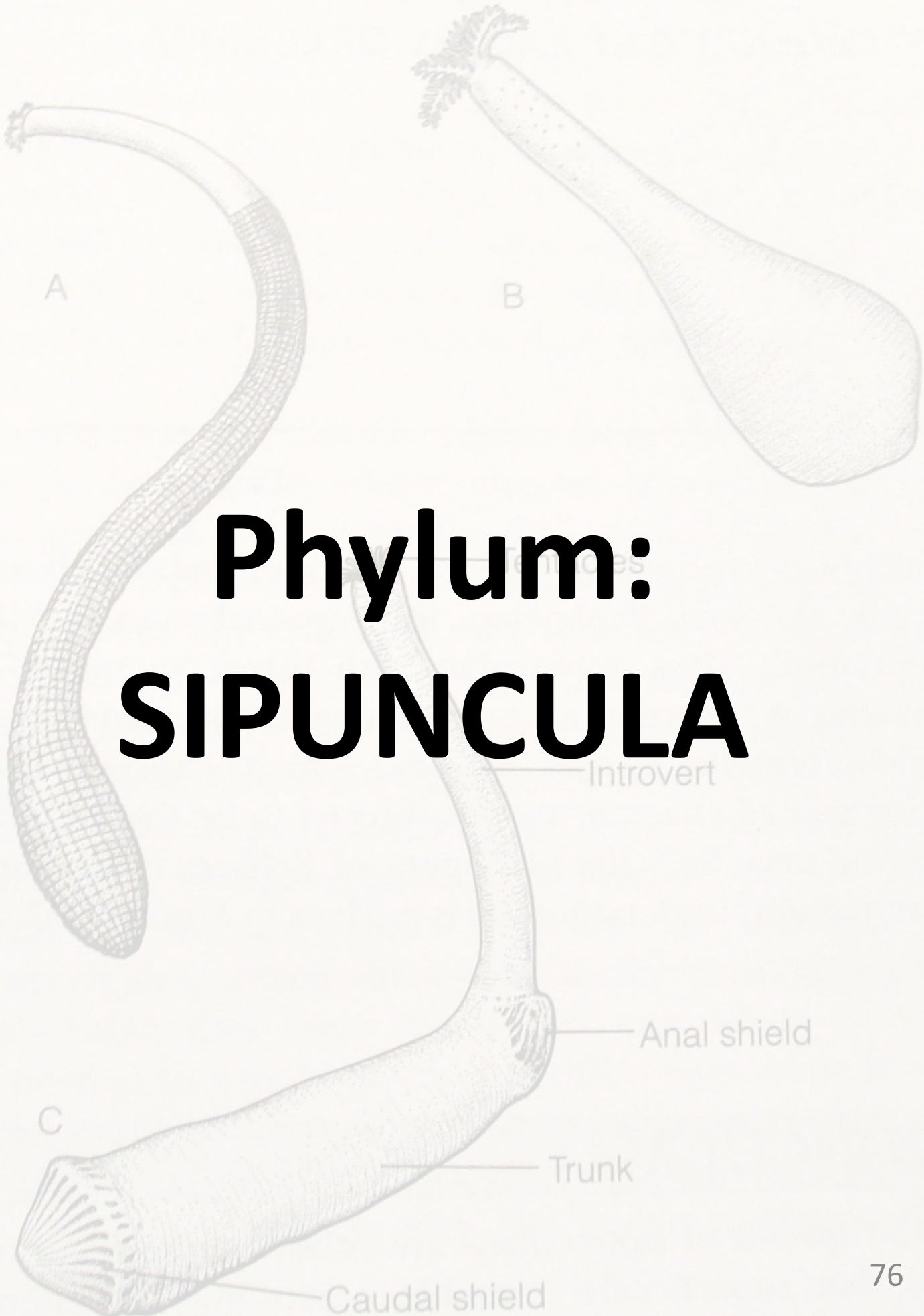
FLATWORM





Phylum

PLATYHELMINTHES



Phylum: SIPUNCULA

Phylum Sipuncula

* Common name “peanut worm”
* Soft, smooth, flexible worm-like body
* Unsegmented
* Has trunk with introvert that extends & retracts from and into trunk
* Mouth, at end of Introvert has tentacles

Peanut Worm

Peanut Worm

PEANUT WORM





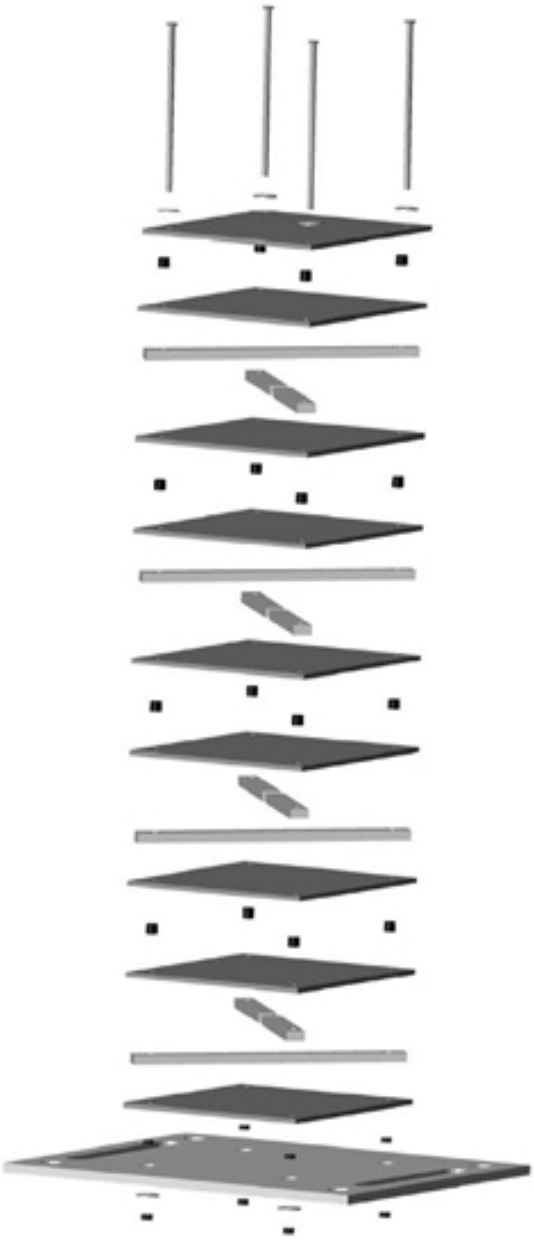
Phylum

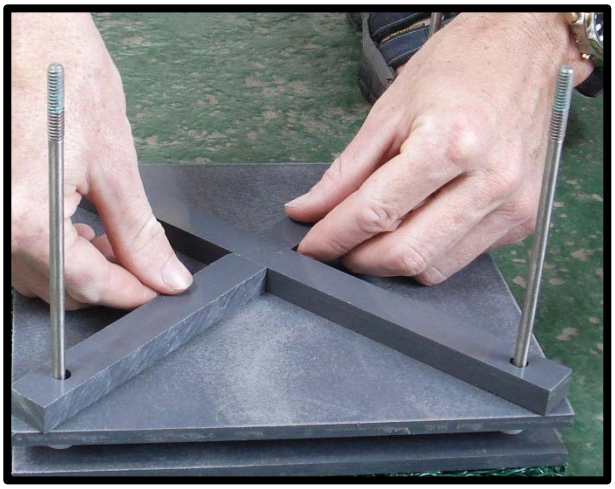
SIPUNCULA

How we collected the organisms for this field guide!

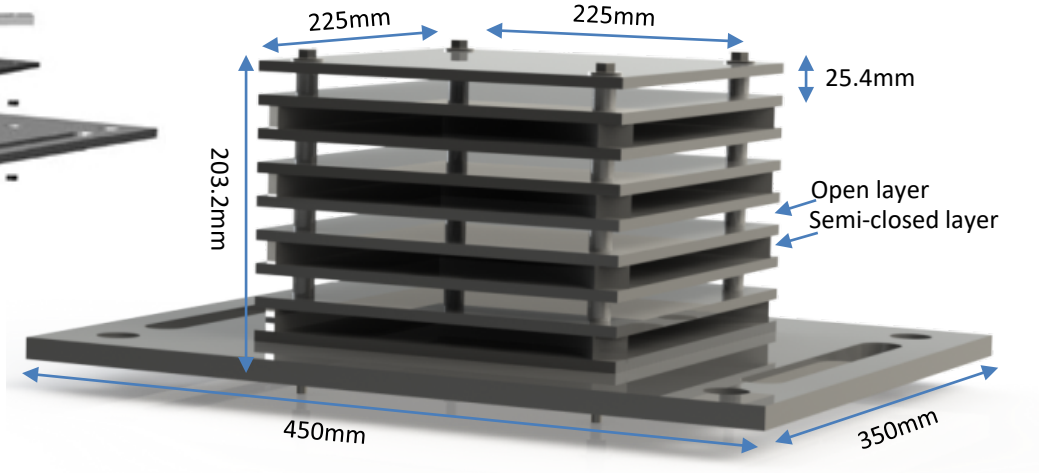
All ARMS and ARMS processing images from here on courtesy NOAA Fisheries

ARMS Construction

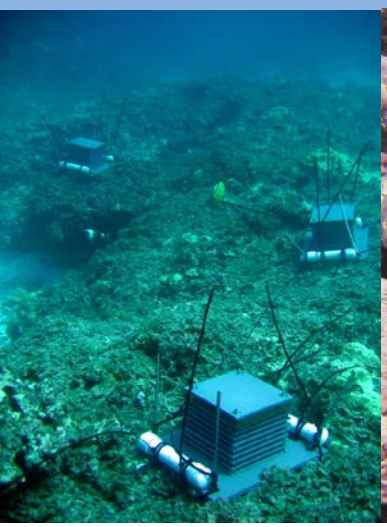
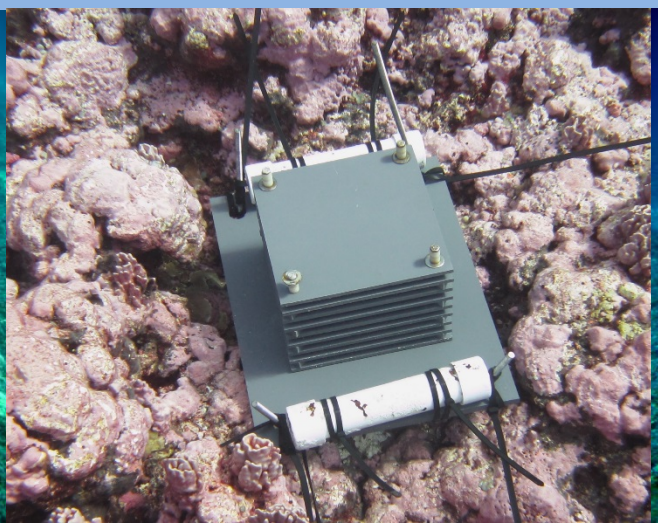
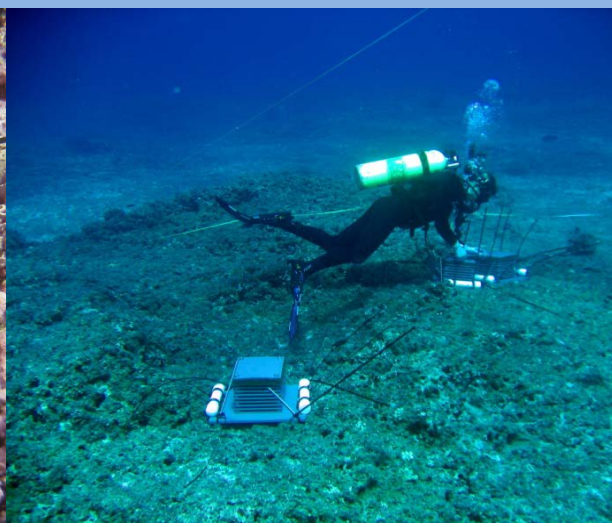




ARMS were built using gray PVC and constructed to have an 8-leveled tier composed of 4 open and 4 semi-closed layers attached to a baseplate. One long and two short cross-bars placed in the shape of an "X" make up the semi-closed layers to provide "caves" for the organisms.



ARMS Deployment and Recovery

ARMS were deployed in sets of 3 on the bottom by scuba divers at 10 sites around Anilao.

They remained fixed to the reef for 3 years enabling the recruitment of cryptofauna organisms.

Upon recovery, they were encapsulated with a mesh-lined crate to prevent the organisms within from escaping. They were brought to the surface and transported to the shoreline for processing.



ARMS Processing for the >2 mm organisms

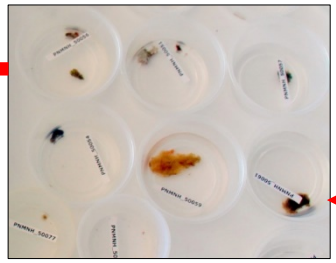
Disassemble ARM Unit and remove plates from recovery bin

Filter the water from the recovery bin into a 2-mm sieve

Dump the contents from the 2-mm sieve into a tray

Sort the organisms from the tray into individuals into cups

Label each cup with an identification number. Record the number and classify what is in the cup



Photograph each specimen

Preserve the Specimens

**2,540 specimens >2 mm were collected from Anilao and are at the National Museum of the Philippines for further identification, while 1,386 tissue samples were exported to the Smithsonian Institution for further scientific research and analysis.*

GLOSSARY

TERM	DEFINITION	SOURCE
Biodiversity	The diversity and variability of living things and of the systems of which they are a part. This includes the range of variation in and variability among systems and organisms at the bioregional, ecosystem and habitat levels, and at the various organism levels.	www.coris.noaa.gov
Calcify	The process by which corals and calcareous algae extract calcium from seawater and produce it as calcium carbonate to grow.	www.coris.noaa.gov
Calcium Carbonate	A molecule consisting of calcium, carbon, and oxygen secreted by corals to their skeleton. It is also secreted by mollusks to form their protective shells.	www.coris.noaa.gov
Climate Change	The long-term fluctuations in temperature, precipitation, wind, and all other aspects of the Earth's climate. It is also defined by the United Nations Convention on Climate Change as "change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods"; an observed change in the prevailing or average weather conditions.	www.coris.noaa.gov
Coral Bleaching	The process in which a coral polyp, under environmental stress, expels its symbiotic zooxanthellae from its body. The affected coral colony appears whitened.	www.coris.noaa.gov

GLOSSARY

TERM	DEFINITION	SOURCE
Cryptofauna	Small organisms that often live in protected or concealed microhabitats.	www.coris.noaa.gov
Ecosystem	An ecological community and the interactions therein of living (including humans) and non-living factors considered together as a unit of the environment.	www.coris.noaa.gov
Habitat	The place or environment where a particular organism, population, or species lives.	https://en.wikipedia.org/wiki/Georeferencing
Invertebrate	An animal that lacks a vertebral column (backbone).	www.coris.noaa.gov
Motile	Organisms capable of self-locomotion.	www.coris.noaa.gov
Nutrient Cycling	All the processes by which nutrients are transferred from one organism to another. For instance, the carbon cycle includes uptake of carbon dioxide by plants, ingestion by animals, and respiration and decay of the animal.	www.coris.noaa.gov
Ocean Acidification	Ocean acidification occurs when carbon dioxide ($CO2_)$ from the atmosphere is absorbed into the ocean and reacts with water to create carbonic acid. This process decreases both ocean pH and the concentration of the carbonate ion, which is essential for calcification by calcifying marine organisms such as corals.	https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=nearshore&*&dobs=nearshore

GLOSSARY

TERM	DEFINITION	SOURCE
organism	Any form of unicellular or multicellular life; a living thing that has (or can develop) the ability to act or function independently.	www.coris.noaa.gov
pH	Provides a measure on a scale from 0 to 14 of the acidity or alkalinity of a solution (where 7 is neutral, <7 is acidic and >7 is basic).	www.coris.noaa.gov
Sessile	Describes an organism that is immobile because of its attachment to a substrate. The term has also been applied to organisms, such as anemones, that move very slowly.	http://support.minitab.com/en-us/minitab/17/topic-library/quality-tools/measurement-system-analysis/other-gage-studies-and-measures/what-is-a-reference-value/
Sieve	A sieve, or sifter, is a device for separating wanted elements from unwanted material or for characterizing the particle size distribution of a sample, typically using a woven screen such as a mesh or net or metal.	www.coris.noaa.gov
Sustainable	Harvesting or using a resource in a way that it is maintained and not depleted or permanently damaged.	https://www.merriam-webster.com/dictionary/sustainable
Taxa	Taxonomic groups or entities.	https://en.wiktionary.org/wiki/subsurface
Trophic	Related to or functioning in (levels of/types of) nutrition.	www.coris.noaa.gov

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