Identification guide for commonly encountered prey items found in stomach contents of Northwest Atlantic marine fishes

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IDENTIFICATION GUIDE FOR COMMONLY ENCOUNTERED PREY ITEMS FOUND IN STOMACH CONTENTS OF NORTHWEST ATLANTIC MARINE FISHES

by

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Darcy, A., Nozères, C., Ricard, D., Robertson, K. and Sylvain, F.-É. 2024. Identification guide for commonly encountered prey items found in stomach contents of Northwest Atlantic marine fishes. Can. Tech. Rep. Fish. Aquat. Sci. 3591: vii + 172 p.

The Gulf Fisheries Centre (Marine Fish and Mammal section) has created the following photographic reference collection and identification guide that documents the commonly encountered prey items found in the stomachs of fishes captured during the annual September ecosystem survey in the southern Gulf of St. Lawrence (2018-2020). The fish sampling, stomach sample preparation and processing procedures are also described. The guide serves as a valuable learning resource for all future stomach content analysis activities in the Gulf Region, and for any other labs or groups working on stomach content analyses in the Northwest Atlantic.

Fifty-one taxon are discussed in the guide; including six phylum, ten classes, five orders, and twenty-one families.

RÉSUMÉ

Darcy, A., Nozères, C., Ricard, D., Robertson, K. and Sylvain, F.-É. 2024. Identification guide for commonly encountered prey items found in stomach contents of Northwest Atlantic marine fishes. Can. Tech. Rep. Fish. Aquat. Sci. 3591: vii + 172 p.

Le Centre des pêches du Golfe (section des Poissons et Mammifères Marins) a créé la collection de référence photographique et le guide d’identification suivants qui documentent les proies fréquemment rencontrées dans l’estomac des poissons capturés lors du relevé écosystémique annuelle de septembre dans le sud du golfe du Saint-Laurent (2018-2020). L’échantillonnage des poissons, et les procédures de préparation et de traitement des estomacs sont également décrites. Le guide servira de précieuse ressource d’apprentissage pour toutes les activités futures d’analyse du contenu de l’estomac dans la région du Golfe, et pour tous autres laboratoires ou groupes travaillant sur les analyses de contenus stomacaux. Cinquante et un taxons sont abordés dans le guide; dont six phylums, dix classes, cinq ordres et vingt-et-une familles.

1 Introduction

The purpose of this identification guide is to serve as a reference tool for individuals who are processing stomach contents and identifying prey items from Northwest Atlantic marine fishes in the laboratory. The guide focuses on a wide variety of commonly encountered invertebrates and fishes, while illustrating key identification features and characteristics. This visual library of images will provide direction and guidance for several laboratories and groups involved with stomach content analyses, and facilitate a more efficient identification process. The taxa presented in the current guide consist of prey items commonly ingested by demersal and pelagic species that are prone to capture in a bottom trawl.

The basic premise behind stomach content analysis is that "*You are what you eat*". Historically, diet analysis of fishes was used to identify patterns or trends in food web ecology, predator-prey relationships, and to model spatial and temporal changes in ecosystems (e.g., King et al. 2018). Various methodologies, metrics, and statistical analyses are utilized to gain insights into the trophic dynamics within an ecosystem or between fish populations. Long-term, continuous data collection involving diet analysis is an important element of various fisheries-based science programs (Link and Garrison 2002; Cook and Bundy 2010; Holt et al. 2019). Although long-term diet studies involving fishes are typically rare due to the amount of resources (time and effort) required for collection and processing of stomach content (Manoel and Azevedo-Santos 2018). High quality long-term diet data sets are primarily the result of government-based commercial species surveys that have been running for decades. Stomach content analysis remains a valuable tool for meeting a variety of academic and government based research objectives such as the diet composition and habitat fidelity for groundfish in the Hecate Strait, British Columbia (Pearsall and Fargo 2007), trophic ecology of deep-sea fishes (Drazen and Sutton 2017), and ecosystem level changes in the diet of demersal fish communities (Ouellette-Plante et al. 2020). Overall, any robust and meaningful diet analysis will be based on comprehensive sampling designs that represent a variety of fish species from the same habitat, covering broad geographic ranges, developmental stages, and time frames (Cook and Bundy 2010).

Regardless of the sampling design, the same type of lab analysis and collection of data are required, which essentially involves collecting information about the identity, abundance, and mass of consumed prey items in a lab setting. All of this information is collected to help evaluate the significance of prey items and to infer ecological interactions taking place in the studied ecosystem. Major fisheries oriented academic and governmental groups, such as Fisheries and Oceans Canada (DFO) are now moving towards an ecosystem-based approach to fisheries management (EBFM) and stock assessments (Pikitch et al. 2004; DFO 2007). This holistic ecological approach attempts to look at ecosystem level changes and dynamics instead of focusing on one species. Thus, there is more relevance than ever to include trophic ecology and diet information into assessments and research programs. Furthermore, this information will also be important to track temporal changes in species composition of specific geographic areas. As a result of climate change, a species distribution and seasonal movement patterns may change and the assemblage of prey species found in fish stomachs are also known to reflect this (Amundsen and Sánchez-Hernández 2019). Overall, long-term stomach content analysis will help to elucidate these food web dynamics. (Perry et al. 2005; Brander 2010; Doney et al. 2012).

2 Methods

2.1 Specimen collection and storage

All fish specimens used in the stomach content analysis discussed here were collected during the annual September ecosystem survey in the sGSL (southern Gulf of St. Lawrence), which is located in Division 4T of the Northwest Atlantic Fisheries Organization (NAFO).

In 2018 and 2019, 5 specimens per species found at each station were collected, with the exception of Atlantic Cod (*Gadus morhua*) and Atlantic Herring (*Clupea harengus*). These would be extracted and processed at a later date as part of the Cod Condition Index and Atlantic Herring Assessment sampling procedures. In 2020 the study was modified slightly and only stomach samples from White Hake (*Urophycis tenuis*) and Redfish species (*Sebastes fasciatus* and *Sebastes mentella*) were collected when they were found together at the same station. Acadian Redfish (*Sebastes fasciatus*) and Deepwater Redfish (*Sebastes mentella*) are the expected species of genus '*Sebastes*' in the Gulf of St.Lawrence. There are a few known captures of *Sebastes norvegicus* in the vicinity of the survey area, but these specimens occurred in NAFO Division 3Pn, a small zone located off the southwest coast of Newfoundland. Other captures of *Sebastes norvegicus* were from areas outside of the Gulf of St. Lawrence. The latin name *Sebastes marinus* was erroneously used for all three species in the past. With taxonomic advances in recent decades, specimens that were identified as *Sebastes marinus* were reclassified to *Sebastes norvegicus* (non-beaked), while others were reclassified to *fasciatus-mentella* (beaked redfish). The species name *marinus* is no longer used, it is now considered to be a synonym for *norvegicus* (Coad and Reist 2017; Mecklenburg et al. 2018).

The annual September ecosystem survey in the sGSL follows a stratified random sampling design and examines all fish and invertebrates taxa captured in a bottom trawl. The survey was designed to provide abundance trends for fish and invertebrates distributed between depths of about 20m to 350m. This survey, conducted annually since 1971, is the primary source of data for monitoring trends in species distribution, abundance, and biological characteristics (e.g., size and age composition, growth) in the sGSL (for details see Savoie 2016).

If the fish were smaller in size (<30 centimeters in length), or a time constraint existed, the entire fish was placed in individual sampling bags. An identification tag detailing the unique survey number, the date of capture, the species code for the individual, a unique fish number (if assigned) and fish length was placed in the bag with the fish. For larger species of fish (>=30 centimeters in length), the stomach was extracted from the body cavity on the boat and placed into a plastic bag with a similar identification tag. Plastic bags were then placed into waxed boxes and put in the freezer (-10 to -20 degrees Celsius) as quickly as possible to stop the digestive process and preserve the stomach contents. The specimen information was also recorded on a tally sheet at the time of sampling, and this information was used at a later date when the actual stomach content identification took place in the laboratory (see Section 2.2.3).

2.2 Processing of specimens

A binocular microscope with an indirect light source, a magnification range of approximately 5X to 50X, and a mount for digital imaging was used to examine stomach contents and is part of the recommended laboratory setup (Figure 1, Table 1). The processing of stomach contents requires an ergonomic workspace located in a well-ventilated laboratory.

The following sections will detail the protocols and techniques used for extracting and preparing stomach content (Section 2.2.1), processing and identifying prey items (Section 2.2.2), and entry of data (Section 2.2.3).

Table 1. Recommended tools and materials required to process fish stomach contents.

Tools and materials	
Scissors	
Tweezers	
Plastic weighing dishes	
Digital scale(s)	One precise scale with an accuracy of $\pm$ 0.0001g
Microscope	Binocular (Leica S9i or equivalent) with a usable magnification range of 5x to 50x
Light source	Indirect light (usually part of the microscope)
Squirt bottle	Used for rinsing
Ruler	Used for measuring length of prey items
Protective gear	
Lab coat	
Gloves	

Figure 1. Laboratory configuration to conduct detailed stomach content identification. This setup uses the Leica S9i microscope (6.1x to 55x) with a digital imaging head and a $\pm$ 0.0001g digital scale.

2.2.1 Protocol for stomach content analysis

1. A few samples are removed from the freezer at a time and immersed in cold water until the specimens are thawed (approximately 15 minutes to several hours depending on the size of the fish or stomach).
   (a) Do not to take out more fish than can be processed. The samples can be refrozen but this practice should generally be avoided as it severely degrades the contents.
2. Take the fish out of the sample bag and transcribe specimen collection information from the tag (Figure 1) onto the data sheet. Also indicate if the stomach was damaged or any other observations made (texture or water content)
3. Lay fish flat with its head on your left and use scissors to cut into the body cavity along the ventral mid-line of the fish, starting at the anus and ending just before the gills allowing the body cavity to open (Figure 2). Flatfish are processed in a slightly different manner by cutting the flesh around the internal organs and peeling it up to reveal the stomach (Figure 3)
   (a) Care must be taken to avoid cutting into the stomach and other organs. Rupturing other organs can make it difficult to locate the stomach and there is the possibility that stomach content will be lost if the stomach wall is perforated.
4. Spread open the body cavity with tweezers and locate the stomach. The stomach is generally located in the anterior portion of the fish underneath the liver which is typically orange, pink, or crimson in color. Remove the stomach by cutting as close to the mouth as possible at the anterior end, and where the stomach meets the intestine on the posterior end. Be sure to check inside the mouth as well in case any of the stomach contents were regurgitated when it was brought to the water surface (especially in redfish) and include in the content weight.
   (a) Remove any unwanted organs that may be attached to the stomach (heart, gallbladder, etc.). Be careful not to lose any stomach content while removing and transferring to the weighing dish.
5. First tare the digital scale to zero with a weighing dish on the scale. Then place the stomach and contents in the weighing dish and record the whole stomach weight (in grams) on the data sheet.
6. Remove the plastic weighing dish from scale and empty stomach contents into the same zeroed dish by cutting the stomach open from one end to the other. Ensuring to remove any contents from the walls by picking or scrapping with tweezers before discarding it.
   (a) We avoid using water in a squirt bottle to rinse off the stomach so as to not add water weight to the content weight. It is also noted if the stomach is completely empty or is inverted.
7. Place plastic weigh dish with stomach contents on the previously tared digital scale and record the content weight (in grams) on the data sheet.
8. Use the microscope to view stomach contents and assist with sorting and identifying various prey items.

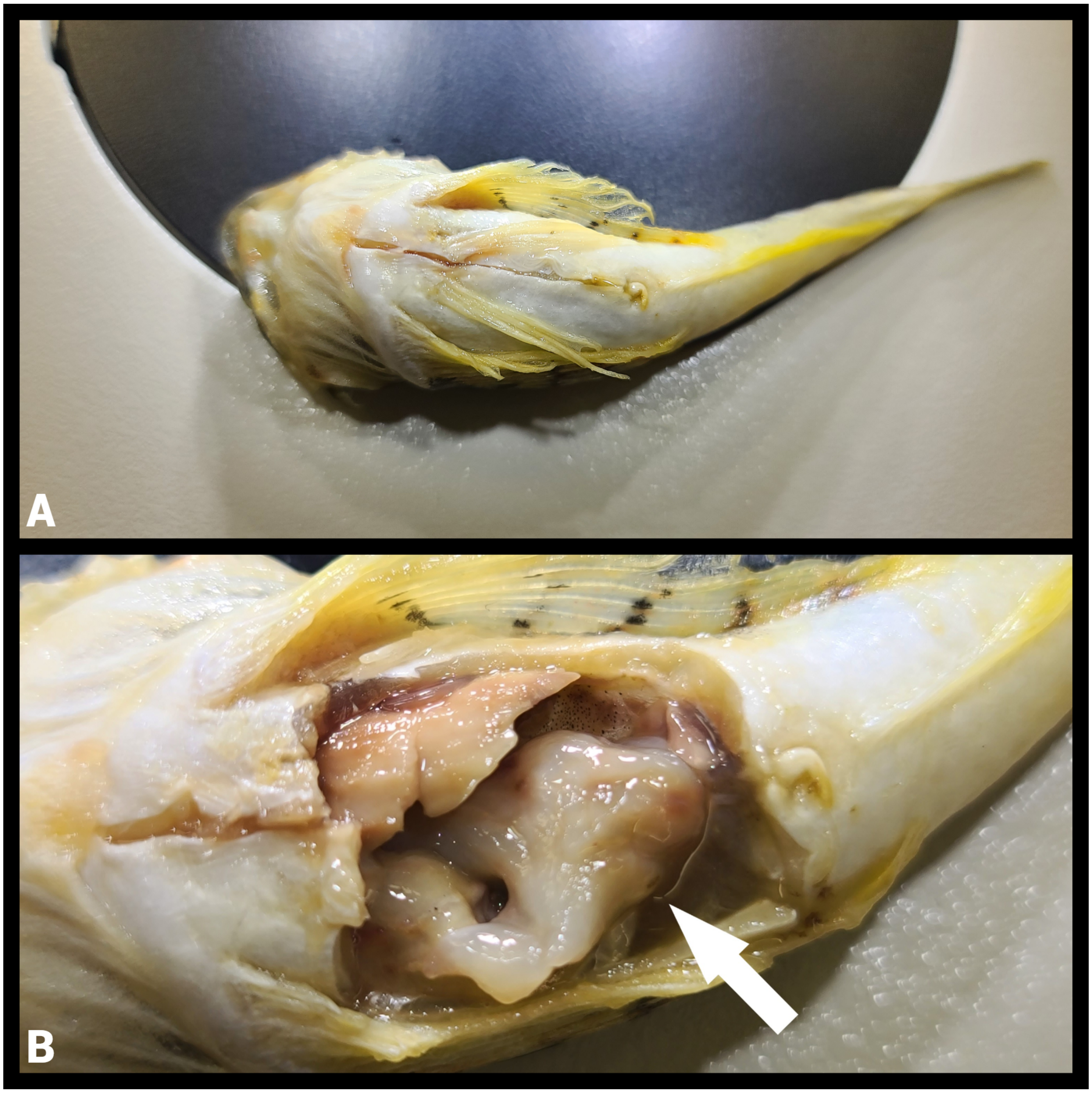

Figure 2. A. Sculpin being dissected for stomach removal. B. Sculpin internal anatomy, the stomach is the large organ on the right identified by a white arrow.

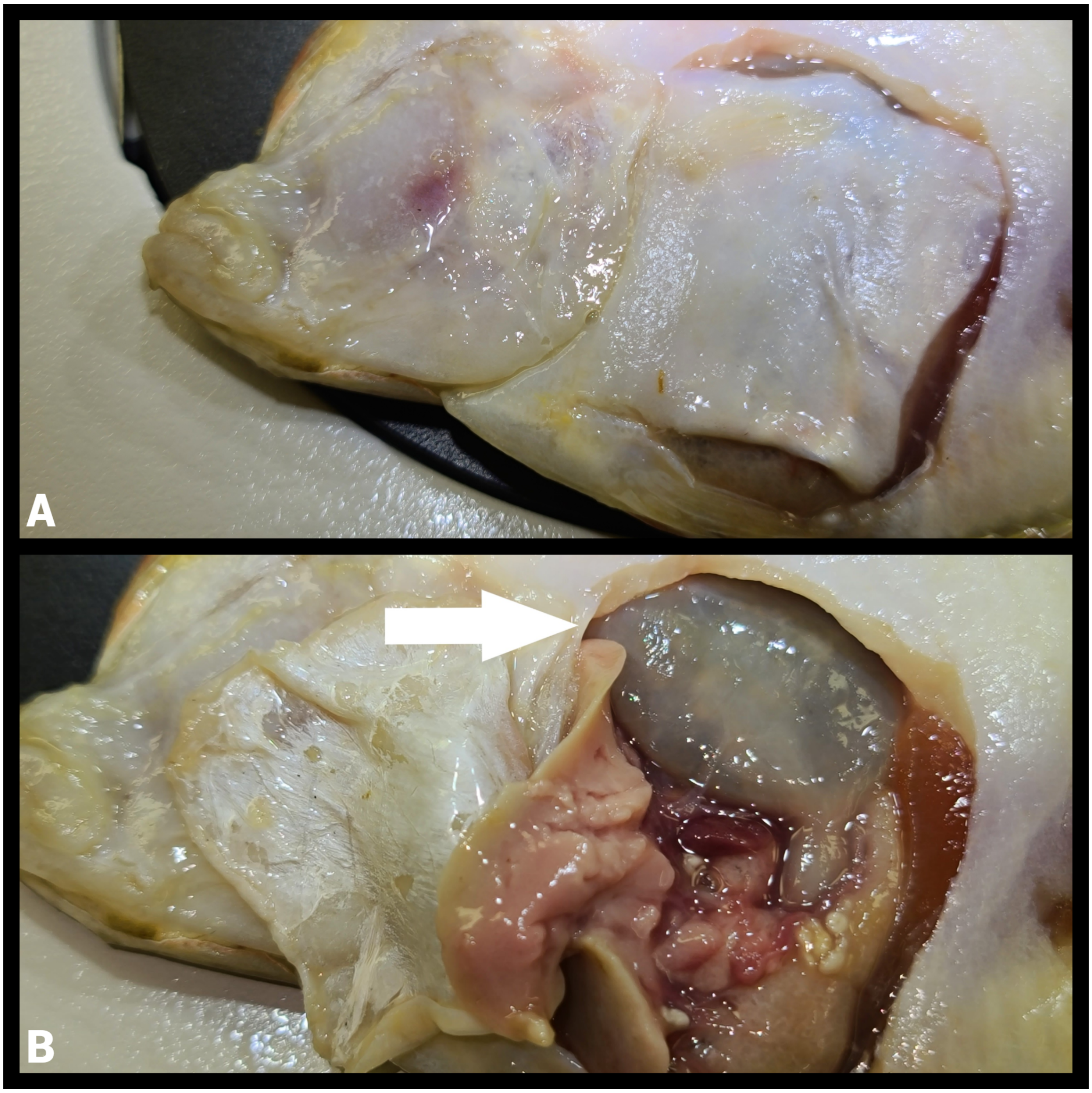

Figure 3. A. Flatfish being dissected for stomach removal. B. Flatfish internal anatomy, the stomach is the large organ on the top-right identified by a white arrow.

2.2.2 Prey item processing and identification

Sort the contents of the stomach, either in the same dish or using small plastic sorting trays. For each of the various prey items or grouping, record the prey code (codes are ones used on our RV survey but should be updated to "AphiaID" which are unique identifying codes used globally), species name, digestion level, length (in millimeters, if it is a crustacean or fish species) and the number/quantity of prey items. Place each prey item or grouping of items in a weighing dish on a digital scale, and record the weight (in grams) on the data sheet. Specimens can dry out quickly under the microscope light, so it is best to process the sample as fast as possible while maintaining accurate species ID. If required, a few drops of water can be added to rehydrate the contents while sorting and identifying, preferably after the sample is weighed. The following points provide guidance on prey identification classification, ID keys, and digestion level classification.

- Prey codes and names can be found in Losier and Waite (1989).
- Prey items should be identified to the lowest level of classification as possible with the aid of identification guides and taxonomic keys (i.e., Kingdom>Phylum>Class>Order>Family>Genus>Species). A very helpful resource for general identification in the Gulf region is Pollock (1998). Family specific guides (e.g., Gammaridean Amphipoda) are also ideal for further taxonomic resolution of prey (Bousfield 1973).
- Some groups are notoriously difficult to identify and species level identification should typically be avoided unless the specimen is in good condition and sampler can be confident with identification following the keys provided. Depending on the digestion level, some items may only be identified to Phylum. Most prey items will be identified to class, order, or family level. If unsure about identification level go to lowest level possible (e.g., can't tell whether prey item is in the Mysidae (mysid shrimp) or Euphausiacea (krill) order, then identify as Malacostraca class, and if unsure about whether it could be a Caridean shrimp, you would classify as phylum Arthropoda).
- Digestion level is classified as a value ranking from 1 to 4. Level 1 would indicate that the prey item that was in excellent condition with little to no digestion or physical degradation and identification to Genus or species could be achieved. Colour is natural and item has most likely been consumed shortly before being captured in the trawl. Level 2 would have some minor level of digestion and physical degradation. Slight discoloration and some breakdown of sensitive tissues, could also be in several pieces, but pieces are solid and discernible. Here identification to Family could be likely. Level 3 would have moderate to severe levels of digestion and physical degradation. Some discernible parts and pieces, but mostly mush with little physical integrity. Level 4 would have a severe level of digestion and physical degradation. Entirely mush with no physical integrity. Class and order may still be possible here but most likely that Phylum or some other broad grouping description will be used (Appendix A; Figure A.1).

Appendix A details the intricacies of digestion levels. Table A.1 and Figures A.1 to A.4 show different digestion levels for Polychaeta worm, Hyperiid amphipod, Hyas crab, and fish, respectively.

- A prey item classified as having digestion level 4 have typically been given a prey code of 9000 and called "unidentified digested remains". A general description of the unknown prey can be included in the name (i.e., pink mush, or bones/flesh). Additional thoughts on potential identification can be added to the comment section. Any questionable prey items that the sampler is unsure of should be photographed and documented with picture number mentioned in the comments section (See section 4 Photographic reference collection). Note that samplers should not assume heavily digested unidentifiable contents in a sample are related to identifiable prey items in the same sample. For example, just because you have several species of shrimp identified to species or family in a sample, do not assume that shrimp related "mush" is in the same species or family of shrimp.
- The length of most prey items is relatively difficult to attain with precision due to digestion and loss of tissue, however any group that can be reliably and consistently measured should be. Brachyura (true crabs) and fish are groups that can typically be measured. If Polychaeta (segmented worms) appear to be whole they can also be measured to help assess the size. If accurate lengths cannot be attained for crabs and fish this should be noted by using the approximate ("~") symbol to indicate the approximate length. Brachyura are measured using calipers across the longest width of the carapace. Fish length can be recorded as total length from head to fork length. If head and/or caudal fin is missing or damaged, use the approximate symbol and make note in comments section of missing parts. If there is only a piece of a fish, no length measurement can be taken.
- The number of prey items for each prey code should be indicated on the data sheet. Care should be taken to only count the "heads" of certain groups if they are broken/separated from the "tail" as to avoid double counting individuals. An estimate can also be given using the approximate symbol ("~"). If you have a group of Gammaridean Amphipoda and there are clearly different families present, you should identify to family and/or genus/species if possible, and give a count for each. All fish and crustaceans (i.e., crabs, , and lobster), and Cephalapoda (squid, bobtail squid, and benthic octopuses) should be processed individually rather than being pooled like other groups because these require individual length and should be weighed individually as well.

2.2.3 Data entry and documentation

A sheet containing the sample information is filled-in with detailed taxon-level stomach contents as described above. The paper sheet used for data capture in the laboratory defines a number of fields that are filled in by technicians (Figure 97), these consist of the following:

1. Information related to sampling at sea

   Survey ID A unique identifier for the research survey mission where the stomach was collected.

   Year collected Year when the stomach was collected

   Set number Set number where the stomach was collected

   Predator code Taxon code of the predator.

   Fish number Unique fish number assigned to the individual at time of collection.

Length Length of sampled individual.

2. Lab

   Sampler name Name of the technician processing the stomach.

   Date processed Date at which the stomach was thawed and its contents were processed in the laboratory.

   Stomach weight Total weight of the stomach after being thawed.

   Content weight Total weight of the contents of the stomach once they are transferred to a weighing dish.

   Prey code Code used for prey taxon.

   Prey common name Common names of prey taxon.

   Digestion level Digestion level, as described in Appendix A.

   Prey length If applicable, length of the prey item (for example if the item is a whole fish).

   Number of prey Count of the number of individuals that can be identified for that prey taxon.

   Prey weight Weight of all individuals that can be identified for that prey taxon.

   Comments Any comments that the technician may have about the stomach sample or its contents.

This information was later digitized in a bespoke data entry application developed in Django/Python which collated all information into a single Oracle relational database management system used for storage and retrieval for diet analyses.

2.3 Photographic Reference Collection

It is beneficial to document any unknown species or unidentified items with a digital photograph (e.g., Figures 10, 15 and 91). Photographs should include a scale for size reference and several images should be captured to include various angles, key identification features, and any anatomy that can be useful for future identification if identity is unknown.

3 Results

This is the first edition of an identification guide that describes the commonly encountered prey items found in stomach contents of Northwest Atlantic marine fishes. The following guide includes a section for each taxon and with a structure that reflects the alphabetic taxonomic hierarchy (a list of taxa used can be found in Table 2). The main components of each section are scientific name, taxonomic level, a brief description, and the AphiaID. The AphiaID is a unique numerical identifier attributed to each variation of a taxon name in the World Registry of Marine Species (WoRMS). The identifier is a key linked to all related versions of a name, which is useful as corrections (spelling) and revision (new relationships) will lead to name changes that can be traced by these linked keys.

A selection of images that highlight features and traits to look for in each group are also included. The images in this guide were all captured using a Leica S9i digital binocular microscope with an integrated 10 megapixel camera, a built-in indirect light source, and a total magnification range of 6.1x - 55x. A small plastic ruler was included in the images for scale (each increment is 1 millimeter).

Table 2. List of taxa identified in this guide that were found in the stomach contents of fishes from the annual September ecosystem survey in the Gulf of St. Lawrence 2018-2020. The AphiaID column contains a hyperlink to each taxon's entry on the World Register of Marine Species (WoRMS). The Section column contains hyperlinks to each taxon's section.

Class	Order	Family	English name	AphiaID	Section
Kingdom: Animalia					
Phylum: Annelida			Annelids	882	3.1
Polychaeta			Polychaetes	883	3.2
Polychaeta	Eunicida	Onuphidae	Tube worms	129402	3.3
Polychaeta	Terebellida	Pectinariidae	Trumpet worms	980	3.4
Phylum: Arthropoda			Arthropods	1065	3.5
Copepoda			Copepods	1080	3.6
Malacostraca	Amphipoda		Amphipods	1135	3.7
			Gammaridea	1207	3.8
	Amphipoda	Ampeliscidae		101364	3.9
		Aoridae		101368	3.10
		Caprellidae		101361	3.11
		Corophiidae		101376	3.12
		Dexaminidae		101378	3.13
		Eusiridae		101380	3.14
		Hyperiidae		101417	3.15
		Lysianassidae		101395	3.16
		Melitidae		101397	3.17
		Oedicerotidae		101400	3.18
		Phoxocephalidae		101403	3.19
		Pleustidae		101404	3.20
		Stenothoidae		101409	3.21
	Cumacea		Cumaceans	1137	3.22
	Decapoda		Decapods	1130	3.23
	Decapoda		Megalops (Decapoda life stage)	1130	3.24
	Decapoda		Brachyura	106673	3.25
	Decapoda	Crangonidae	Sand shrimps	106782	3.26
		Paguridae	Hermit crabs	106738	3.27
		Pandalidae	Pandalid shrimp	106789	3.28
		Thoridae	Cleaner shrimp	883967	3.29
	Euphausiacea	Euphausiidae	Euphasids	110671	3.30
	Isopoda		Isopods	1131	3.31
	Mysida	Mysidae	Mysids	119822	3.32

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Class	Order	Family	English name	AphiaID	Section
		Tanaidacea	Tanaids	1133	3.33
Ostracoda			Ostracods	1078	3.34
Phylum: Cnidaria			Jellyfish, anemones, soft and hard corals	1267	3.35
Phylum: Echinodermata			Echinoderms	1806	3.36
Asteroidea			Sea stars	123080	3.37
Echinoidea			Sea urchins	123082	3.38
Holothuroidea			Sea cucumbers	123083	3.39
Ophiuroidea			Brittle stars	123084	3.40
Phylum: Mollusca			Molluscs	51	3.41
Bivalvia			Bivalves	105	3.42
Cephalopoda			Cephalopods	11707	3.43
Gastropoda			Gastropods	101	3.44
Phylum: Nematoda			Nematodes	799	3.45
Phylum: Chordata					
Teleostei			Teleost fish	293496	3.46
Kingdom: Chromista					
Phylum: Foraminifera			Foraminifera	1410	3.47
Kingdom: Plantae					
			Algae		3.48
Other					
			Casings		3.49
			Eggs and egg masses		3.50
			Zooplankton		3.51

3.1 Annelida (Phylum) - AphiaID: 882

Description:

A relatively large phylum of segmented worms that are generally classified into four groups; polychaetes (primarily marine species), oligochaetes, sipunculids, and leeches (e.g., Figure 4). This group is usually characterized by its bilateral symmetry, segmented body, and presence of parapodia, which are paired fleshy protrusions on the body that are utilized for protection, gas exchange, and locomotion.

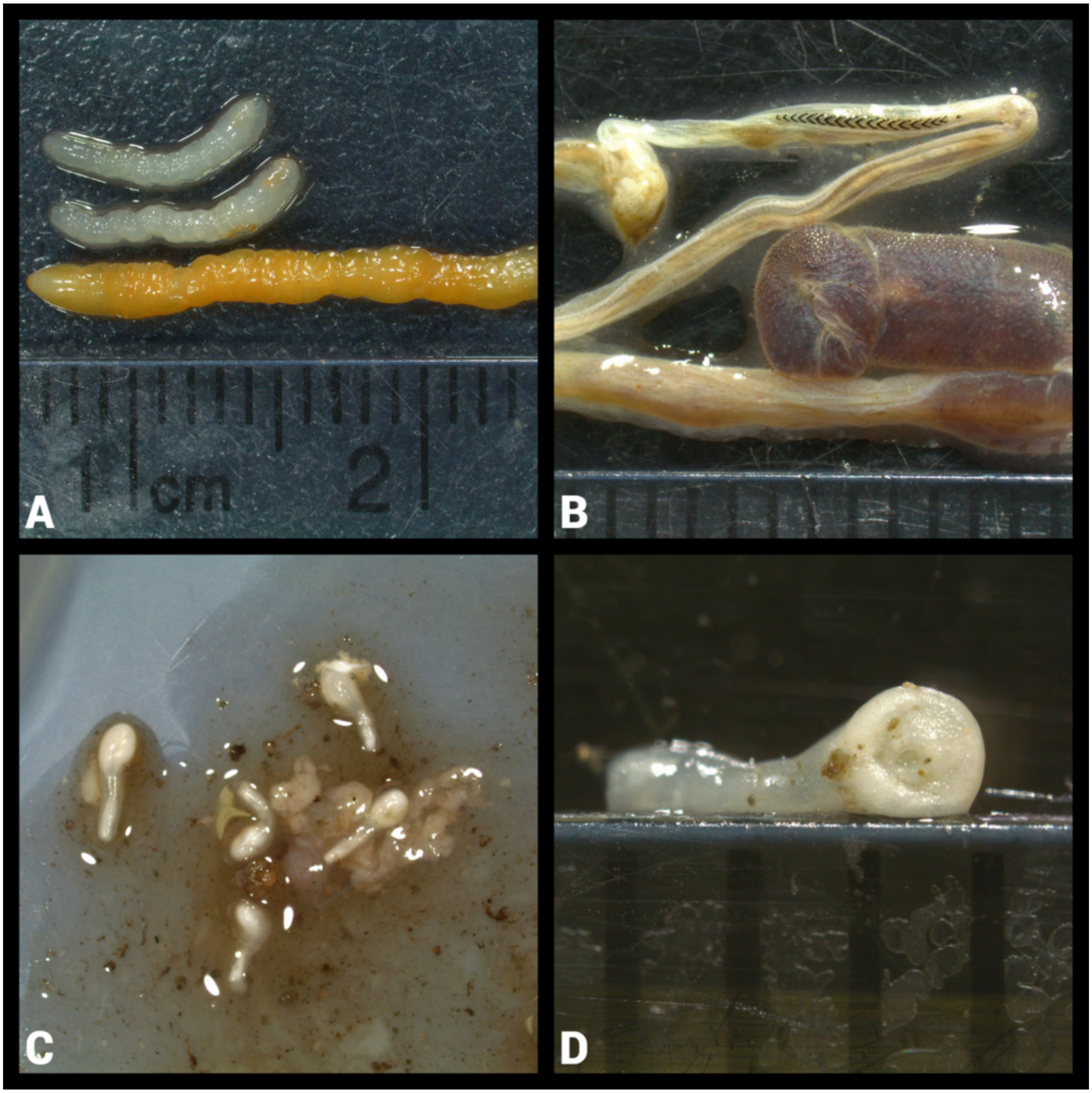


Figure 4. **Annelida**. A) Unknown Annelida. B) Goniadidae. Enlarged at one end, body is divided into a trunk and evertable/retractable proboscis, with the mouth and often tentacles at its tip. The chevron teeth are a key identification feature for this group and can be seen clearly near the top of this image. C) Parasitic worms (Acanthocephala). D) Close-up of a parasitic worm.

3.2 Polychaeta (Class) - AphiaID: 883

Description:

This abundant and diverse group can be especially challenging to identify to genus or species. Specimens are typically found in poor condition, their soft tissue structures typically used for identification degrade and digest relatively quickly (Figures 8, 9). Depending on the state of decomposition, often the only distinguishable features that remain are the setae (Figure 10). Setae are hairs or bristles, and “Polychaeta” literally translates to “many bristles”. Individuals are often found in pieces and missing both the anterior and posterior ends, making identifications to anything beyond phylum unachievable. When attempting to classify this group, attention must be taken to the detail surrounding the anterior end or head, as this is where most of the distinguishable features are located. The two important areas to focus on are the prostomium (a lobe that overlaps the mouth area), and the next body segment that surrounds the mouth which is called a peristomeum (Figure 7). The prostomium is where several sensory structures are located which can include tapering antennae, food-gathering appendages called “palps”, and one to several pairs of ocelli or eyespots (Figure 5). The peristomeum and occasionally the segments that follow usually lack the parapodia found on subsequent segments. Tentacular cirri are tapering antenna like structures and can also be found in this area. Many polychaetes can evert their proboscis or pharynx through the mouth opening. The shape and defense mechanisms (modified “stinging” setae, powerful jaws) associated with these parts can be useful identification features. Form and function of parapodium (lateral flaplike appendages) can also be used for identification purposes (Figure 6). See Figure 100 in the Appendix for a diagram showing the arrangement of external features in polychaetes (Beesley et al. 2000) and the following reference for definitions and keys to the Polychaete worm orders, families and genera (Fauchald 1977).

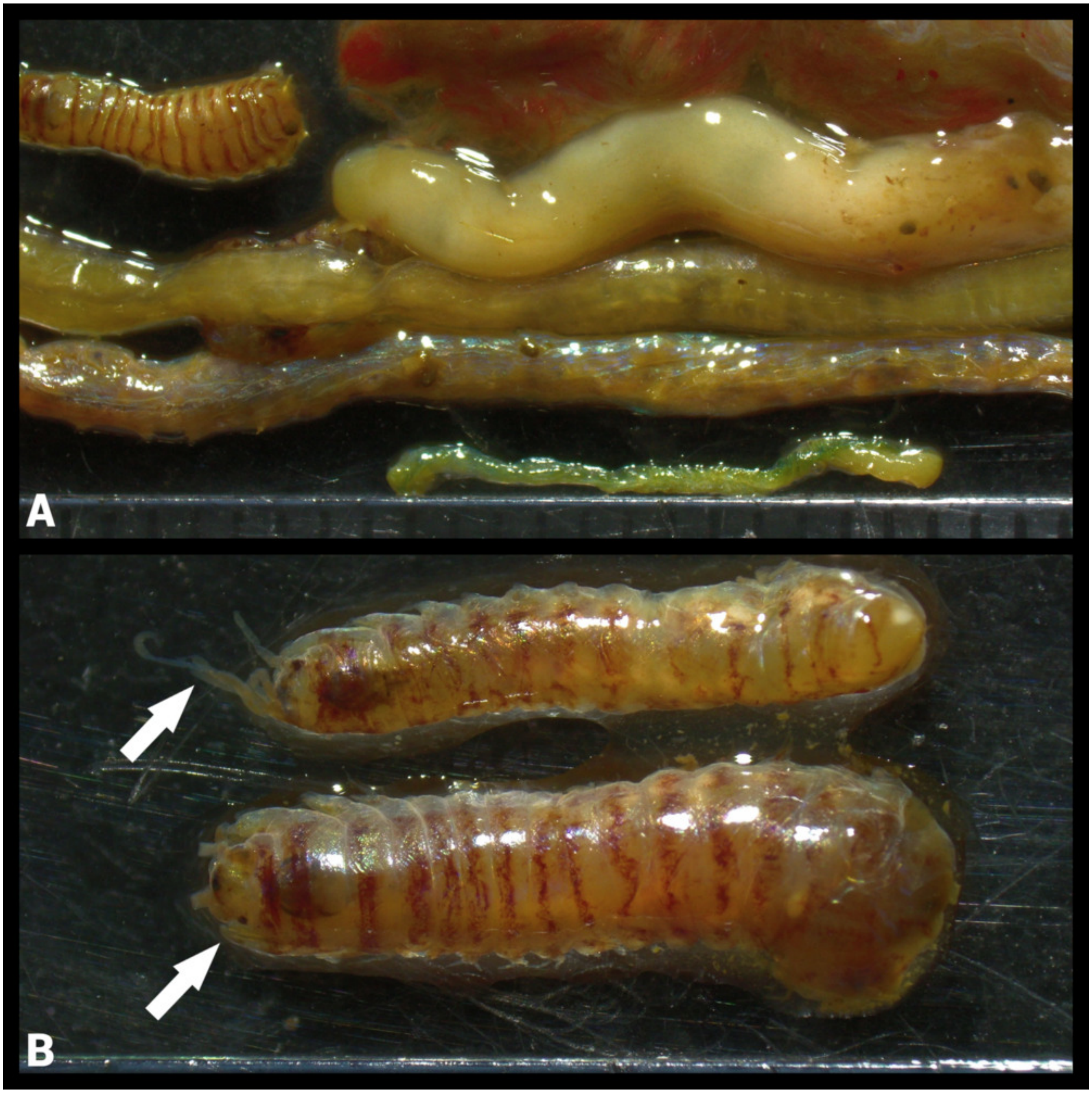


Figure 5. **Polychaeta**. A) Variety of Polychaete worms, e.g., *Nothria conchylega*. B) *Nothria conchylega*. Short, subconical prostomium with pair of awl-shaped frontal palps, and a pair of cushion-like ventral palps. Two large eyes next to the posterior antennae, and two small eyes behind the frontal antennae. Colour is variable but usually with bluish or whitish yellow with red or brown transverse stripes.

Figure 6. C) Paddleworm; Phyllodocidae. Prominent lateral parapodia, and several, obvious anterior appendages. D) Phyllodocidae. Slender often brightly coloured,parapodia uniramous with flattened, leaflike dorsal and ventral cirri.

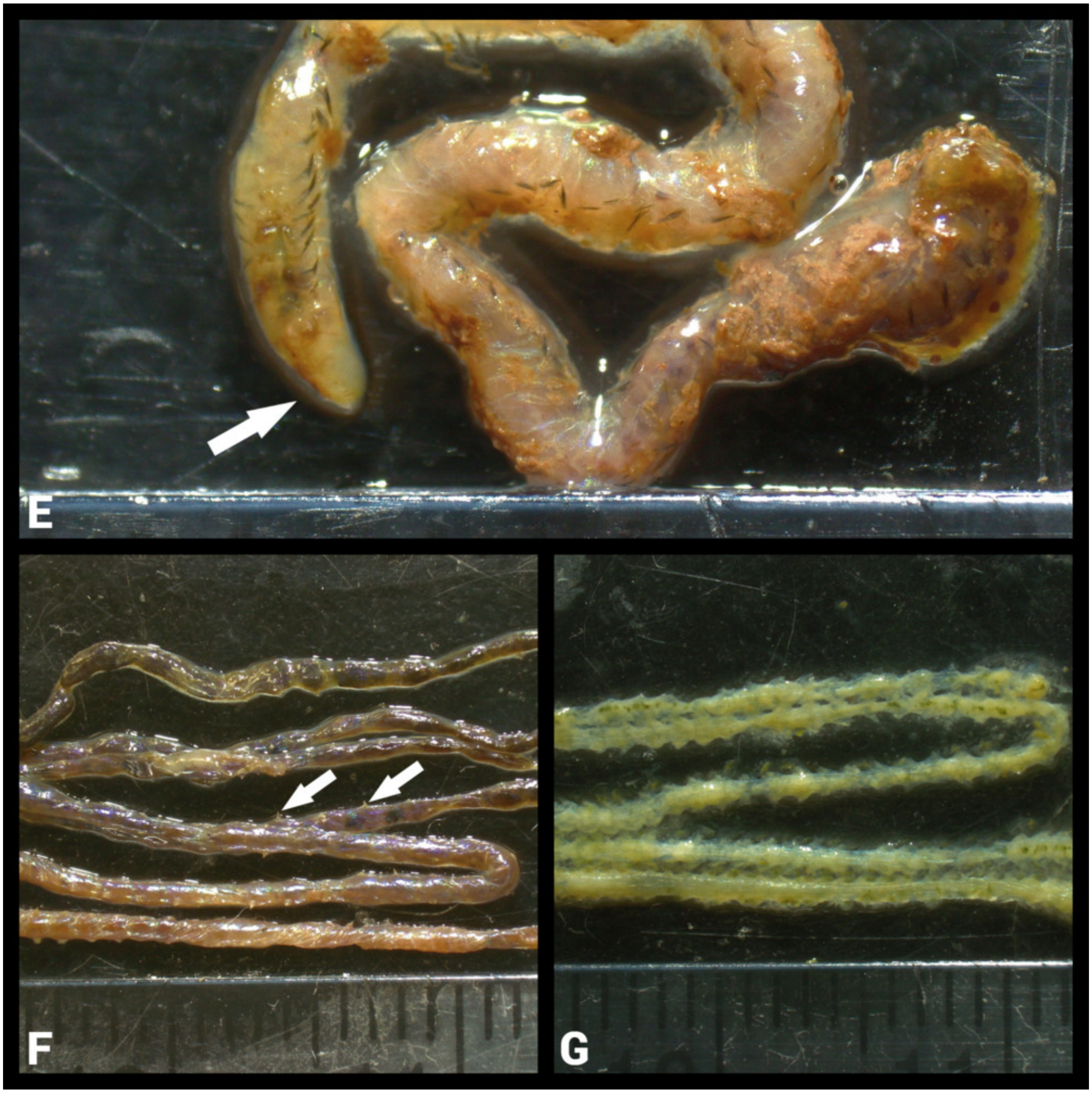


Figure 7. E) Threadworm; Lumbrineridae or Arabellidae. Prostomium a smooth cone or lobe without appendages, first two segments lack parapodia. F) Lumbrineridae. Some setae are sharp-tipped and others are blunt or hooked. G) Lumbrineridae. Long, slender worm.

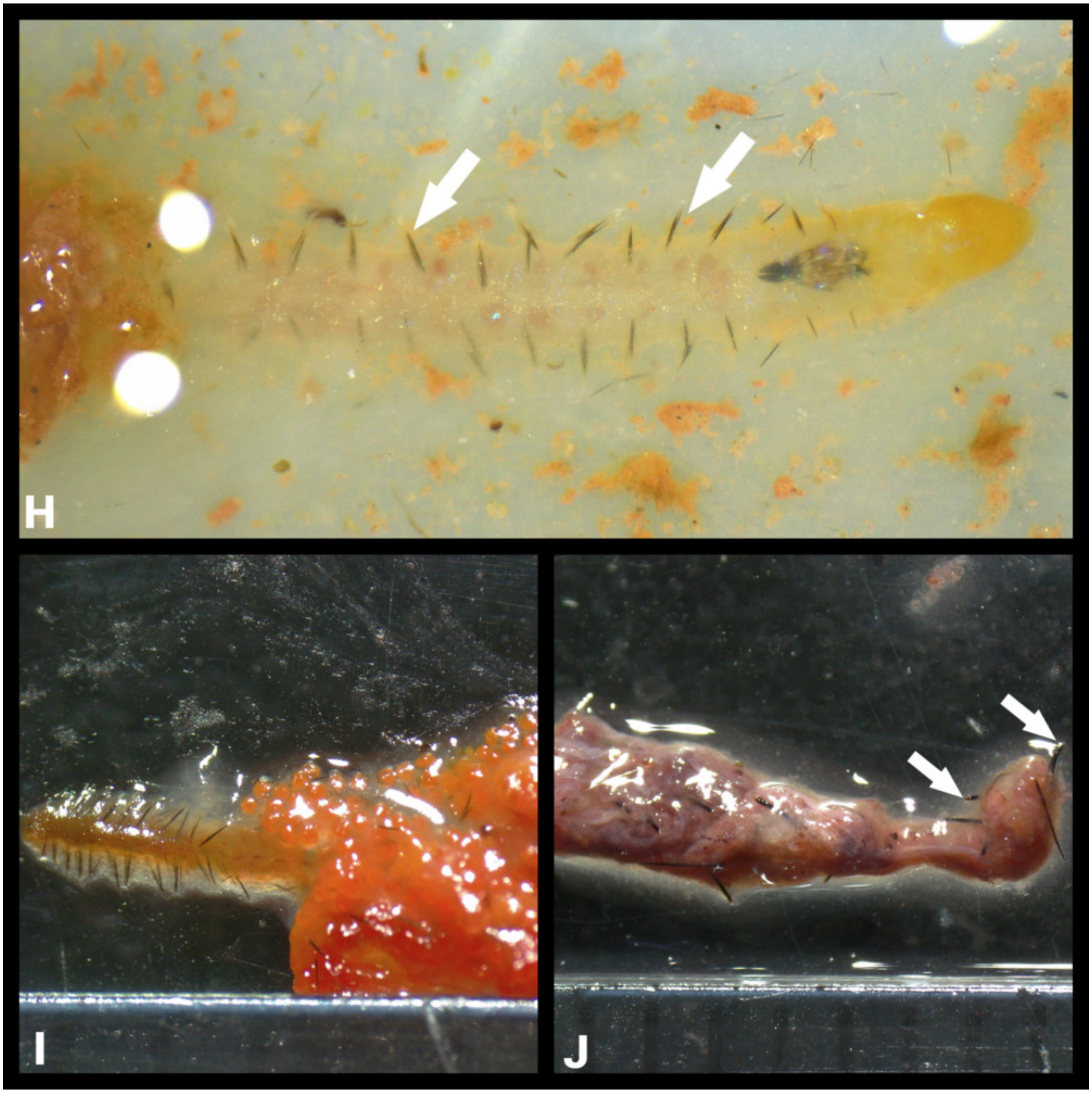


Figure 8. H) Arabellidae. All setae are sharp-tipped and similar. I) Partially digested Polychaeta. J) Partially digested Polychaeta with long, robust black setae.

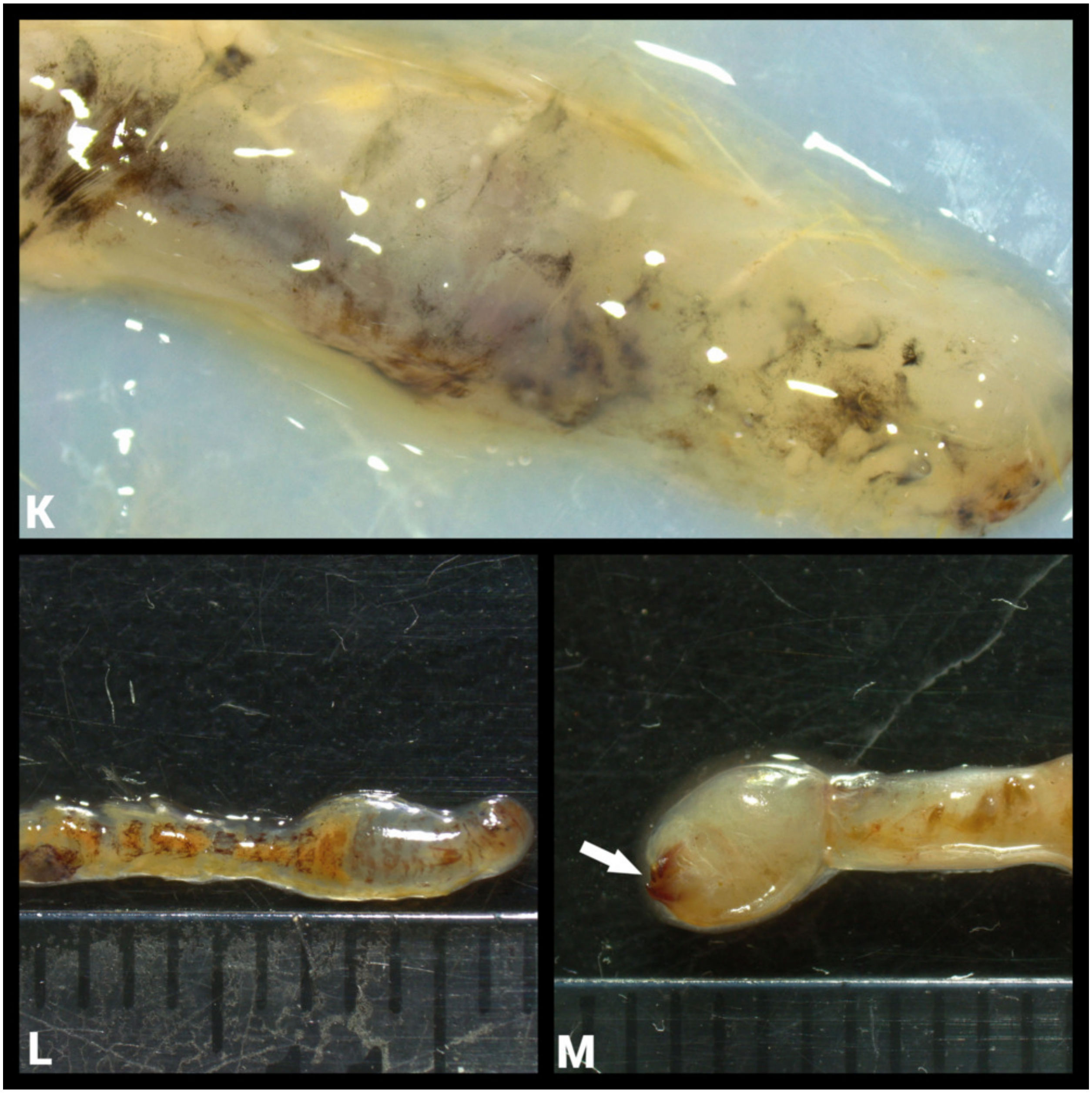


Figure 9. K) Partially digested Polychaeta. L) Partially digested Polychaeta. M) Well digested polychaete with mandibles still intact.

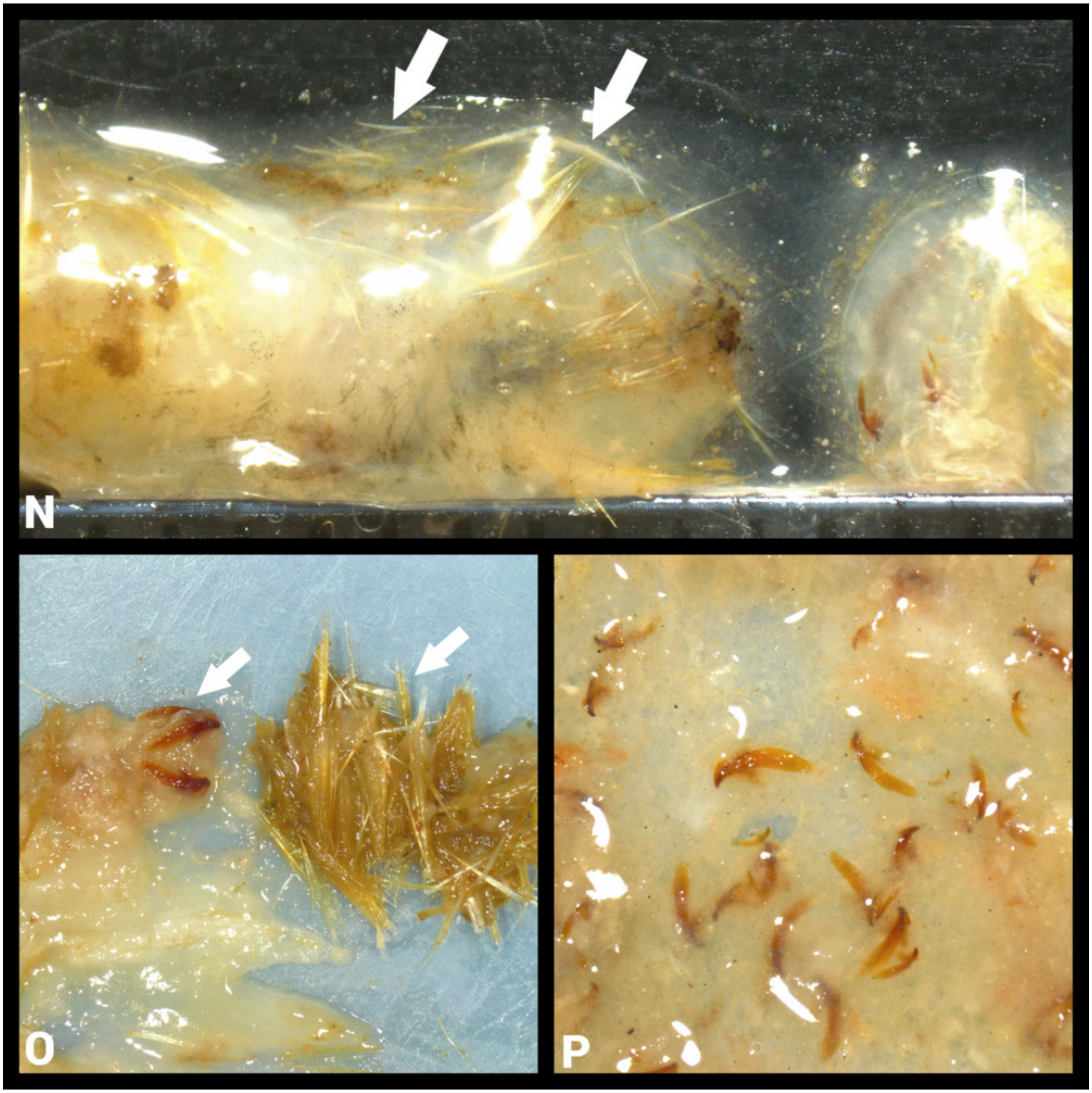


Figure 10. N) Well digested polychaete with setae (hairs) still intact. O) Well digested polychaete with setae (hairs) and mandibles still intact. P) Polychaete mandibles.

3.3 Onuphidae (Family) - AphiaID: 129402

Description:

Commonly referred to as tube-building worms, this family is one of the more frequently encountered and easier to identify polychaeta groups. They are characterized by an elongate body that is cylindrical in cross-section. The prostomium has two short frontal antennae, two globular palps and five main antennae. Key features to look at with this group would be large mandibles and the maxillae have several pairs of plates edged with fine teeth, some tentacular cirri are present, anterior parapodium points forward and has tapered ventral cirri, and biramous posterior parapodia with cushion-like cirri (Figure 11). The shape of lobes and cirri can help to differentiate species.

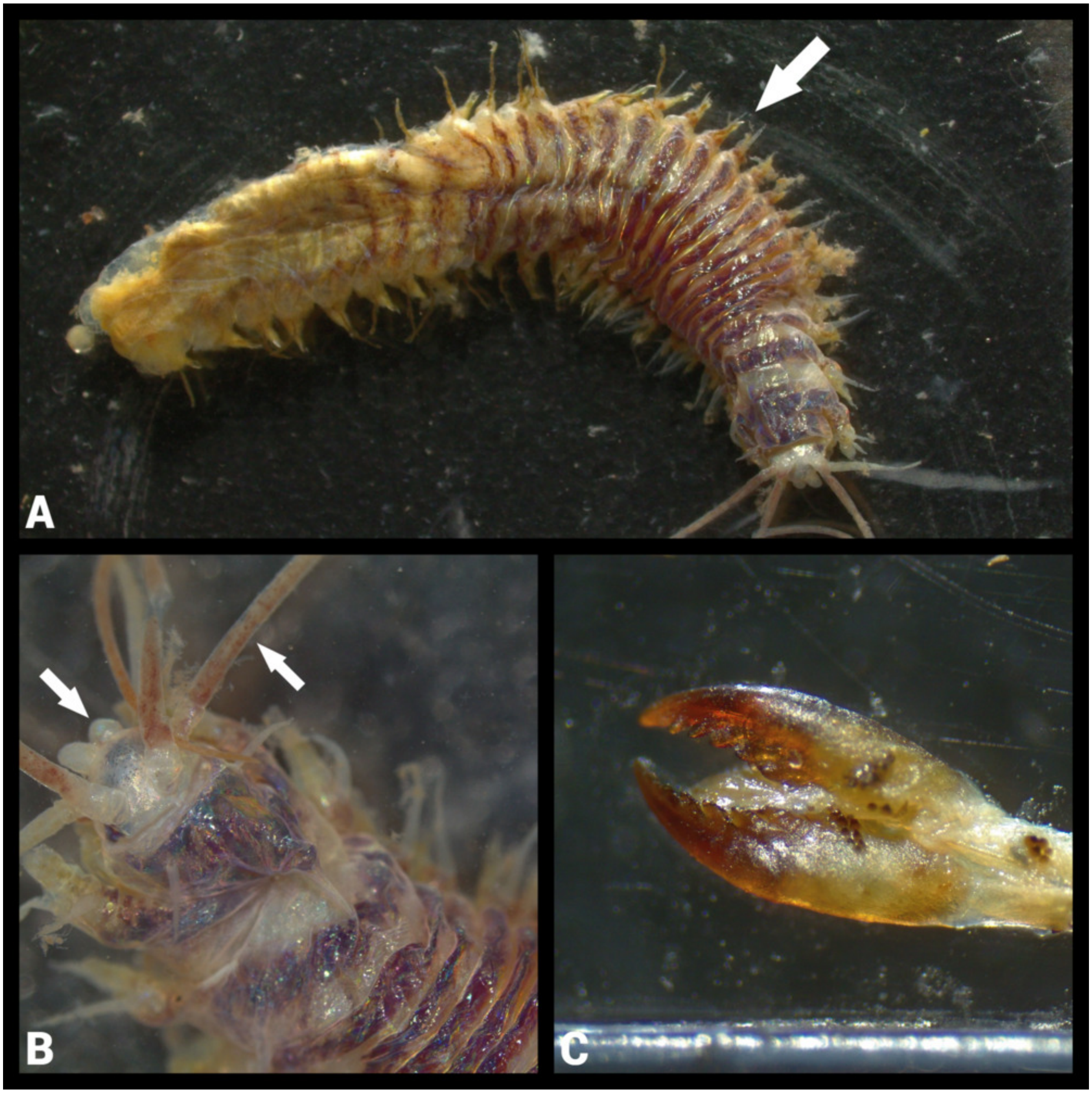


Figure 11. **Onuphidae**. A) *Nothria* species. Long tentacles, barred body with iridescent colouring, and parapodium along sides of body. B) Closeup of anterior section that includes prostomium, palp, and cirri (tentacles). C) Pair of curved mandibles.

3.4 Pectinariidae (Family) - AphiaID: 980

Description:

Commonly referred to as “ice cream cone worms” because of their casings resemblance to an ice cream cone that is made up of small sand grains (tubes are usually no more than 5 cm in length). The worm itself that resides inside the tube has large golden setae that form an arch over the flattened head and well-developed parapodia (Figure 12).

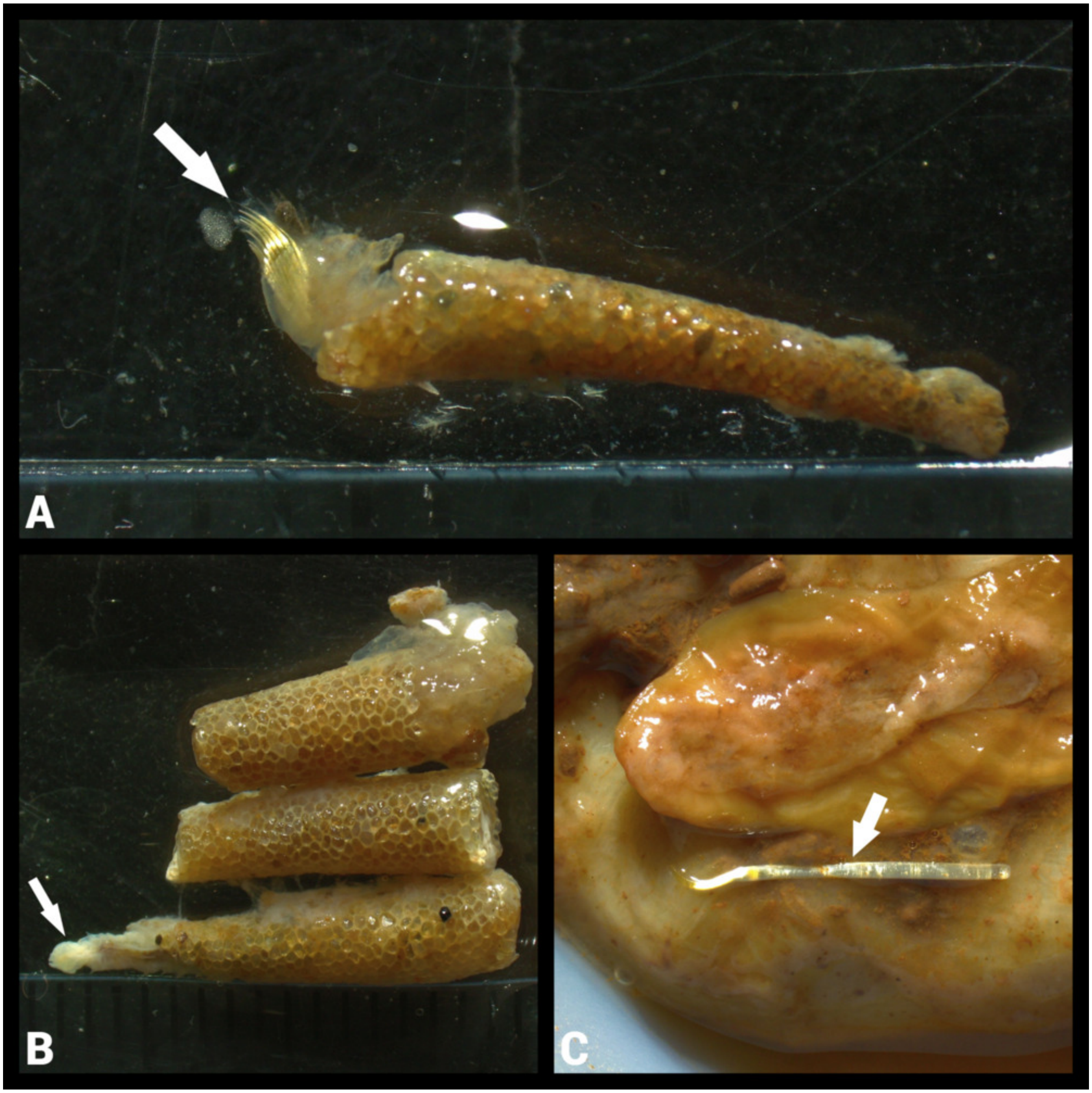


Figure 12. **Pectinariidae.** A) Large golden setae on left. B) Casing that is made up of small sand grains, posterior end of worm can be seen at bottom left. C) Golden setae (long and hooked) from Pectinariidae, also known as an “ice cream cone worm”.

3.5 Arthropoda (Phylum) - AphiaID: 1065

Description:

A large phylum of invertebrates that are characterized by segmented bodies and jointed limbs. There are four major groups in this phylum and only two that you would expect to encounter in the marine environment. These being the sub-phylum *Crustacea* which includes copepods, malacostracans, oligostracans (ostracods), and to a lesser extent the sub-phylum *Chelicerata* which includes sea spiders and horseshoe crabs.

3.6 Copepoda (Subclass) - AphiaID: 1080

Description:

A group of small crustaceans with planktonic (the orders Cyclopoidea and Calaniodea) and benthic forms (Harpacticoidea). Adults and juveniles are often very abundant in plankton samples. Copepods are considered zooplankton and form the base of many food webs. Copepod bodies are divided into a combined head and thorax portion (6 segments), and a skinnier abdominal portion (2-5 segments). The head and first thoracic segments are covered by a singular carapace. The calanoid group is very diverse and widespread, with long antennules that extend past the thorax, and distinct tapering from the trunk to the abdomen region (skinnier abdomen and wider trunk region). In contrast the cyclopoids have shorter antennules and their bodies are less tapered (Figure 13, 14).

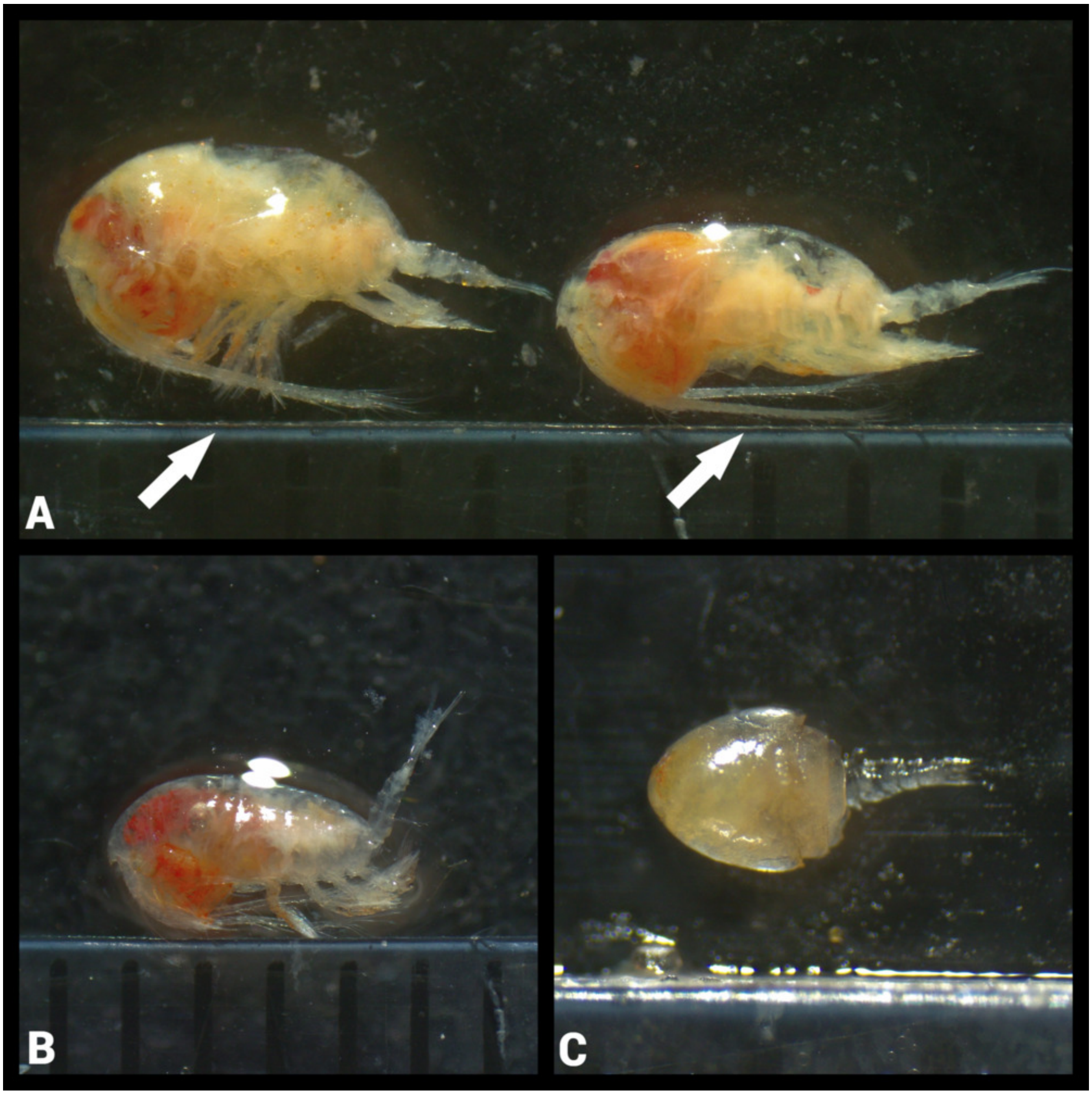


Figure 13. **Copepoda**. A) Calanoid. Long antenna that extend past thorax, with distinct tapering from trunk to abdomen region. B) Calaniod copepod. C) Cyclopoid copepod. Short antennules and less tapered body.

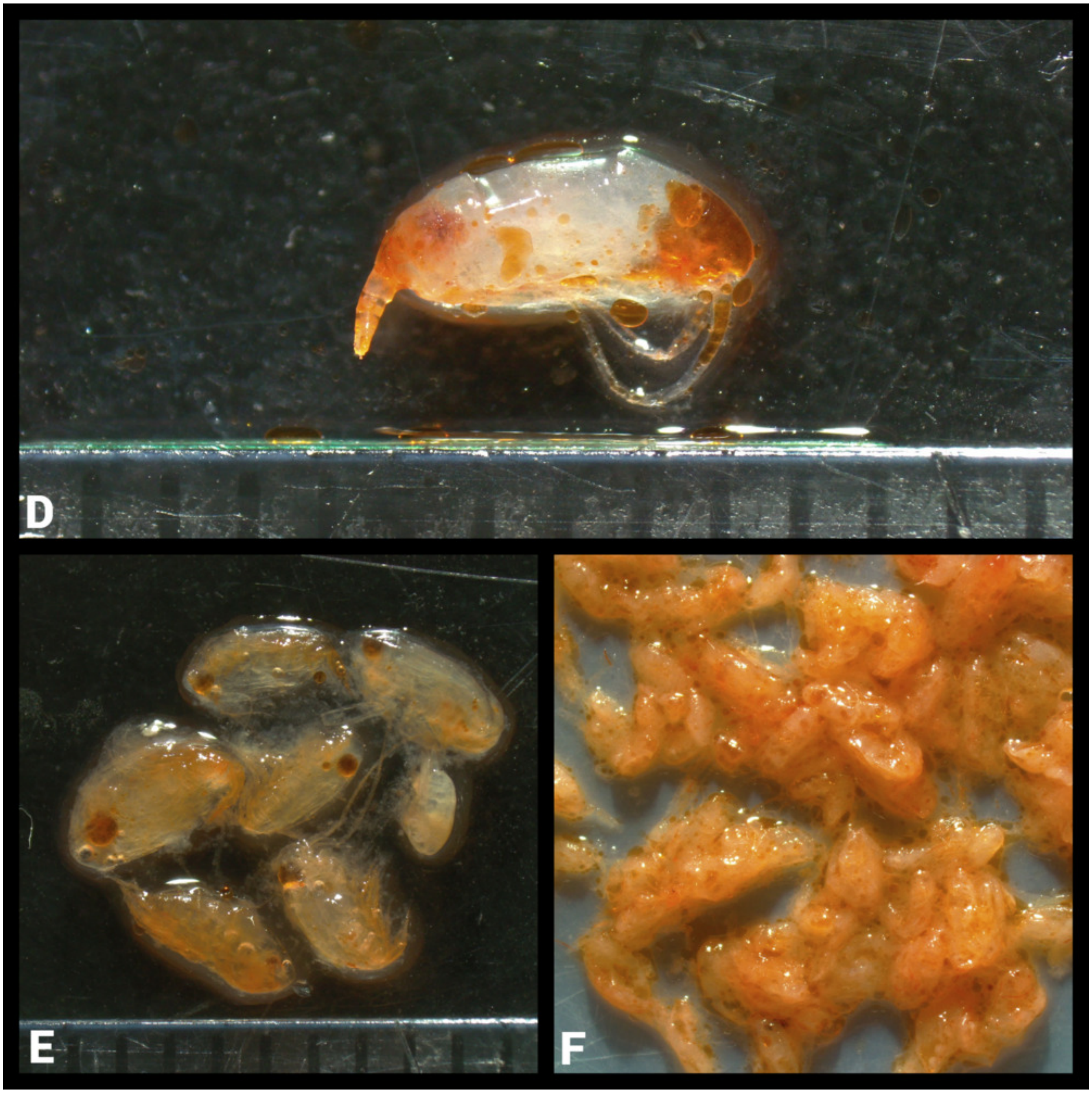


Figure 14. D) Lightly digested calanoid. Copepods are very rich in oils, and orange globules of oil can be seen in this image. E) Partially digested calanoid. F) Partially digested copepods. Even when copepods are well digested you can still see the globules of orange oil, which are an excellent indicator for identification purposes. Size is also a good indicator, especially for calanoids such as *Calanus hyperboreus* and *Paraeuchaeta norvegicus*, which are larger in size (4-8 mm in length) compared to the smaller cyclopoid species (0.5-2 mm).

3.7 Amphipoda (Order) - AphiaID: 1135

Description:

A diverse group of relatively small shrimp-like crustaceans that are characterized by a lack of carapace and typically have a laterally compressed body. The Gammaridea, Hyperiidaea, and Caprellidea suborders all fall under the order Amphipoda (Figure 15). Peracaridans which include amphipods, mysids, cumaceans, isopods, and tanaids differ from the malacostracan crustaceans such as decapods and euphausiids in that they only have one true thoracic segment fused to their head (only have one pair of maxillipeds), females have eggs that originate in a thoracic brood pouch, and hatch into a juvenile rather than a true larval stage (Bousfield 1973).

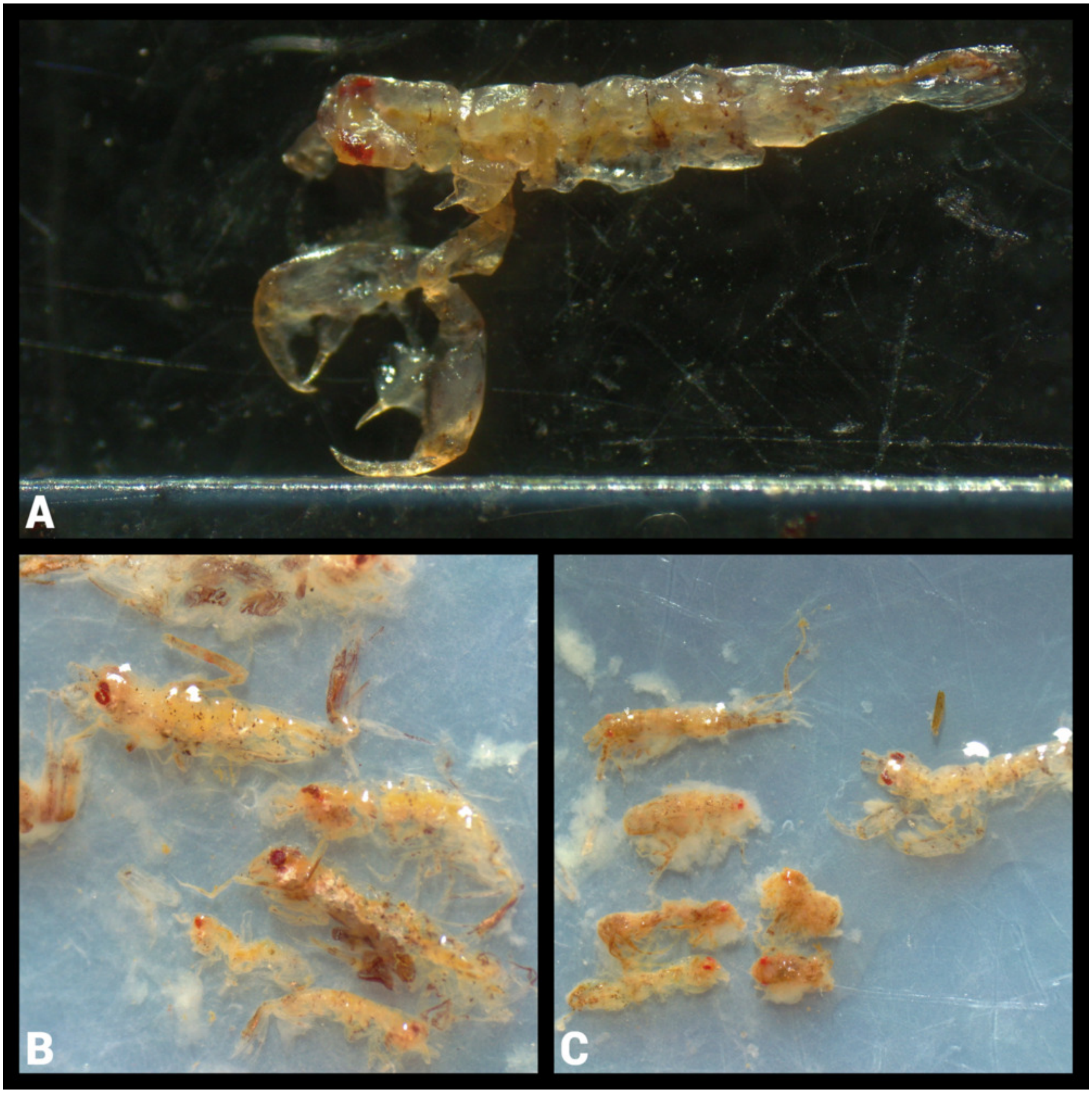


Figure 15. **Amphipoda**. A) Amphipoda species. Possibly Podoceridae. B) Variety of Amphipoda. C) Variety of Amphipoda.

3.8 Gammaridea (Suborder) - AphiaID: 1207

Description:

Gammaridean amphipods make up almost 90% of all amphipod species (note: group has been divided into others), and most likely more than 95% of all amphipod biomass in the southern Gulf of the St. Lawrence region (Bousfield 1973). This is a broad grouping of 'typical' amphipods, excluding the pelagic Hyperiidea and Skeleton shrimp (Caprelloidea). Compared to groups like Caprelloidea and Hyperiidea, the grouping of Gammaridea have normal sized eyes that generally take up less than half of the head, the presence of coxal plates (usually large), a maxilliped with palp, and the first uropod is always biramous (leg branches into two and each branch has a series of segments that are attached end to end) (Figure 16). These features can be used to distinguish them from the other three suborders of Amphipoda (Caprellidae, Hyperiidae, and Ingolfiellidae). See Figure 98 for anatomical features of a basic gammaridean amphipod (Bousfield 1973).

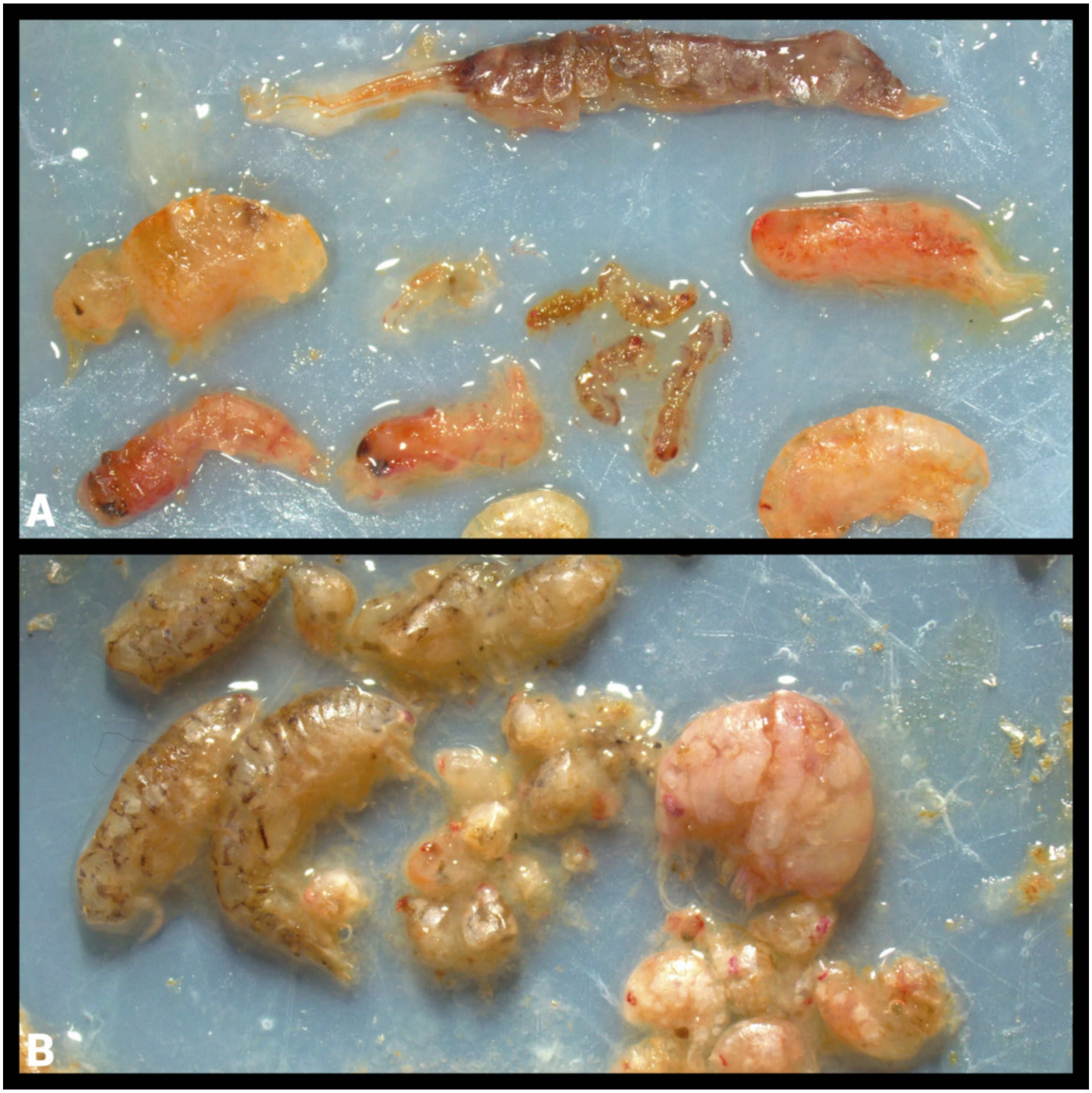


Figure 16. **Gammaridea**. A) Assortment of Gammaridean amphipods. Melitidae at top, and Lysianassidae (*Syrrhoe crenulata*) in the middle on right side. Head anteriorly not produced, rounded. Rostrum reaching about half of antenna 1; lateral cephalic lobe pointed; eyes present, with dark pigmentation; large, oval, on dorsal part of head. B) Oedicerotidae on top left and Lysianassidae on bottom right.

3.9 Ampeliscidae (Family) - AphiaID: 101364

Description:

This family of "four-eyed" gammarids is characterized by a smooth body, deep coxal plates, relatively shortened and shallow head (longer than deep) with no rostrum, 2-6 eyes (usually 4), located anteriorly on the side of the head, first antennae short and thin, frequently attached far ahead of the second antennae, and a deeply cleft telson (Figure 18F). It is easy to distinguish this family even with severe digestion as the 4 eyes will remain (Figure 17).

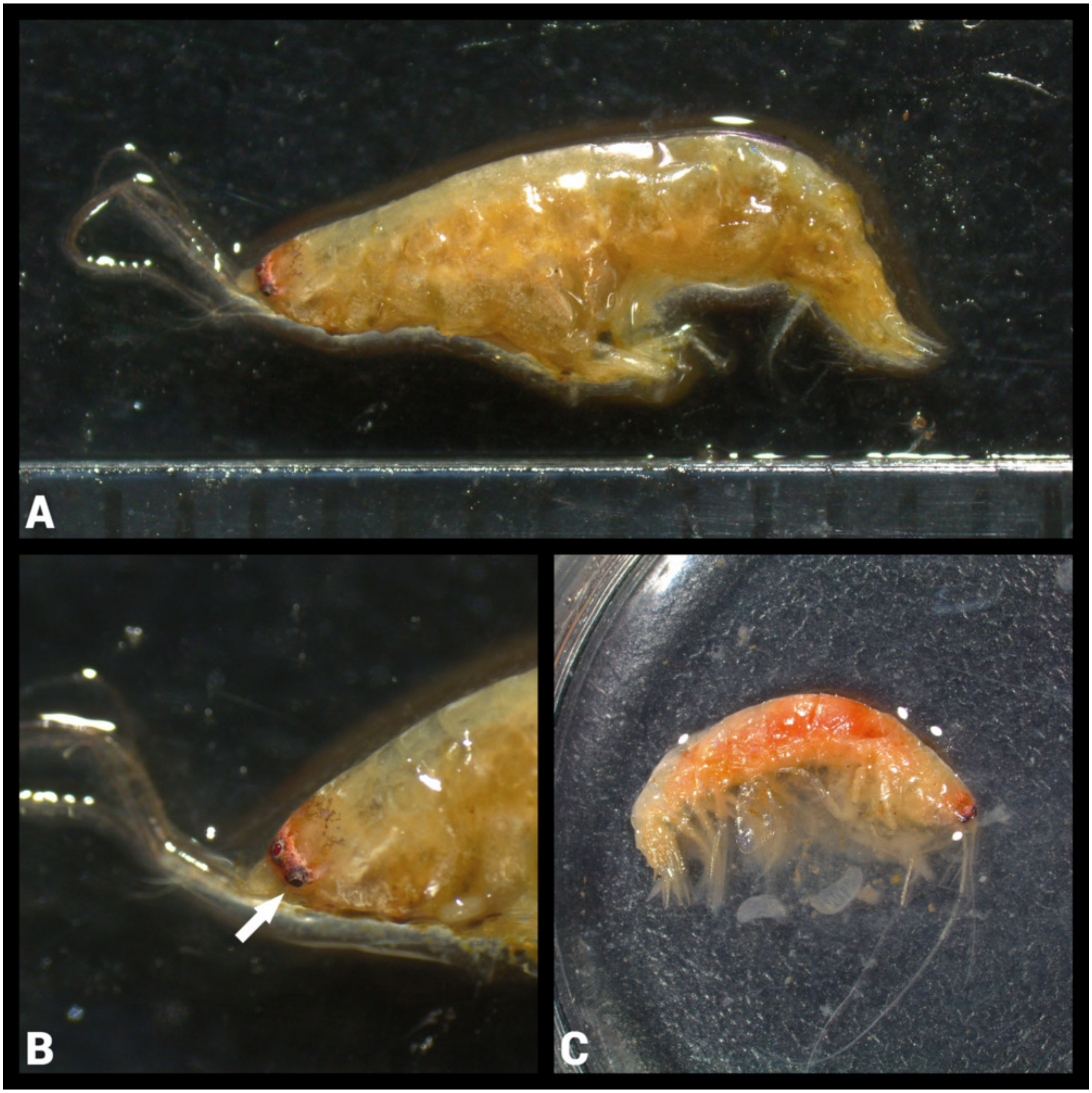


Figure 17. **Ampeliscidae**. A) *Byblis gaimardii*. B) Last pleon segment (epimeron) is hooked. C) Slightly digested *Byblis gaimardii*.

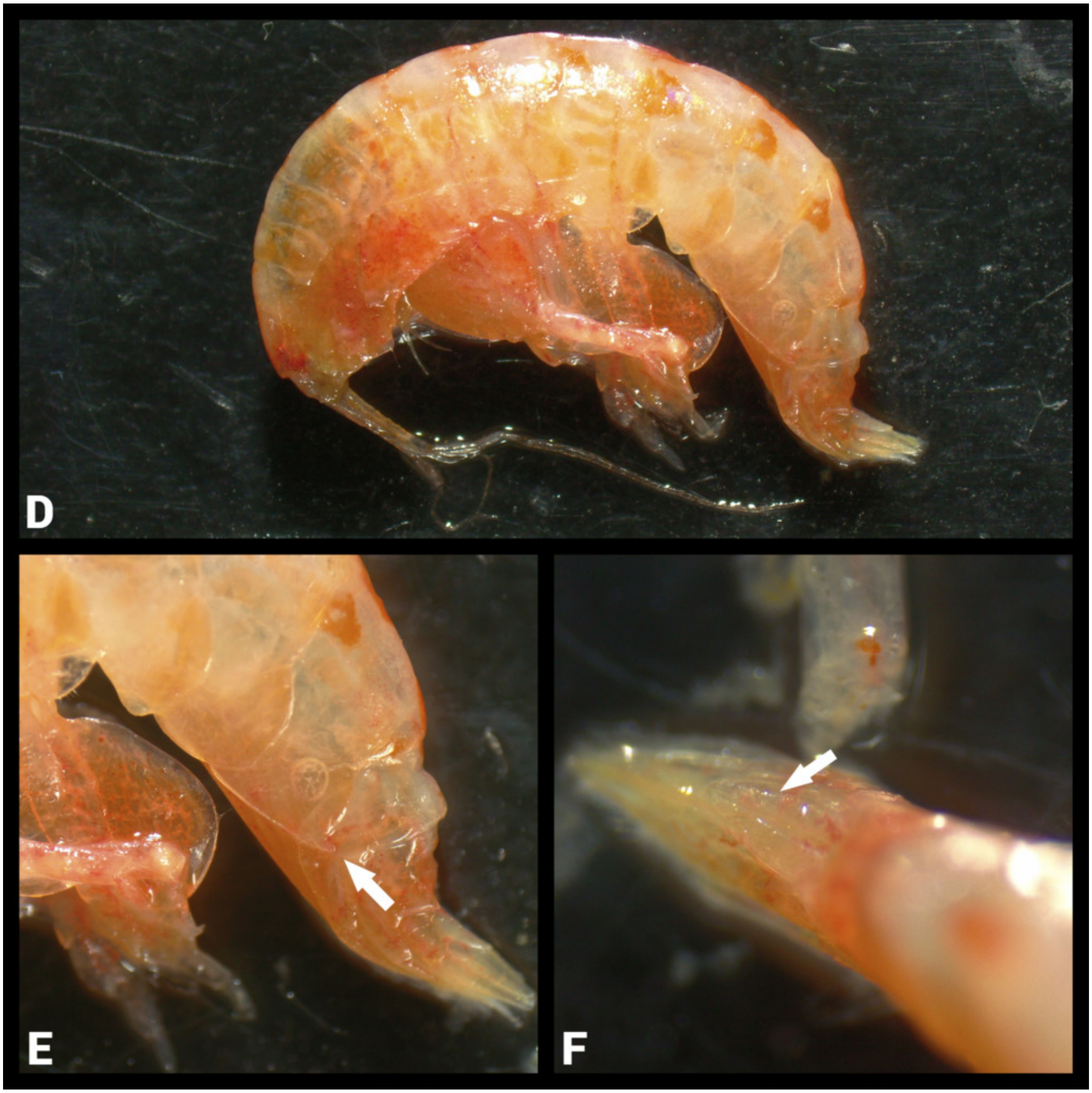


Figure 18. D) *Ampelisca eschrichti*. Note very long antennae, and body can be red, tan, or colourless. E) Bottom set of eyes are located in lower front corners of head, and directed laterally and downwards. F) Deeply cleft telson.

3.10 Aoridae (Family) - AphiaID: 101368

Description:

Also known as nest-building amphipods, the majority of species in this group are benthic organisms (epifaunal) that build tubes or nests of detritus and organic material that are stuck together using the animals secretions or attached to the substrate. The body is usually smooth and slender with coxal plates that are medium to small in size and usually separated at the base. Very short rostrum with a blunt head lobe, and with eyes positioned laterally at base (Figure 19). The first antenna is longer than the second, and accessory flagellum is almost always present. Sexual dimorphism is strongly illustrated in the first gnathopods and second antenna. Both gnathopods are subchelate and often complexly subchelate in the first gnathopods of males. Telson is short, deep, and entire, often with widely paired apical cusps (Figure 20).

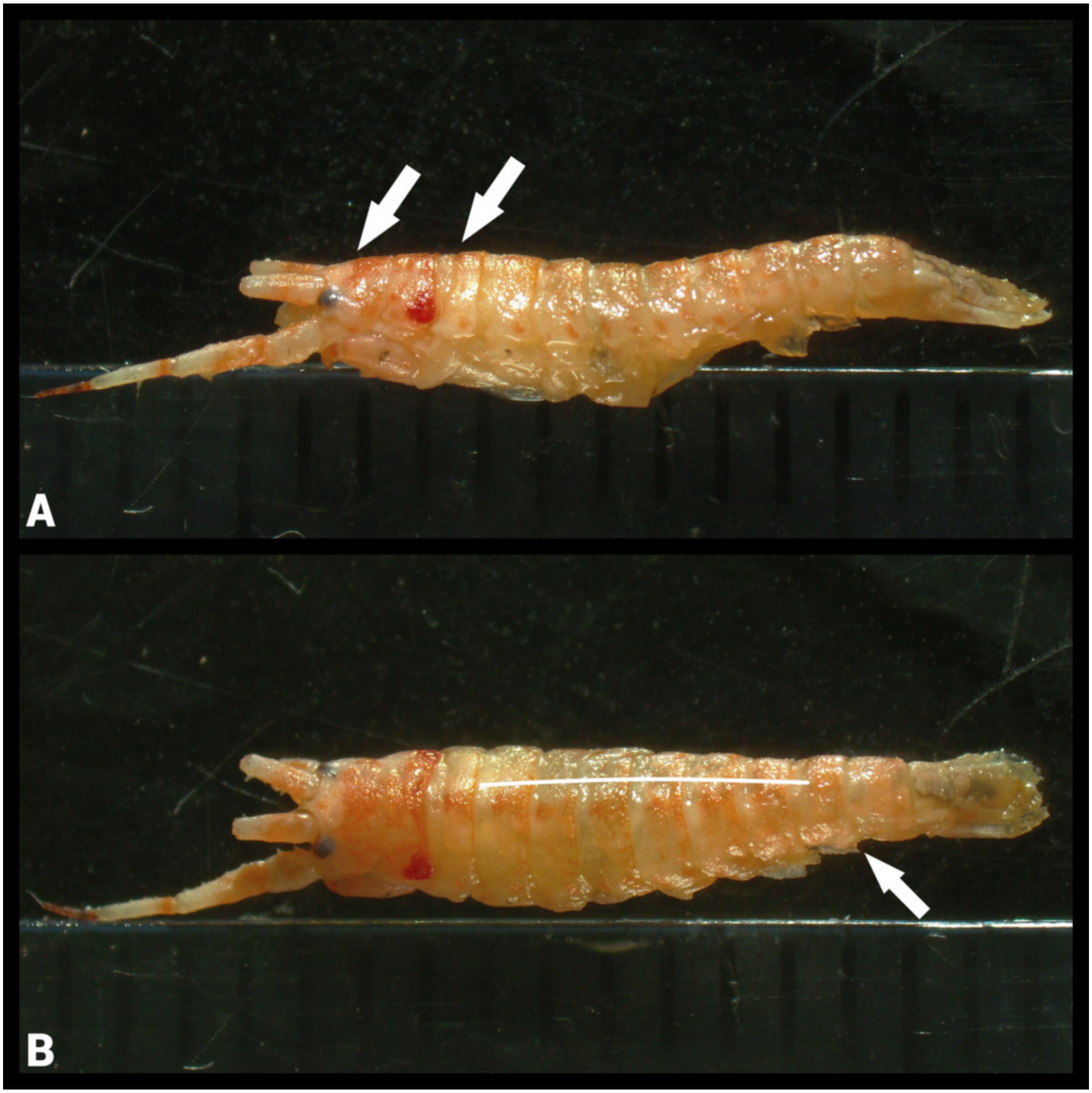


Figure 19. **Aoridae**. A) *Unciola irrorata*. Red middorsal band and lateral hook on last abdominal segment bends distinctly upwards. B) Red spots on side and length of second antenna segment clearly longer than the first segment. Eyes are small, black and oval in shape.

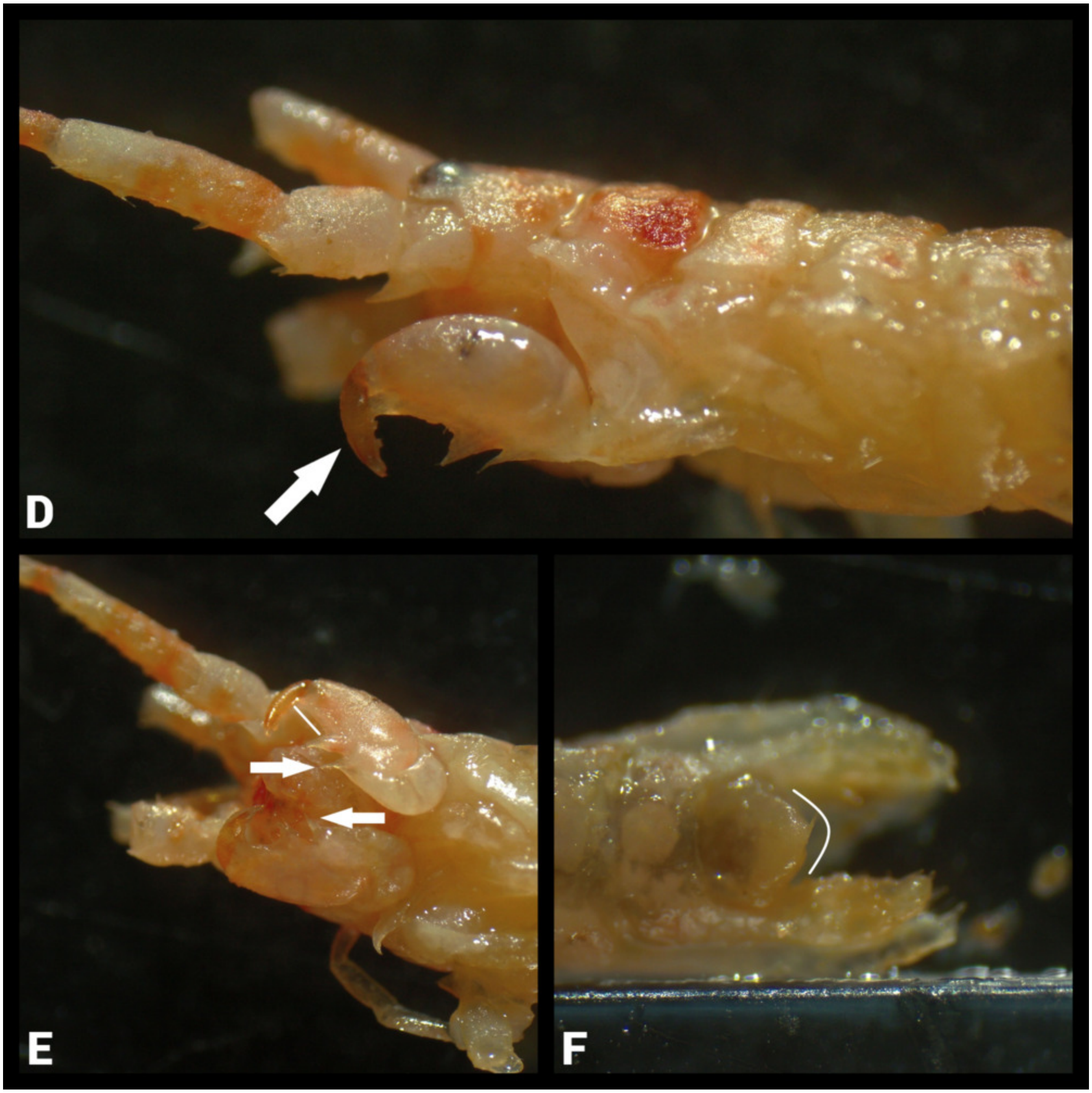


Figure 20. C) Powerful and stout, subchelate gnathopods. D) First gnathopod has straight palm, small prominence near hinge; posterior angle, prominence with stout apical spine; dactyl is setose or serrate behind. E) Noncleft subovate (almost egg-shaped) telson.

3.11 Caprellidae (Family) - AphiaID: 101361

Description:

Also known as “Skeleton shrimp”, Caprellidae are a group of amphipods with elongated bodies and several pairs of pereopods (Figure 21). Although several species do inhabit deeper waters, they are typically found within shallower intertidal and subtidal areas. Commonly associated with eelgrass, hydroids, and bryozoans (Figure 22E). See Figure 99 for anatomical features of Caprellidae (Guerra-García 2014).

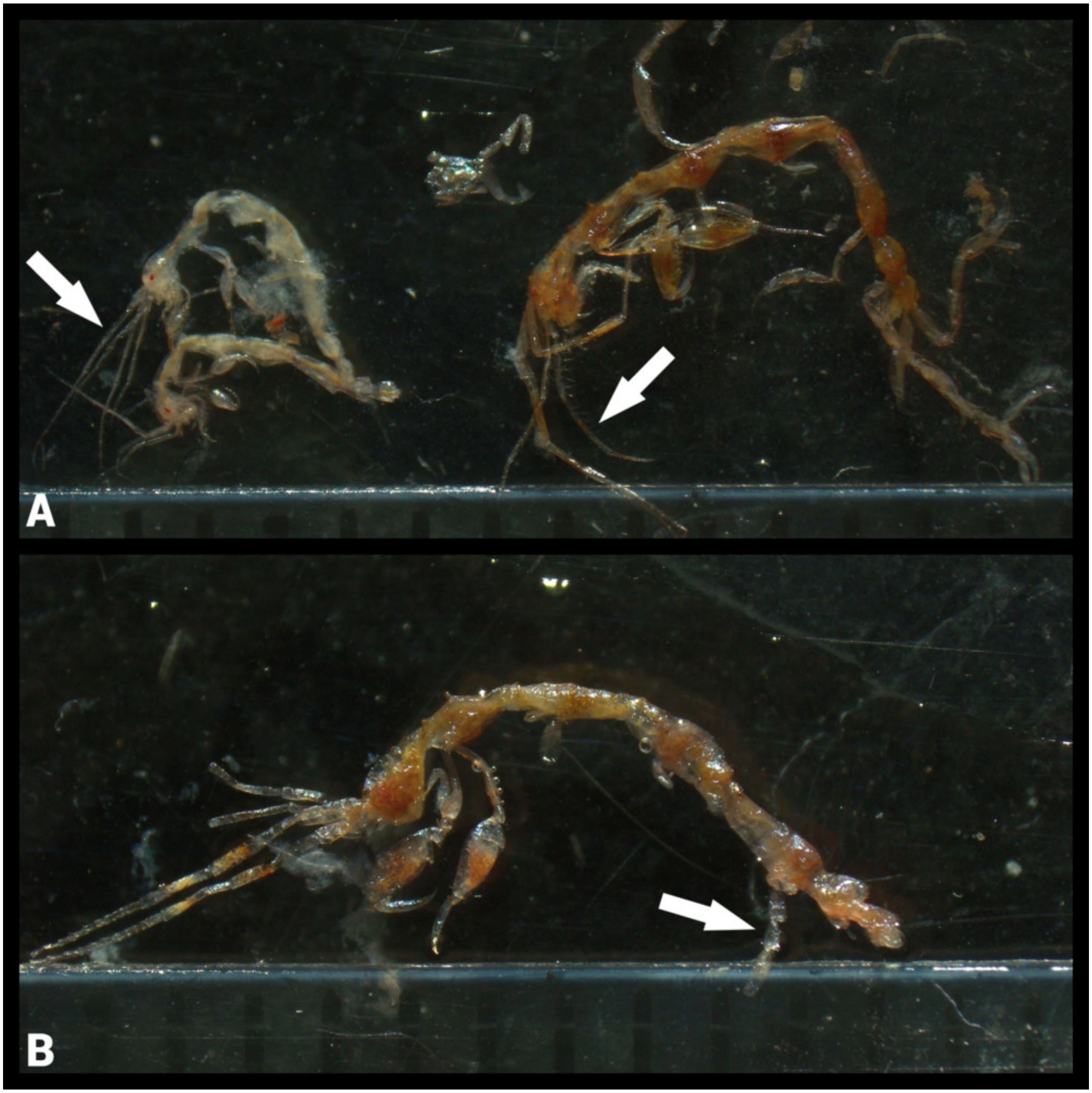


Figure 21. **Caprellidae**. A) Possibly Long-horned skeleton shrimp (*Aeginina longicornis*) or another *Caprella* species. Note very long antennae, and body can be red, tan, or colourless. B) Slender elongated body with a pair of rear legs for holding onto hydroids, ectoprocts, or seastars.

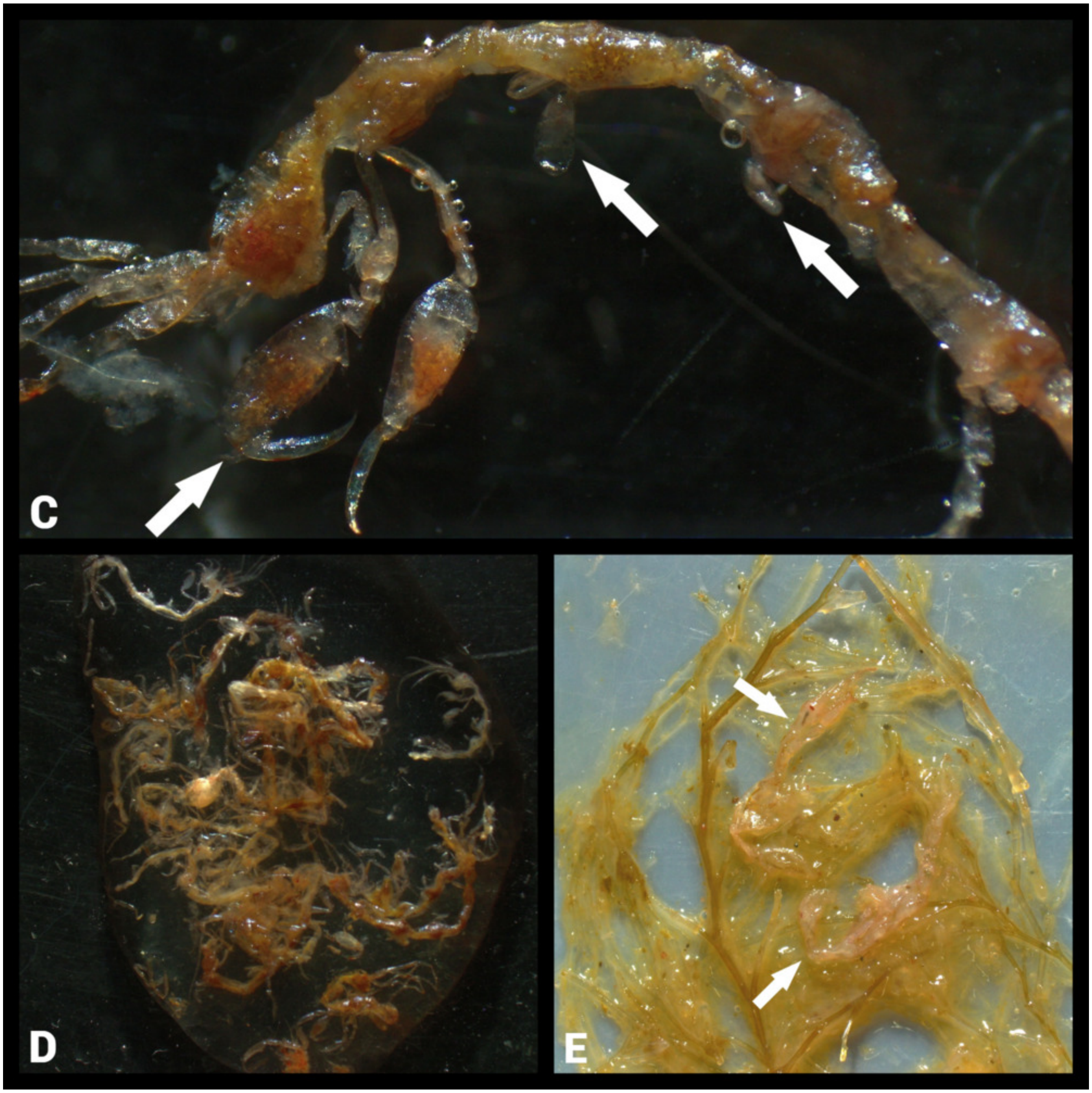


Figure 22. C) Two mid-body segments that each house a pair of stalked, oval-shaped gills, and a large pair of gnathopods. D) A large grouping of Caprellidae. E) Caprellidae hidden amongst the seaweed.

3.12 Corophiidae (Family) - AphiaID: 101376

Description:

Most species in this family are tube-dwellers and have a cylindrical body shape with long antennae that assist with acquiring food from outside the burrow. They are typically considered "suspension feeders" or "surface detrivores", which means they trap and collect food out of the water column or scavenge through detritus on the benthic surface for food items. This group generally has smooth bodies with a visibly depressed urosome, short and shallow coxal plates that are separated at the base, and a short head and rostrum. The first set of antennae are slender and shorter than or equal to the length of the second pair of antennae, and lack an accessory flagellum. The segments on the second pair of antennae are often very stout (especially in males), and the flagellum is short.These segments of the antennae are used for identification. They also possess a short and fleshy telson (Figure 23C).

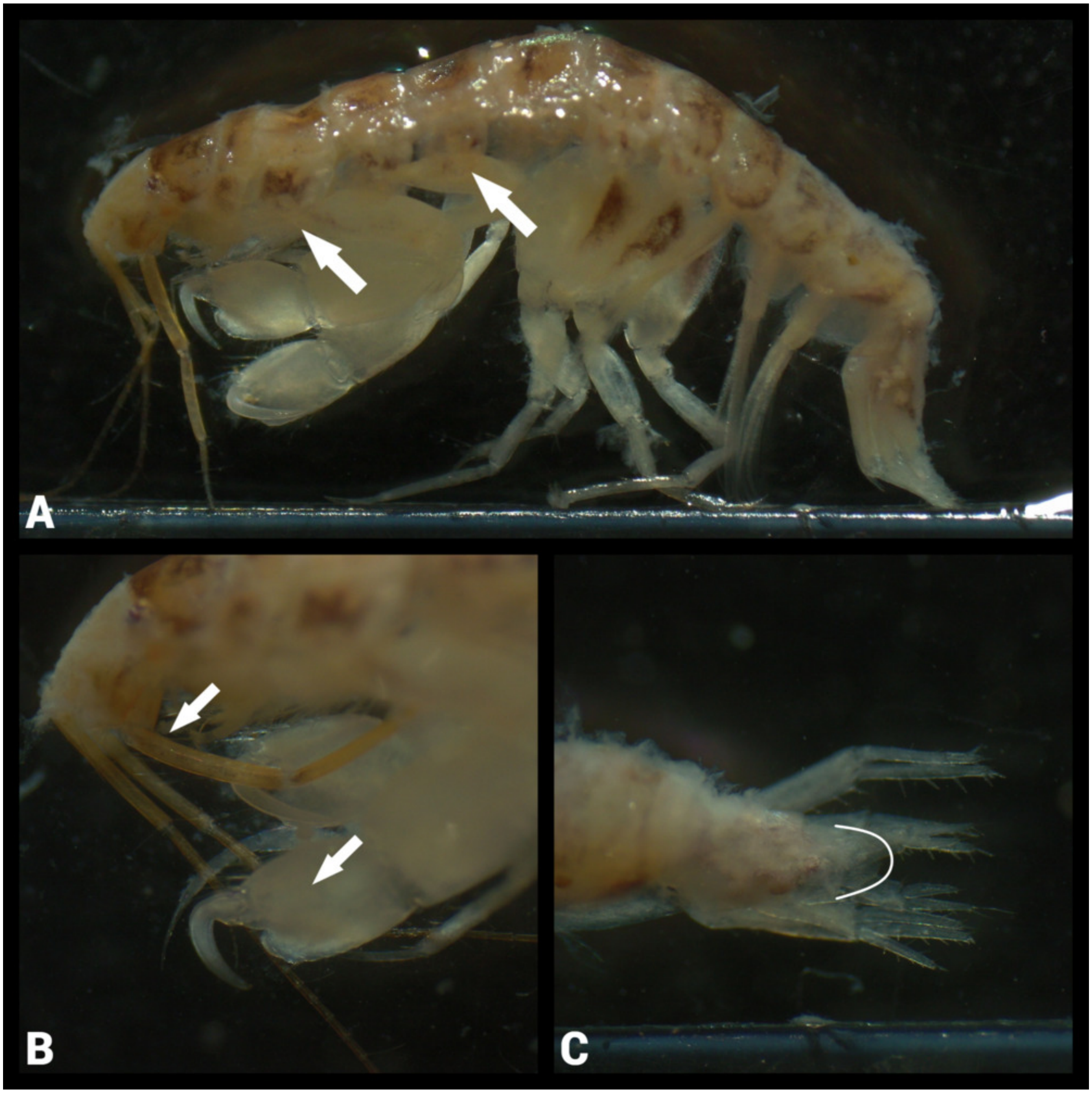


Figure 23. **Corophiidae**. A) cf. *Cerapus*. Short and shallow coxal plates that are separated at the base. B) Large, powerful subchelate gnathopods and stout second antenna segments that are often seen in males of this family. C) Short and fleshy telson.

3.13 Dexaminidae (Family) - AphiaID: [101378]

Description:

This family typically has moderately compressed bodies (often with dorsal spines), urosome dorsally carinate or humped, weak rostrum, large eyes on well-developed anterior head lobes, weakly subchelate gnathopods, and a large deeply cleft telson (Figure 24).

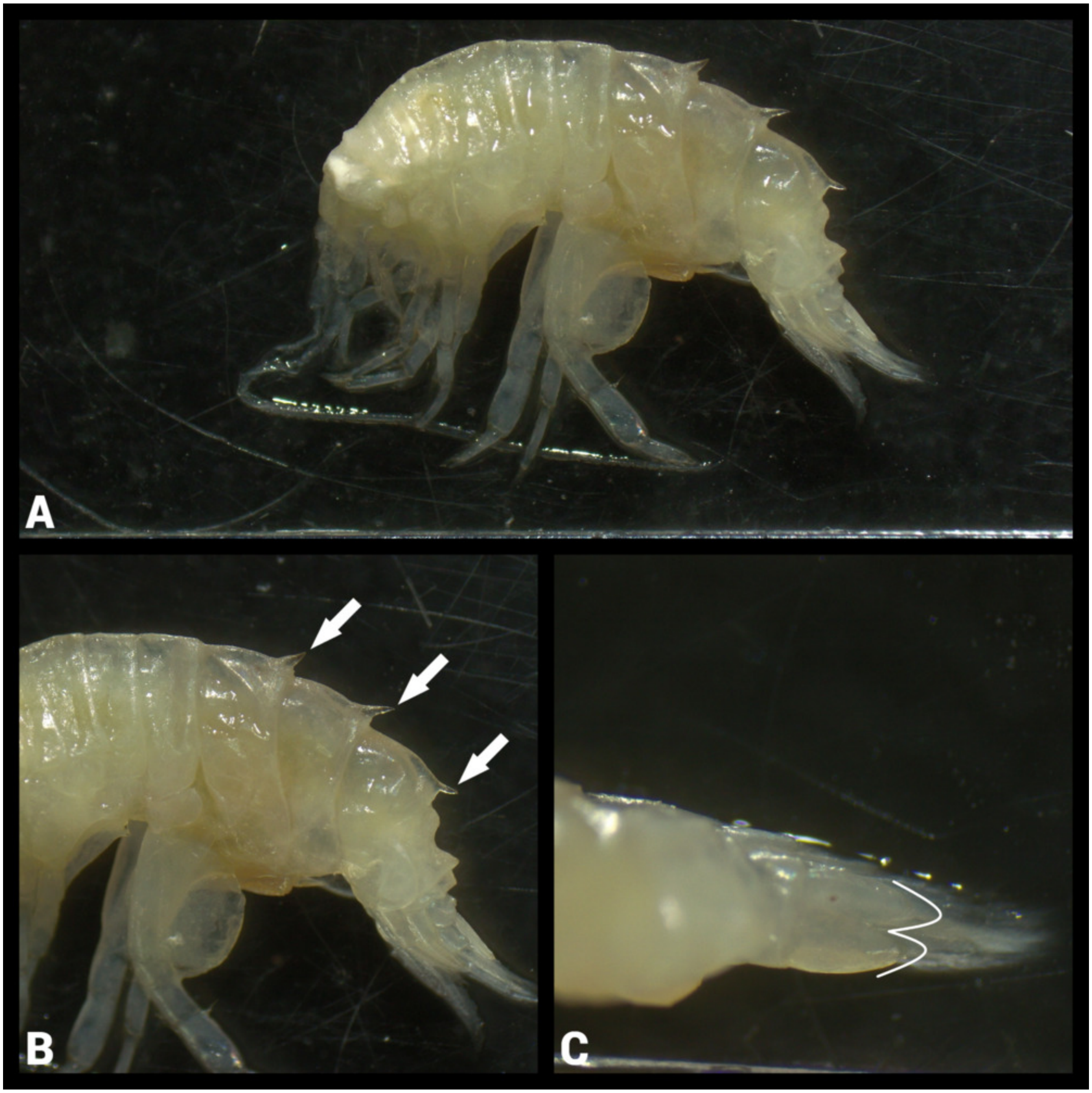


Figure 24. **Dexaminidae**. A) Dexaminidae, possibly *Dexamine thea*. B) Dorsal surface of pleon is mucronate. C) Telson is large and cleft.

3.14 Eusiridae (Family) - AphiaID: 101380

Description:

This family has a pleon that is dorsally carinate, mucronate, or both, small to medium deep coxal plates (usually smooth below), large well developed eyes, short thoracic segments, large abdomen, slender antennae, large and powerful subchelate gnathopods, and a large, tapering, narrowly cleft telson (Figure 25, 26).

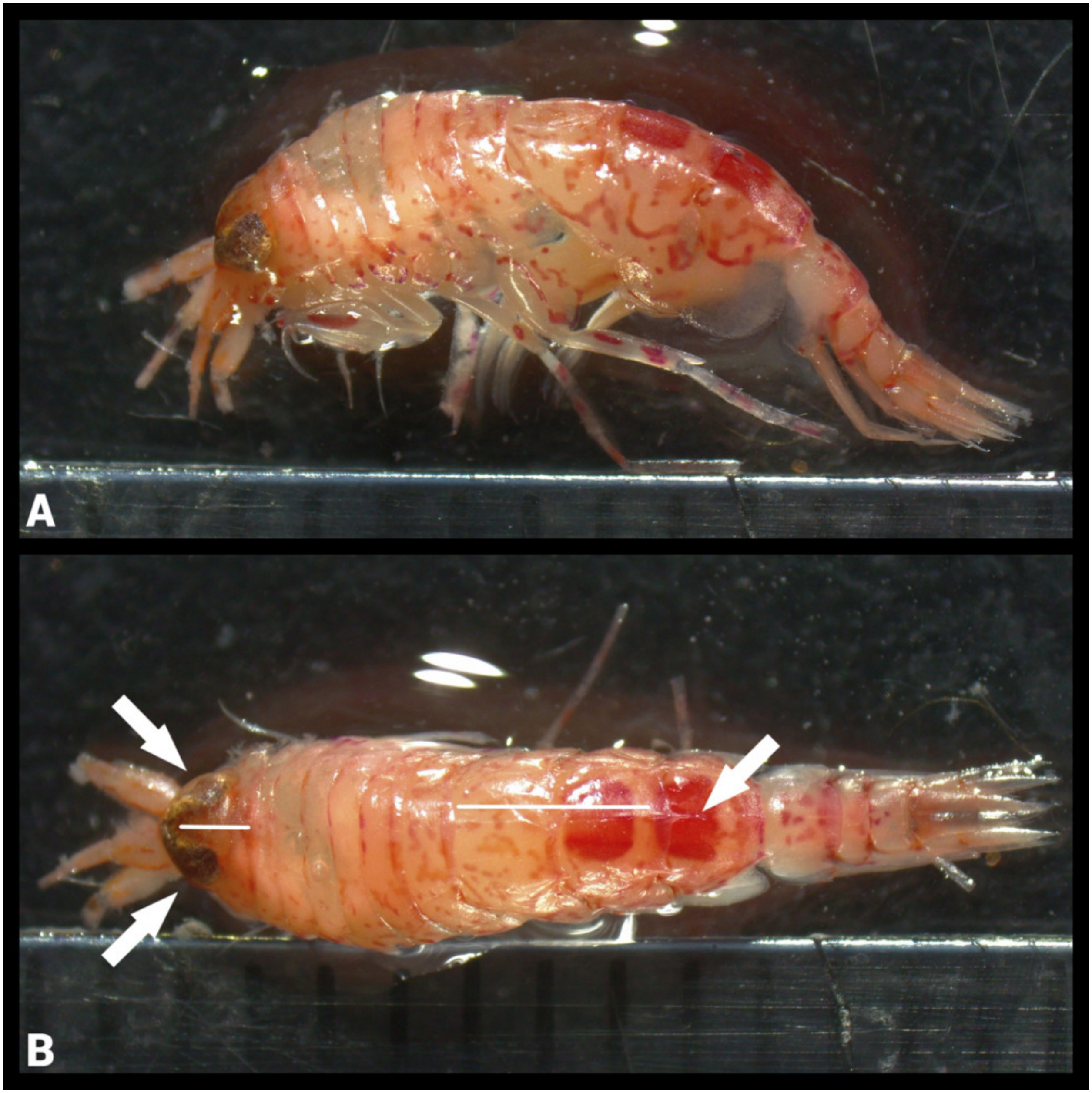


Figure 25. **Eusiridae**. A) *Rhachotropis oculata*. Coxal plates are small and deep, thoracic segments short, abdomen large and powerful. B) Very large eyes that meet middorsally, pleon with single dorsal and dorsolateral low carina and posterior tooth.

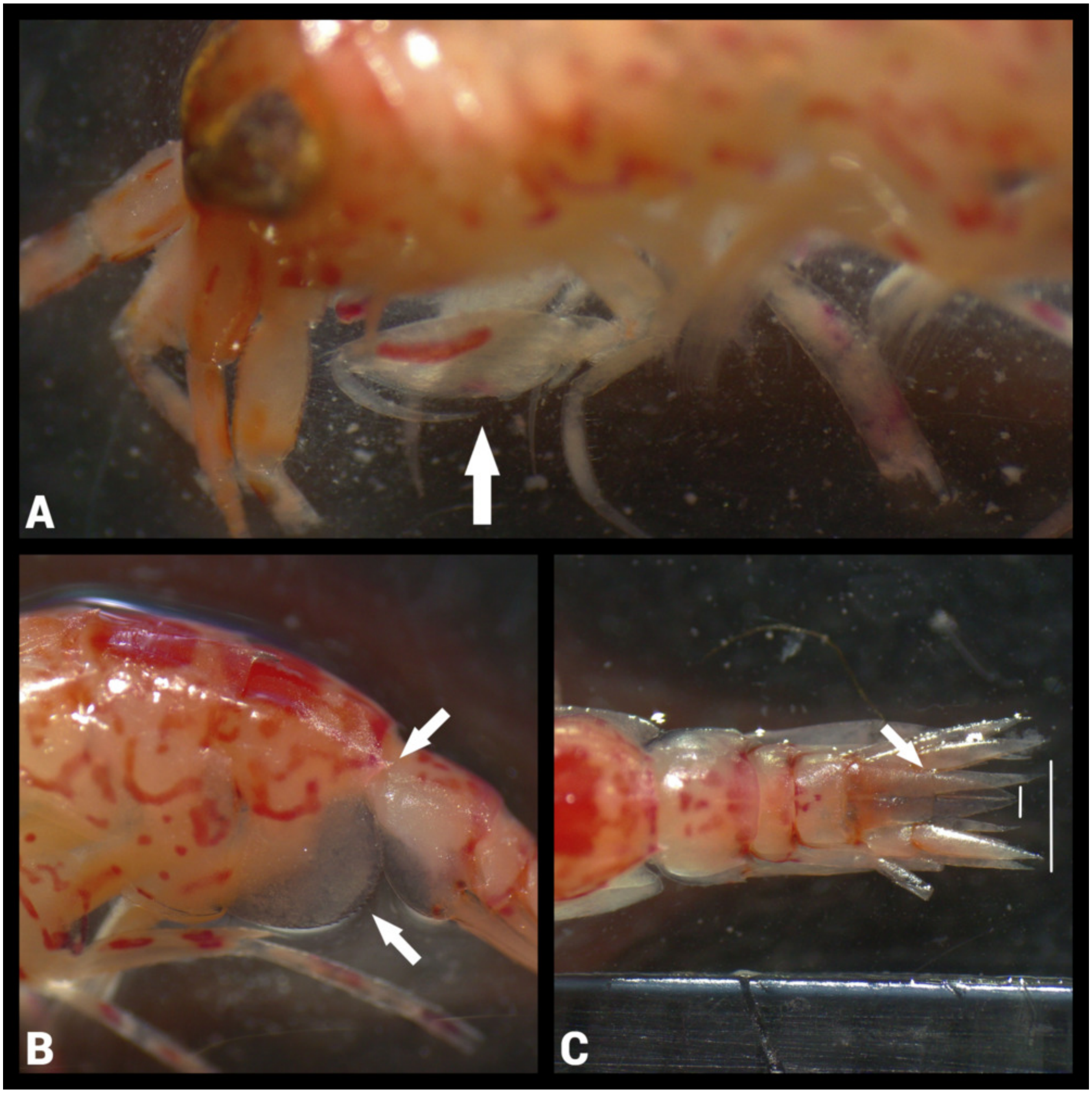


Figure 26. *Rhachotropis oculata*. C) Large subchelate gnathopods that are longer than deep. D) Third pleon segment with approximately 20 posterior marginal serrations and hooked dorsolaterally. E) Large, tapering, narrowly cleft telson that does not reach to tip of uropods.

3.15 Hyperiidae (Family) - AphiaID: 101417

Description:

A group of laterally compressed amphipods that are characterized by a first pair of walking legs located on the thorax and huge lateral eyes that cover the sides of the head (Figure 27, 28). These amphipods are pelagic animals that are often found offshore. Adults of this group are most often observed in commensal relationships with gelatinous macroplankton. Jelly fish and salps are generally the hosts, although some species (*Themisto libellula*) (Figure 29) can also be pelagic organisms.

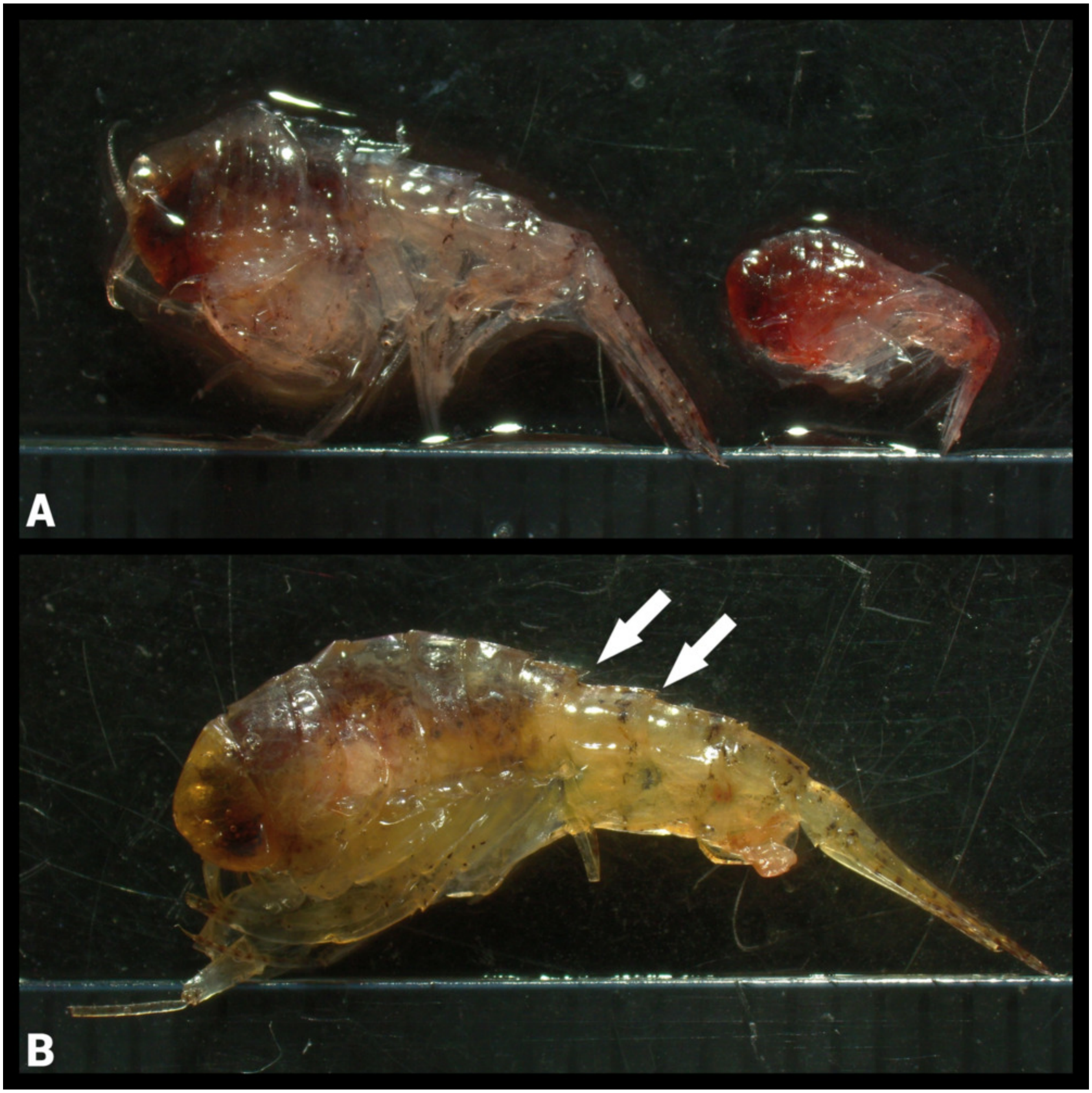


Figure 27. **Hyperiidae.** A) *Themisto compressa* on left (dorsal spine), and *Themisto abyssorum* on right. B) *Themisto compressa* is smaller than *T.libellula* and has dorsal spines.

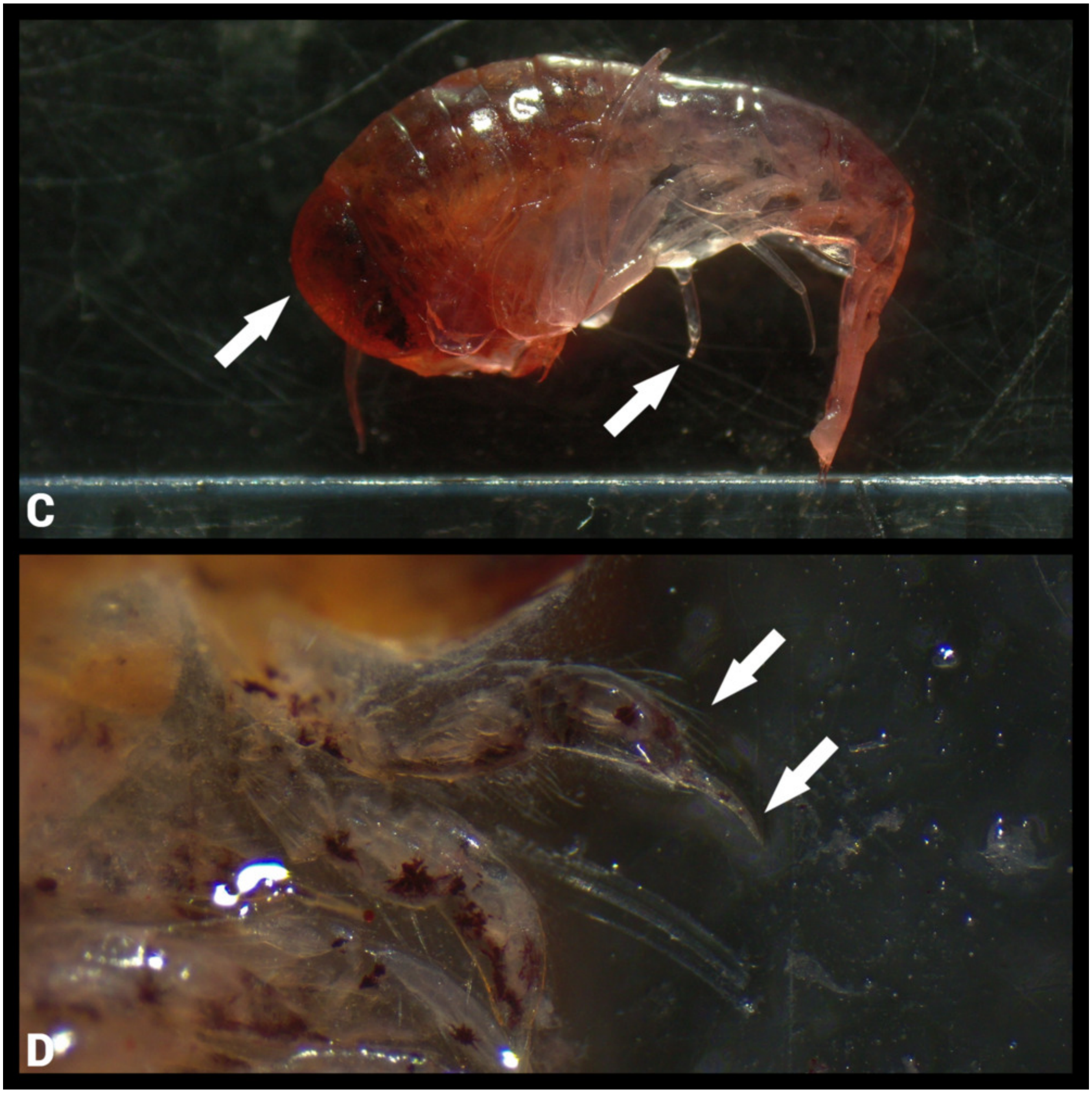


Figure 28. C) *Themisto abyssorum*. Large eyes, appendages less hairy than *Hyperia medusarum*. D) First appendages not chelate (lack pincers) and not especially hairy.

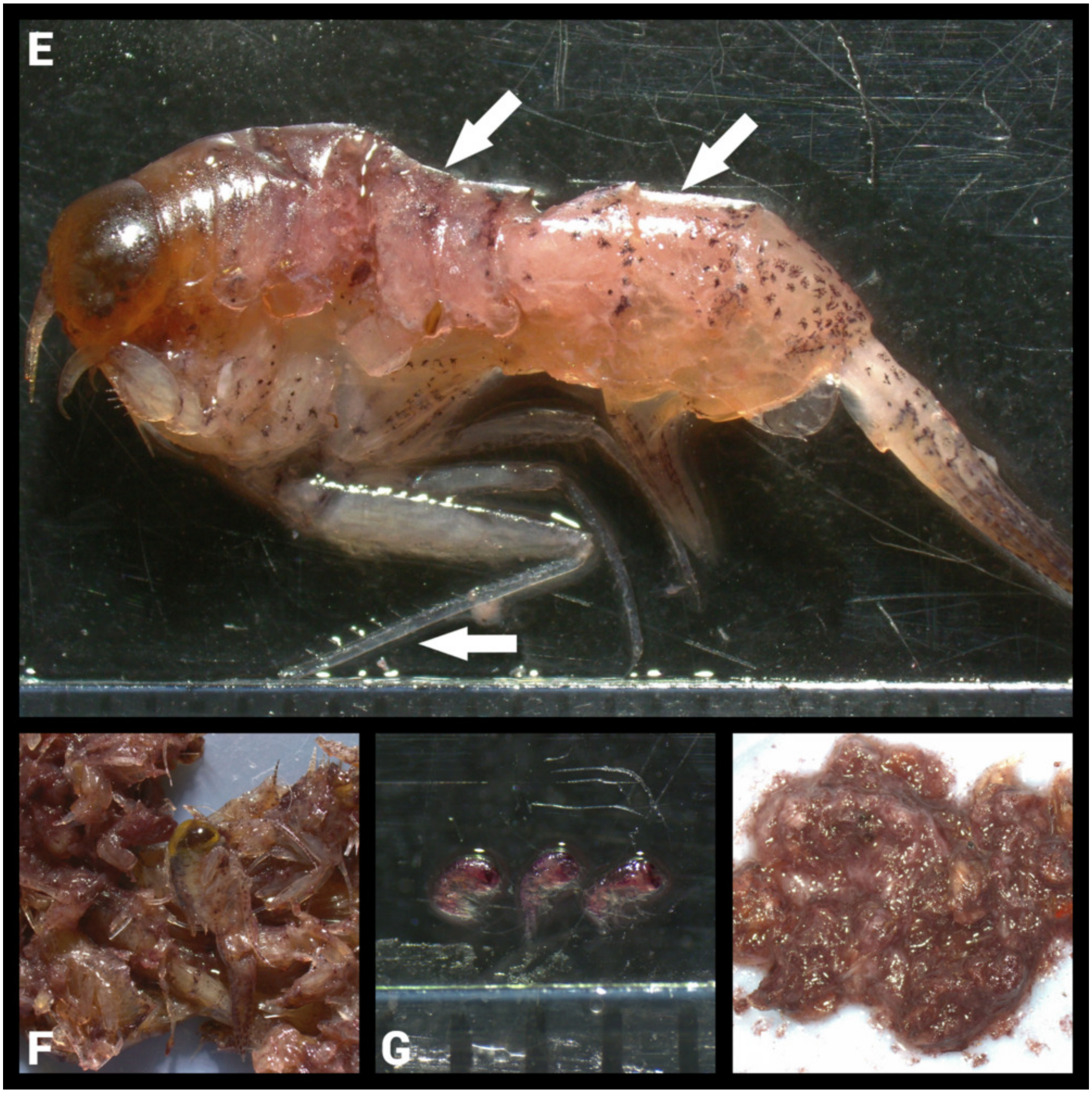


Figure 29. E) *Themisto libellula* is larger than *T. compressa*, has a smooth dorsal surface (no spines), and very long peraeopods. F) Group of lightly digested Hyperiids. G) Juvenile Hyperiids. H) Well digested Hyperiids. The purple colour and several less digested individuals aid in identification.

3.16 Lysianassidae (Family) - AphiaID: 101395

Description:

This family has deep, smooth bodies that are subcylindrical or subfusiform with hard exterior, coxal plates 1-4 large, deep, smooth below, 4th excavate behind (Figure 31), head has weak rostrum, large laterally positioned eyes, first antenna has an inflated, robust first peduncle, with short 2nd and 3rd segments, well developed accessory flagellum, and a telson that is usually deeply cleft, occasionally notched or entire (Figure 32G). The size, shape, and colour of the eyes are also diagnostic and aid in identification (Figure 30).

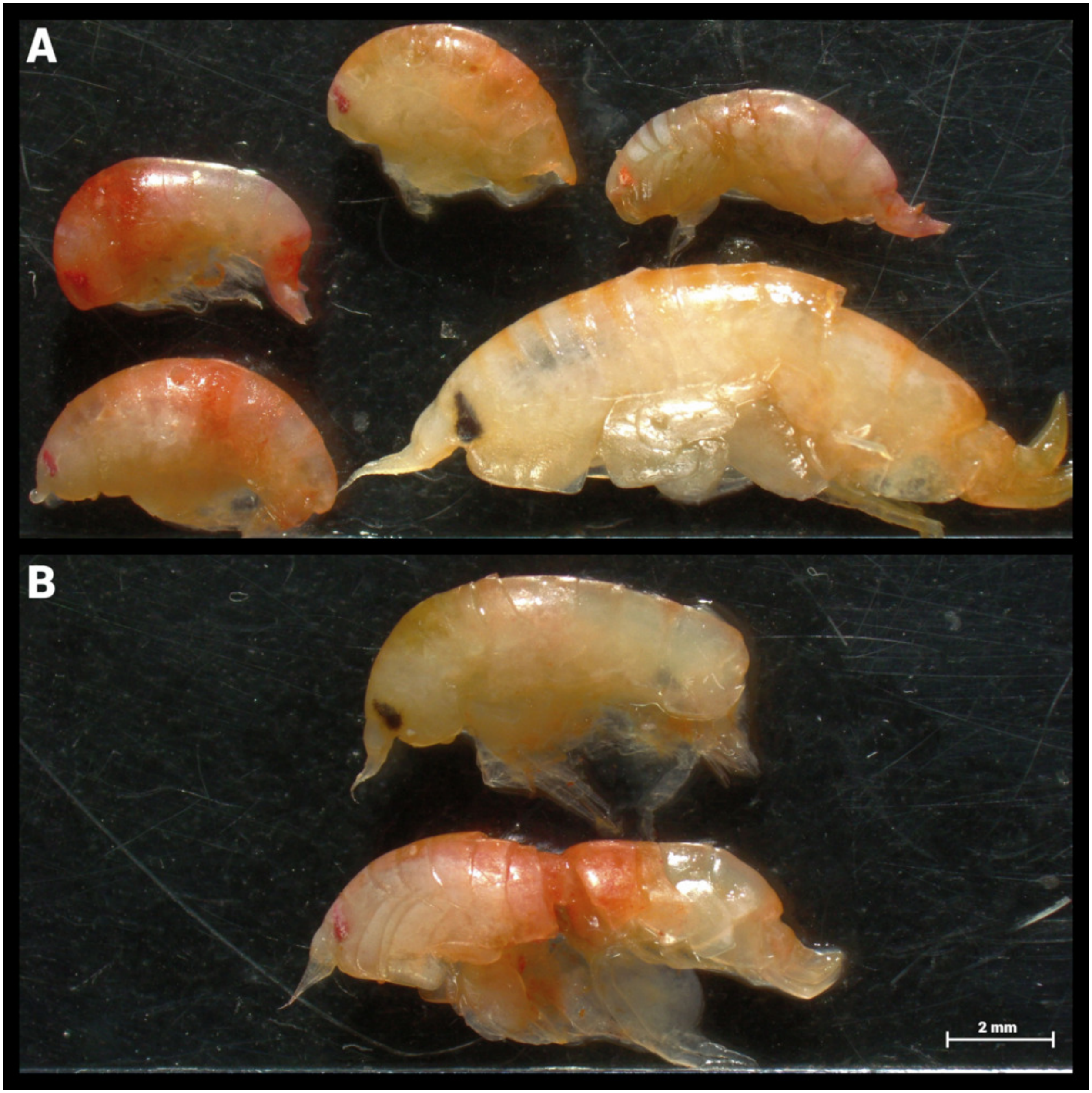


Figure 30. **Lysianassidae**. A) Assortment of Lysianassidae. Red-eyed, pear-shaped ones here are likely *Tmetonyx cicada* (or *Orchomenella*, *Orchomene*, *Hippomedon*—see Fig 31). B) *Hippomedon cf. robustus* below. Very large eyes that meet middorsally, pleon with single dorsal and dorsolateral low carina and posterior tooth.

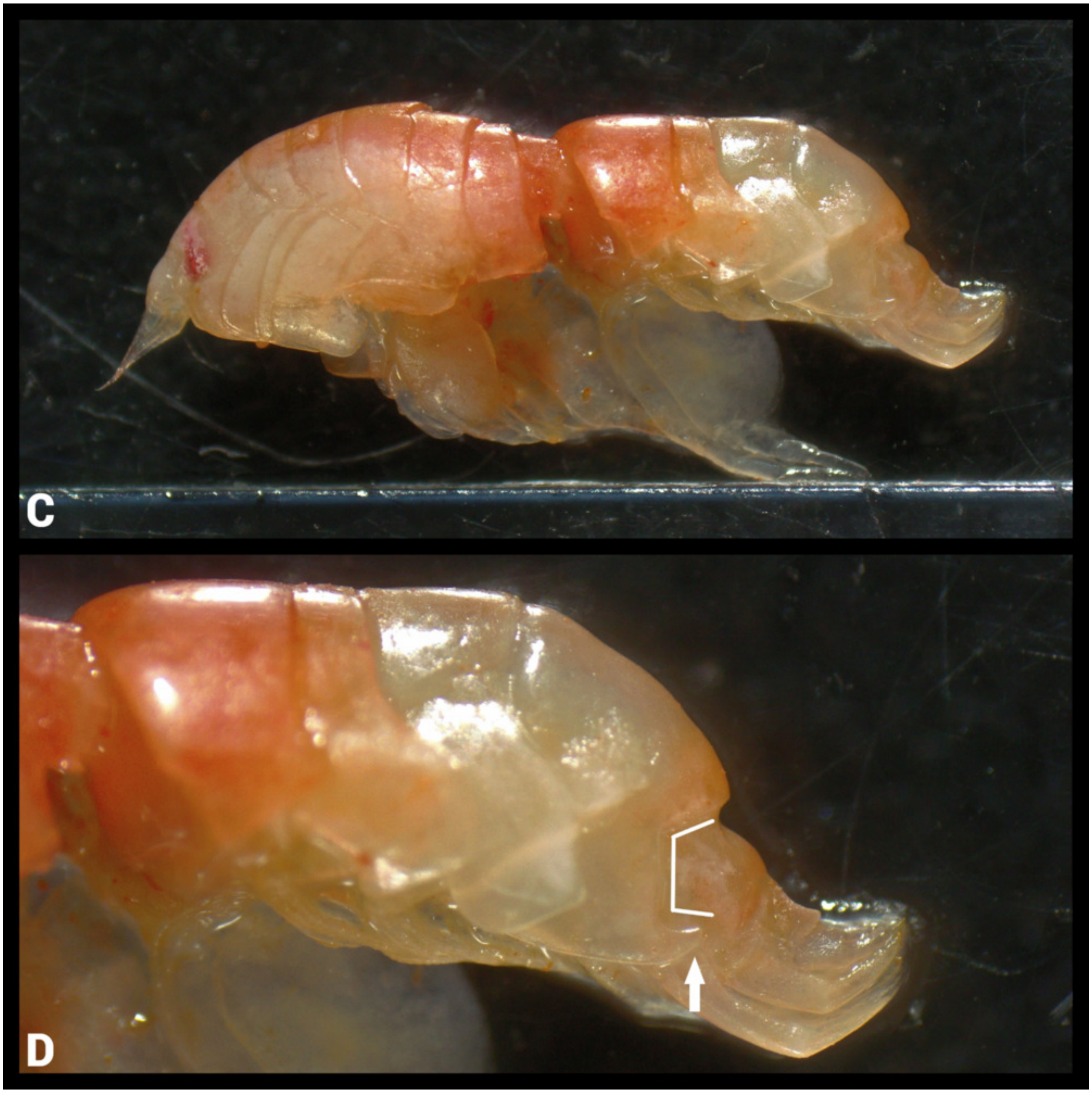


Figure 31. C) *Hippomedon*. Large red eyes, first four coxal plates large and deep. D) Note hooked hind corners.

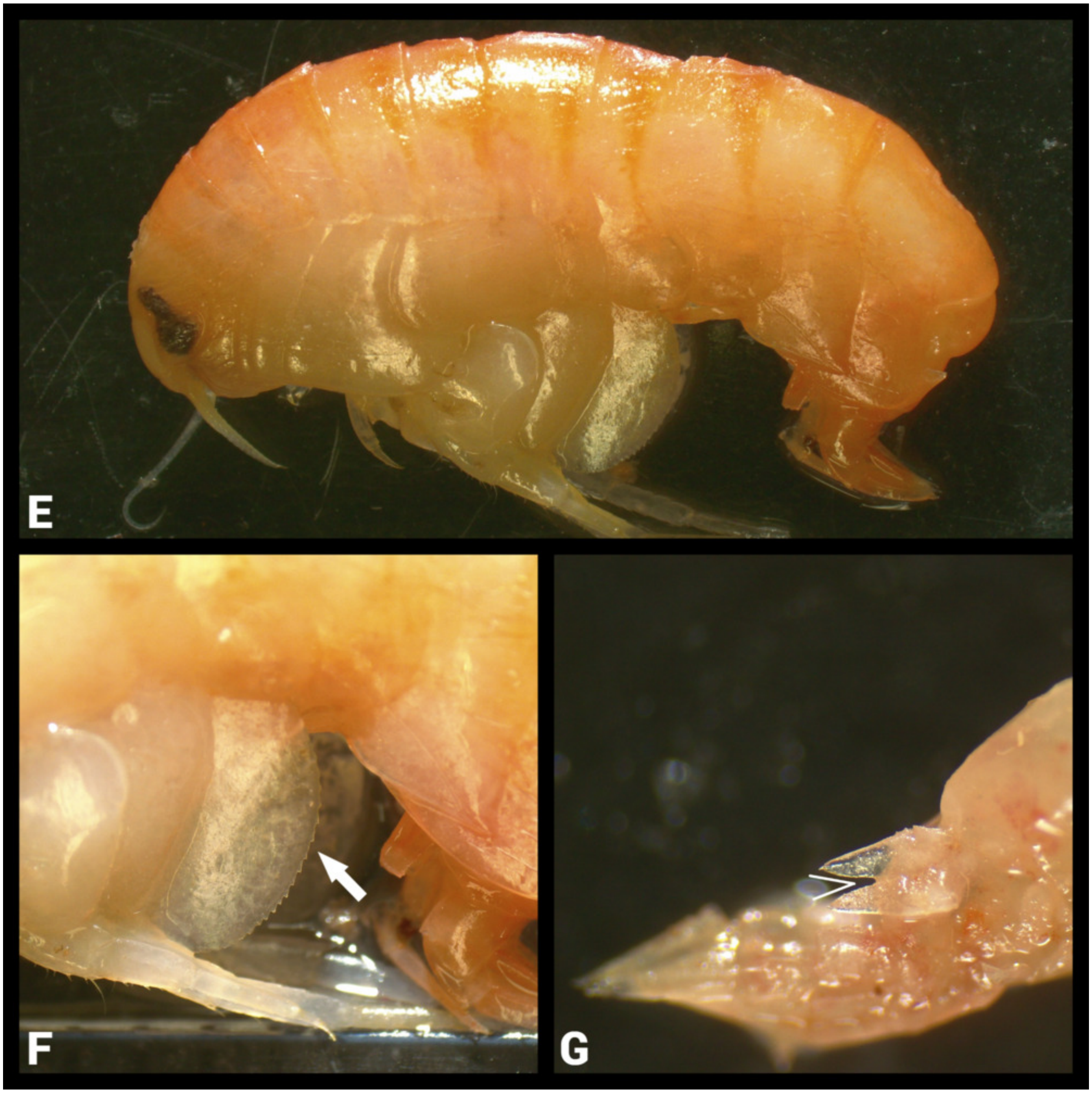


Figure 32. E) *Hippomedon serratus*. F) Last peraeopod has hind margin with numerous fine serrations. G) Telson lobes deeply V-cleft, apices somewhat diverging, subacute.

3.17 Melitidae (Family) - AphiaID: 101397

Description:

This family is characterized by a generally slender and anteriorly smooth body, shallow coxal plates that tend to separate at the base (Figures 33, 34), sexual dimorphism of gnathopods (second gnathopod is larger and more powerful than the first in both sexes, but especially in males), small rounded eyes, lacking a rostrum, rounded anterior lobe, and sharply incised antennal sinus, distinct abdominal segments, urosome, mucronate, dentate, spinose, or smooth, and a deeply cleft telson, lobes diverging, apices acute, with spine(s) (Figures 35, 36).

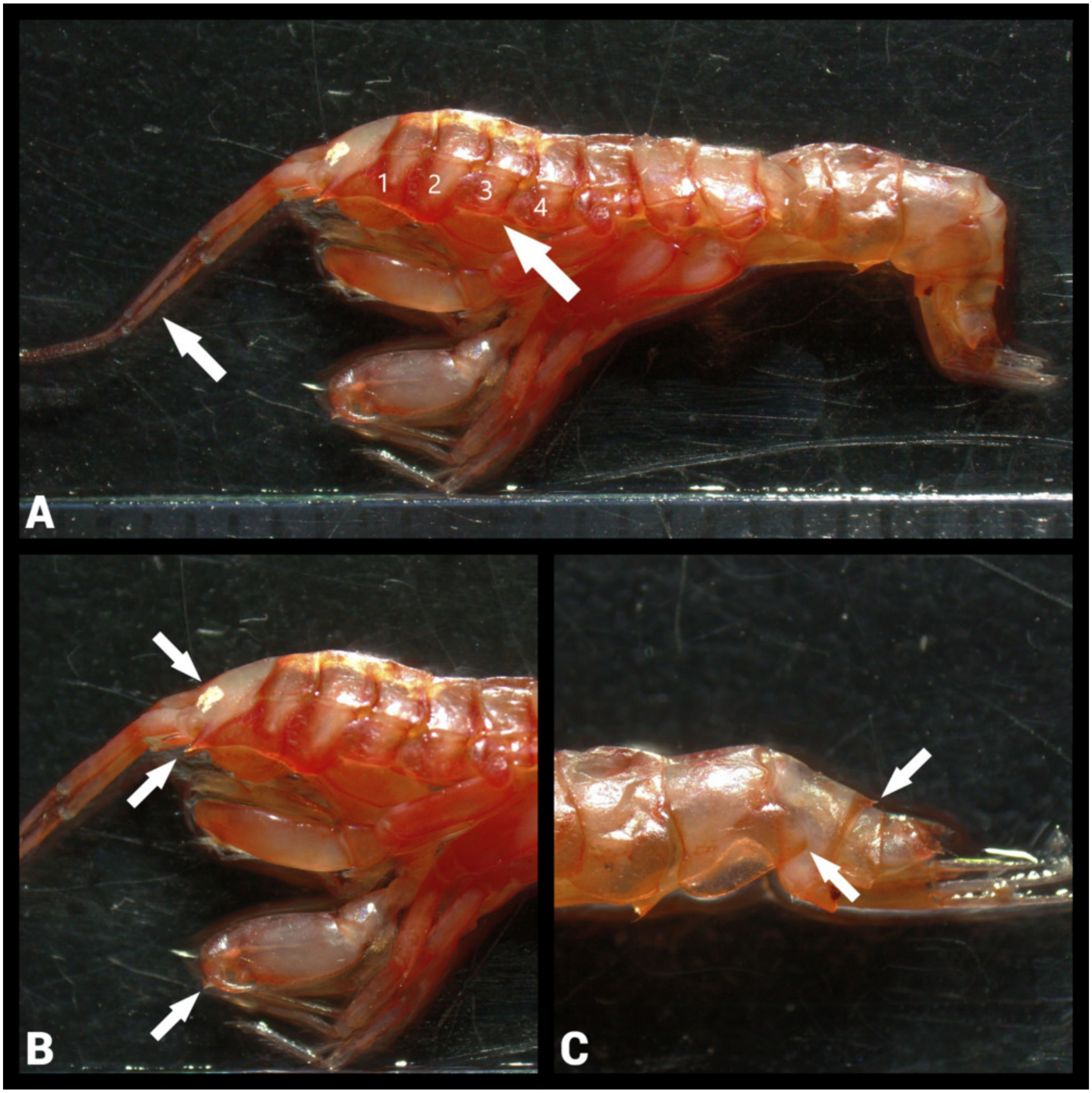


Figure 33. **Melitidae**. A) *Casco bigelowi*. Body slender, coxal plates three and four shallow, first antenna shorter than the second. B) Eyes weakly pigmented, anterior head lobe with sharp point, first gnathopod is sub-chelate (palm very short, and second gnathopod more powerfully subchelate (especially in males). C) Rounded hind quarters. First urosome with middorsal tooth.

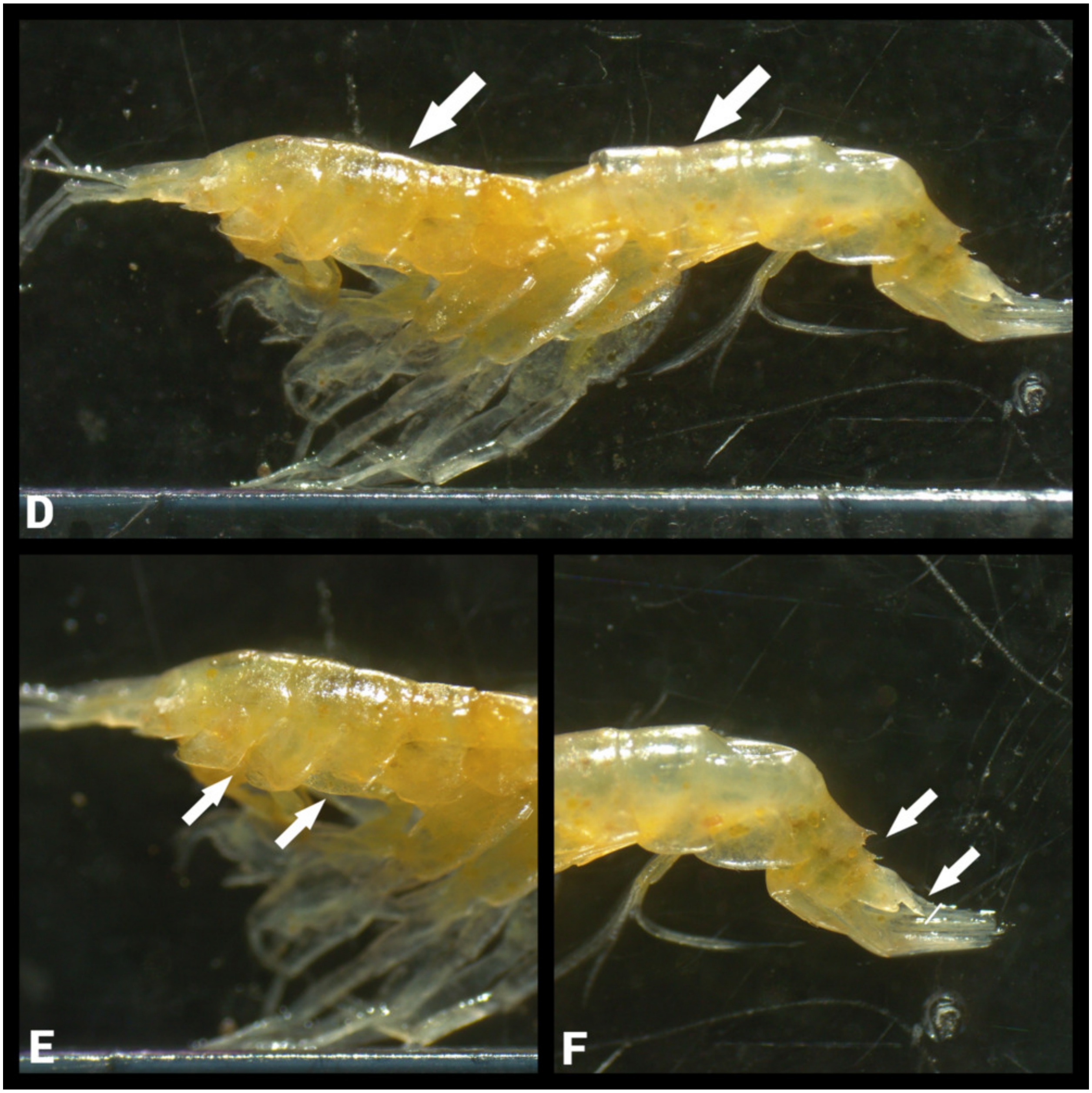


Figure 34. D) *Melita* species. Body slender, elongate, dorsally smooth. E) *Melita* (anterior end). Coxal plates shallow, smooth below, usually separated at base. Short head and rostrum, eyes small and rounded. F) *Melita* (posterior end). Short telson, lobes slightly diverging, first and second urosomes with middorsal teeth.

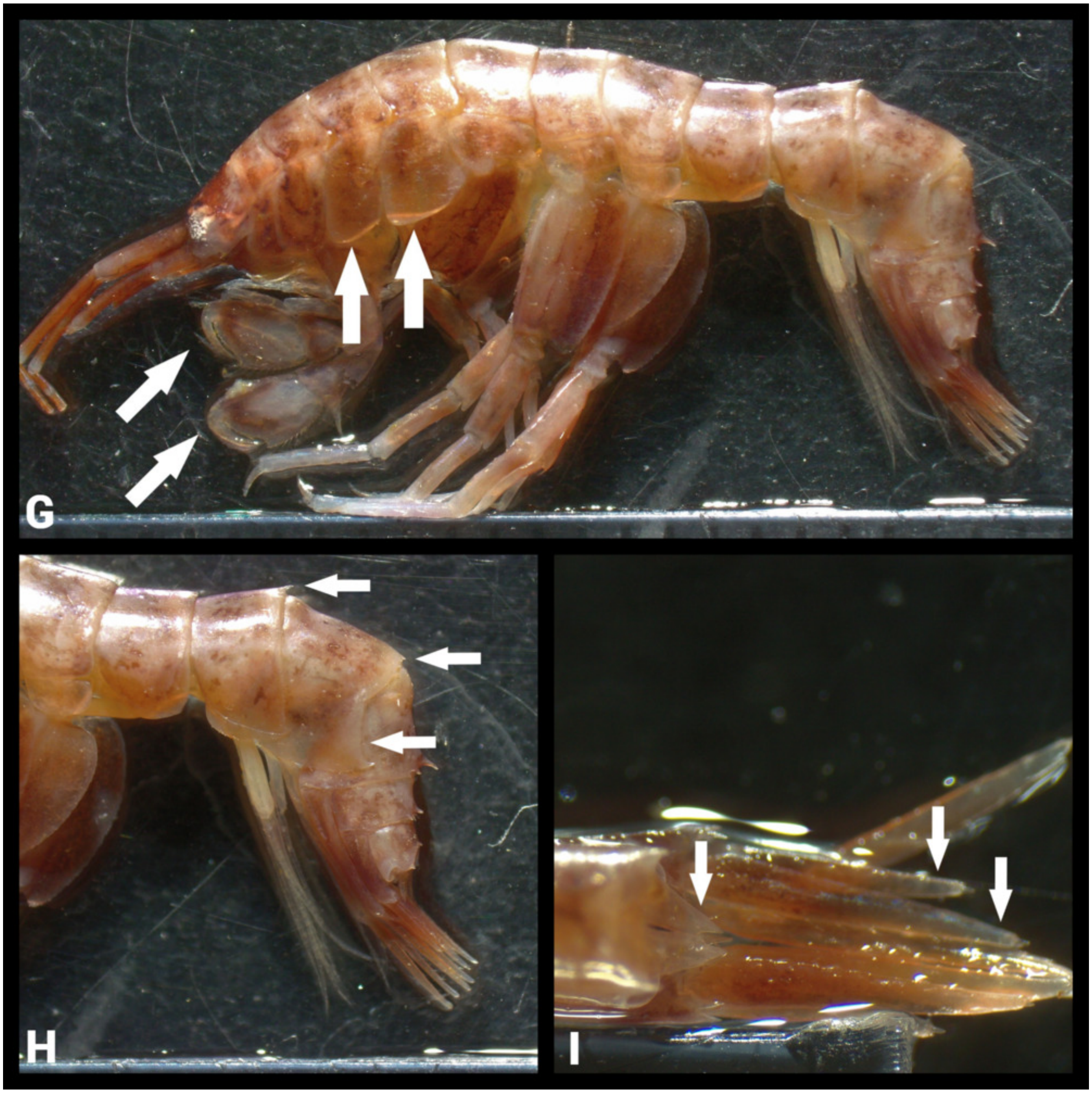


Figure 35. G) *Megamoera dentata*. Body slender, elongate. Relatively deep coxal plates, hind corner notched. Large powerful subchelate gnathopods. Second gnathopods with oblique palm, irregularly low-toothed, dactyl strongly curved, closing on acute angle. H) Pleosome and urosome segments with several teeth or mucronations, strong middorsal tooth. Last pleon segment hooked. I) Short telson that is deeply cleft, lobes diverging, apices acute. Uropods one and two short, uropod three long and slender.

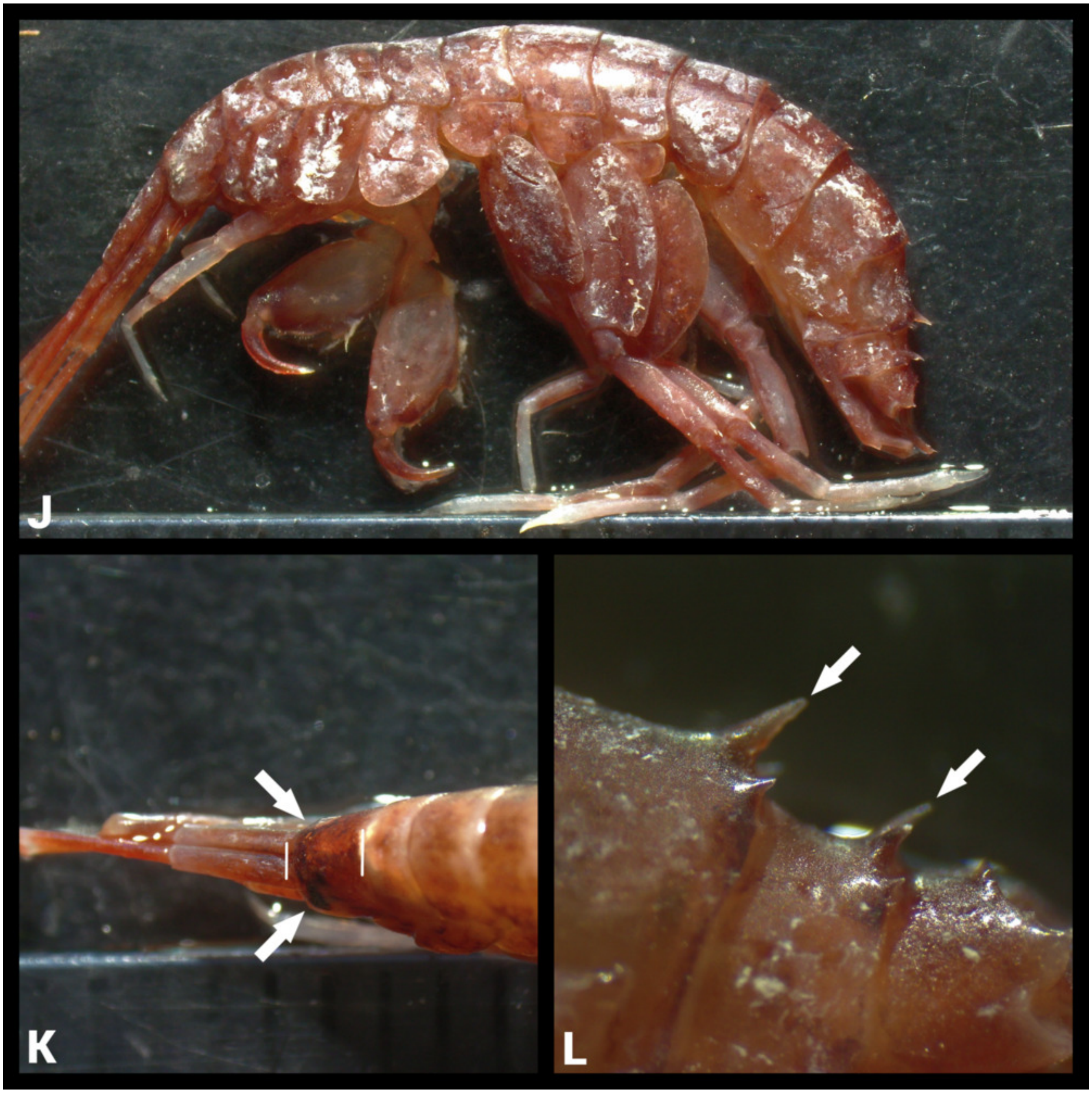


Figure 36. J) *Megamoera dentata*. K) Dorsal view of anterior region. Laterally compressed. Eyes small and lateral, head and rostrum very short. L) Closeup of paired teeth on urosome segments (key ID feature for this species).

3.18 Oedicerotidae (Family) - AphiaID: 101400

Description:

This family of “free-burrowing” (do not build tubes) gammarids have smooth bodies, large abdomens with a powerful pleon, a strong falcate rostrum, telson is entire and small, eyes are fused or approximated dorsally on or at the base of the rostrum (Figures 37, 38). Minimal sexual dimorphism in antennae only. The first antenna is usually shorter than the second, accessory flagellum is lacking or rudimentary. The flagellum in the second antenna is elongate in males.

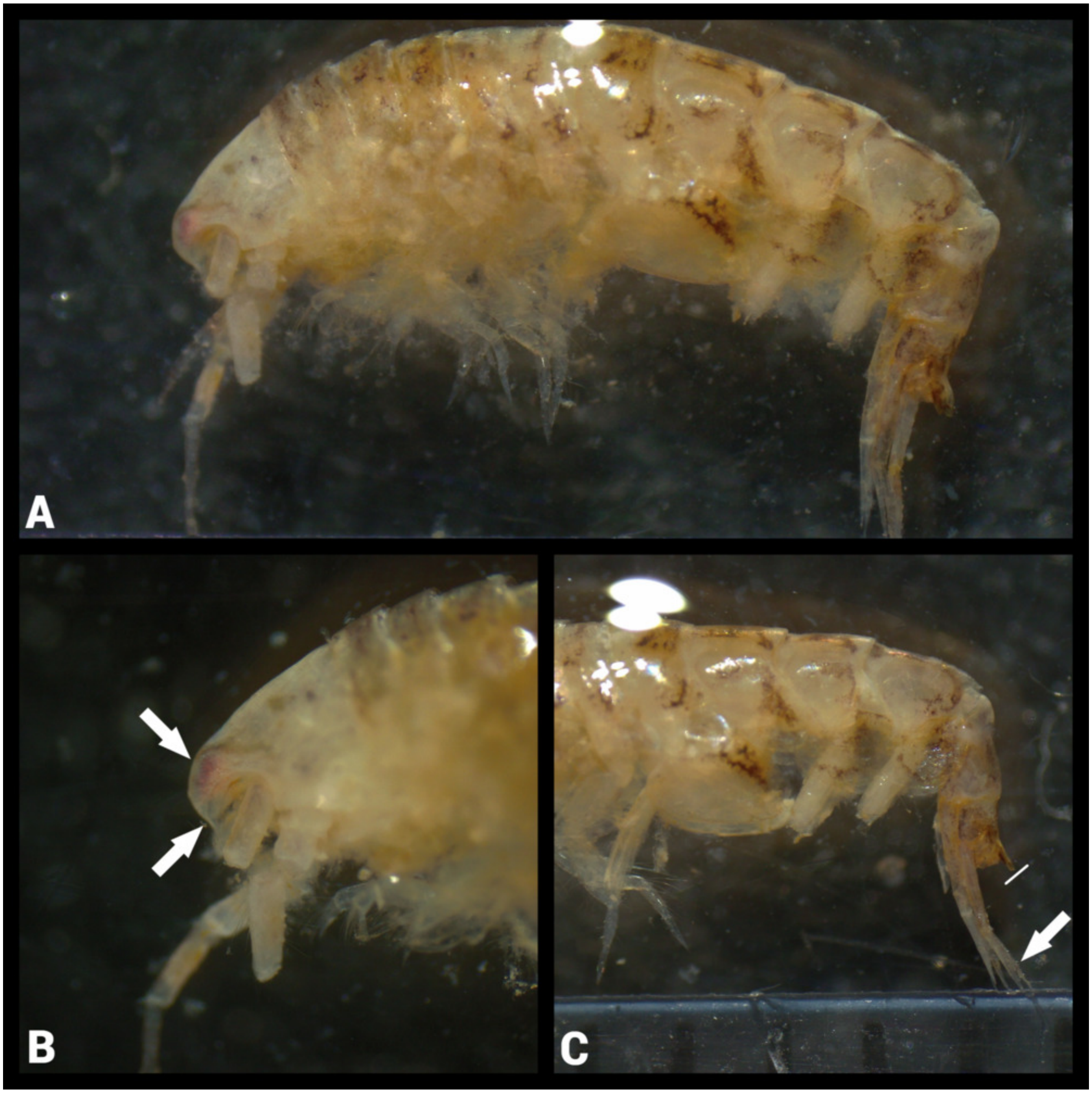


Figure 37. **Oedicerotidae**. A) *Monoculodes*. Smooth body, large abdomen, powerful pleon, coxal plates moderately deep. B) Closeup of anterior region. Strong falcate rostrum, eyes contiguous on dorsal border of head. C) Posterior region with peraepods and/or third uropod often elongate, “rudder”-like. Telson entire and small.

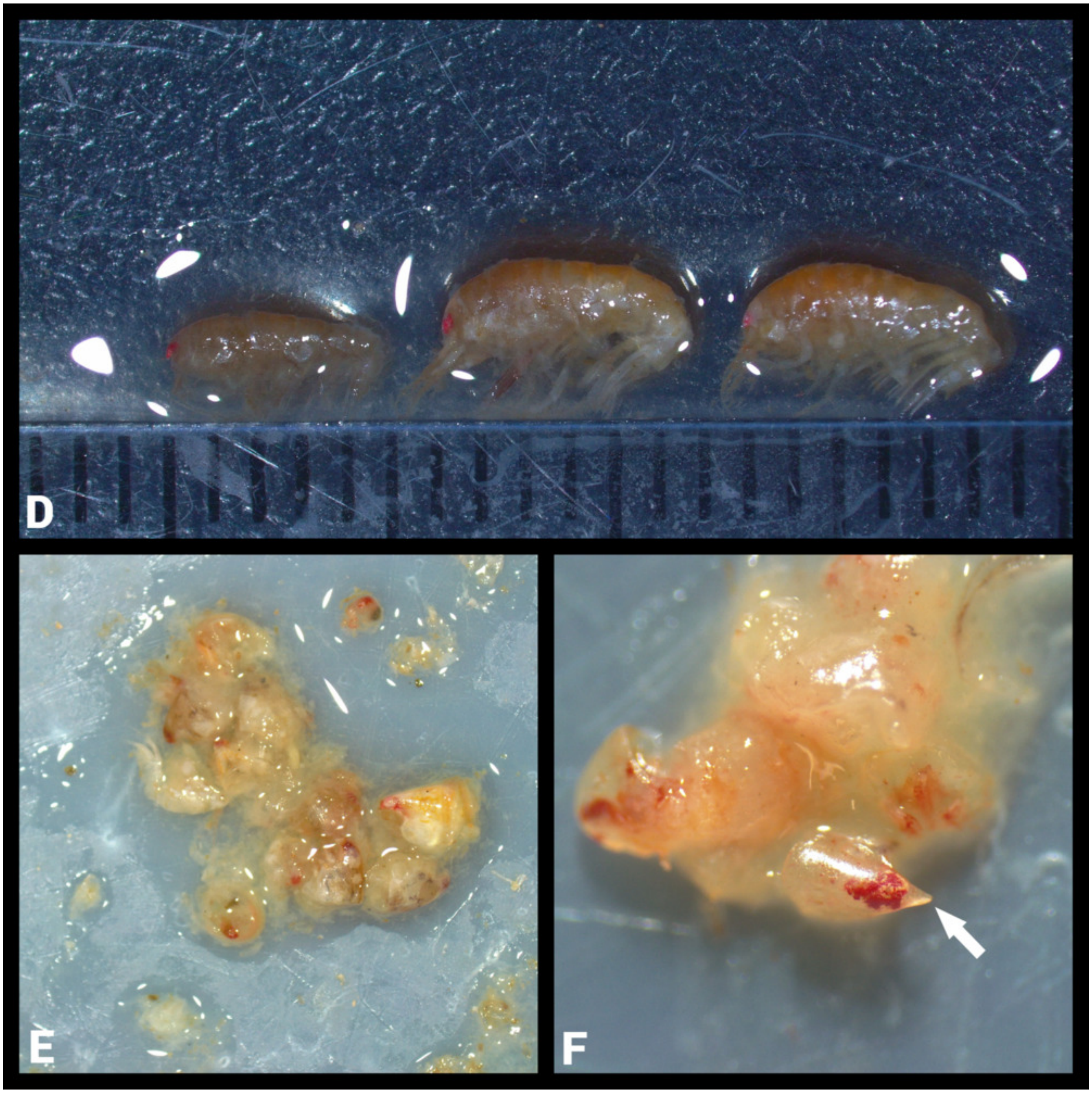


Figure 38. D) Oedicerotidae. E) Partially digested Oedicerotidae. F) Head and rostrum of partially digested Oedicerotidae. Head is distinct and can be used as a gross separation feature.

3.19 Phoxocephalidae (Family) - AphiaID: 101403

Description:

This family is characterized by a fusiform smooth body shape (dorsal aspect), deep coxal plates, head with rostrum overhanging base of antennae, usually in the form of a broad hood, antennae are short and vertically inserted (bases separated), accessory flagellum well developed, sexual dimorphism is pronounced except in gnathopods, and telson entire or deeply cleft (lobes approximate) (Figures 39, 40). Second antenna is elongate, calceolate, and third uropod fully foliaceous in males.

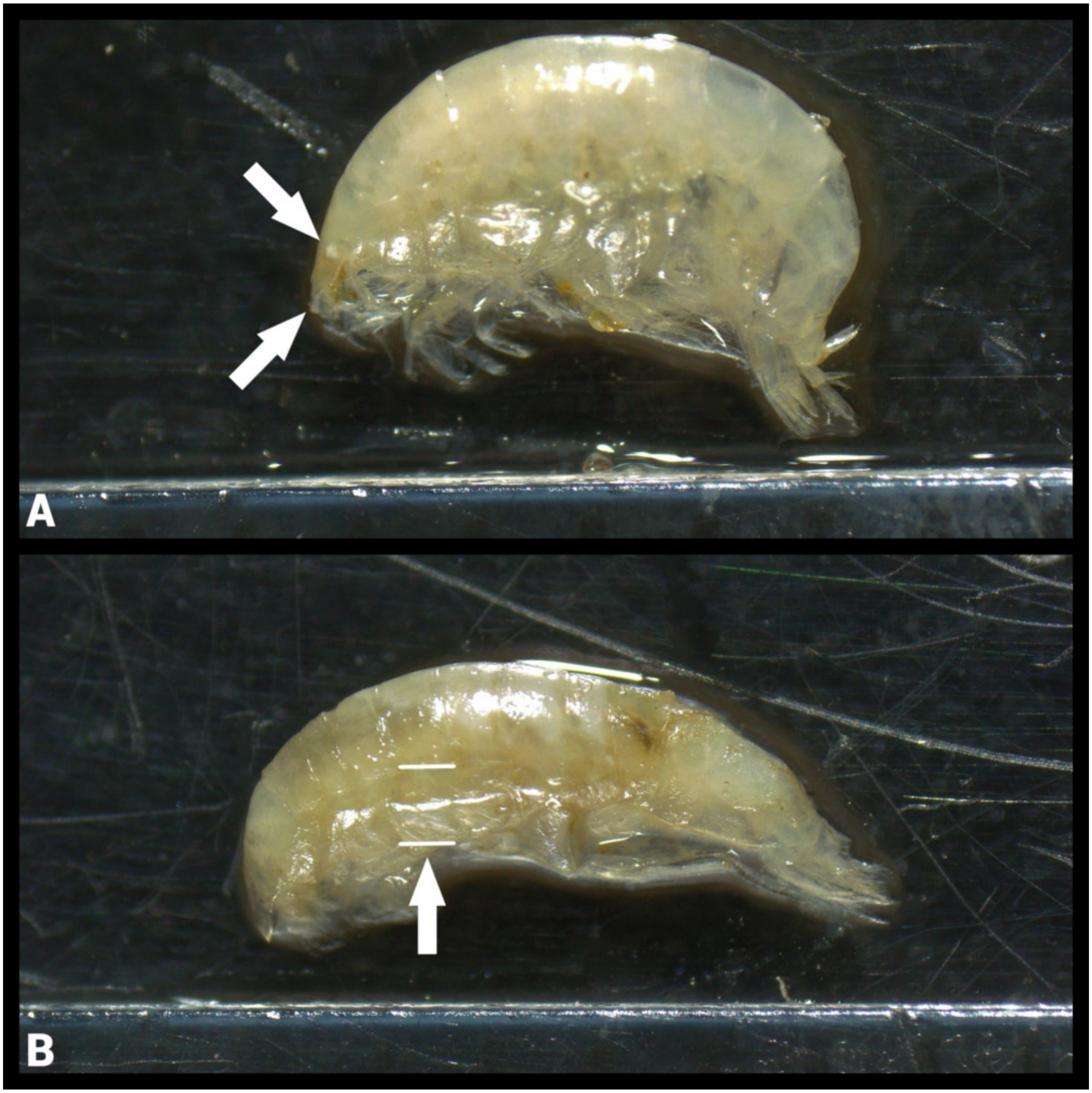


Figure 39. **Phoxocephalidae**. A) *Phoxocephalus holbolli*. Body slender-fusiform, coxal plates lined with long moderately simple setae. Head with broad hood, rostrum overhanging base of antennae. Eye small, oval, and unpigmented. Second antenna is very long (much longer than first antenna). B) *Harpinia propinqua*. Body small, very slender-fusiform. Coxal plates deep, lower border with many, fine setae (fourth plate wider than deep).

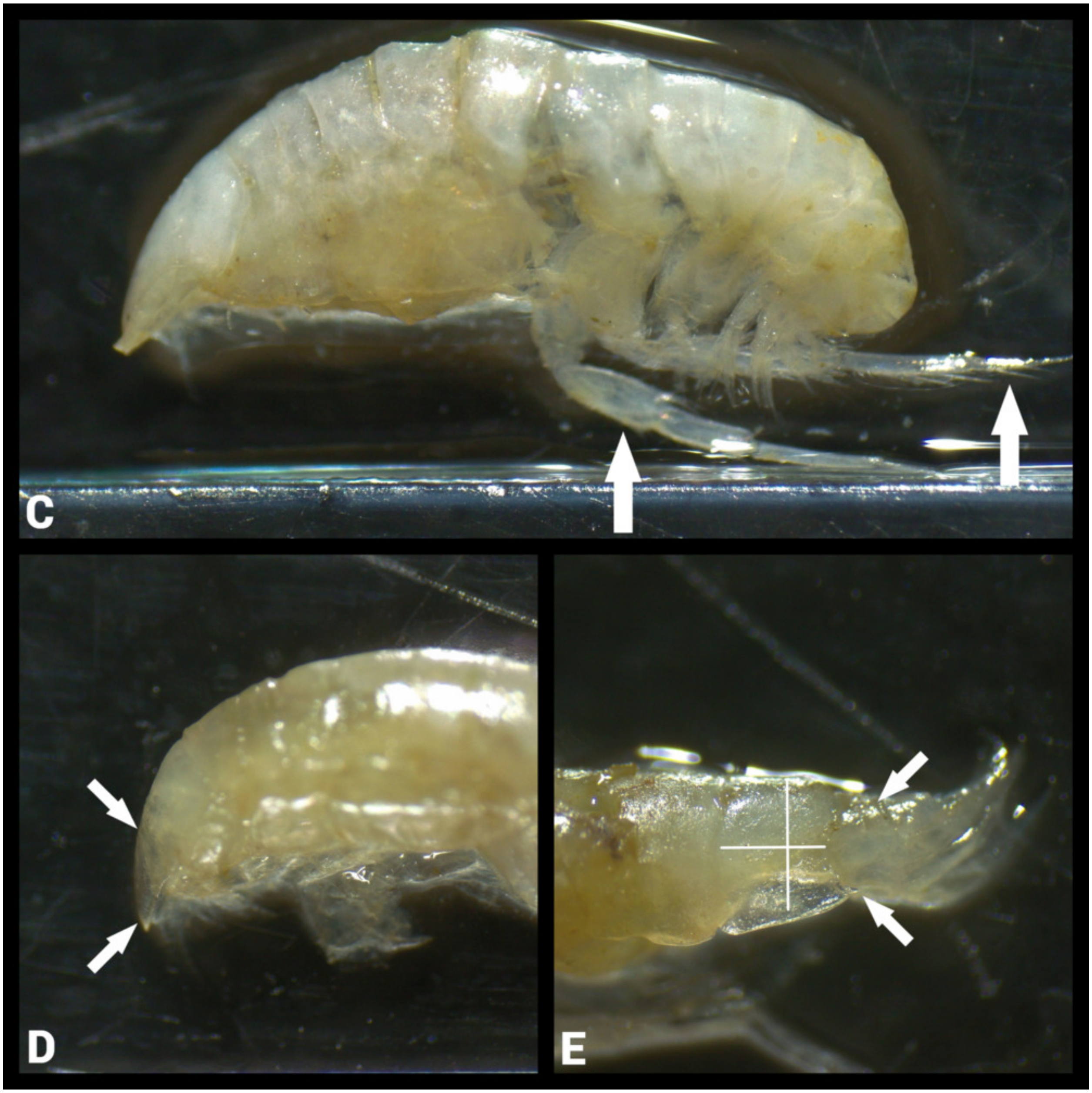


Figure 40. C) *Harpinia propinqua*. Last pair of peraepods are very long and bearing medium length setae. D) Head and rostrum large, deep, completely overhanging peduncle of first antenna. Rostral hood broad, narrowing evenly to acute apex, head angle produced forward (acute). Eyes lacking. First and second antenna short and subequal. E) Telson short (broader than long), apices subacute, each with 2 slender apical spines.

3.20 Pleustidae (Family) - AphiaID: 101404

Description:

This family is deep-bodied and broad, with a smooth or carinate dorsal surface, coxal plates that are deep and smooth below with a notch at posterior angle, short head and rostrum, broad eyes and convex, long and slender antennae (antennae 1 is longer than antennae 2), accessory flagellum is lacking, gnathopods 1 and 2 are subchelate (second is larger with short carpus), and telson is entire or slightly emarginate (Figure 41).

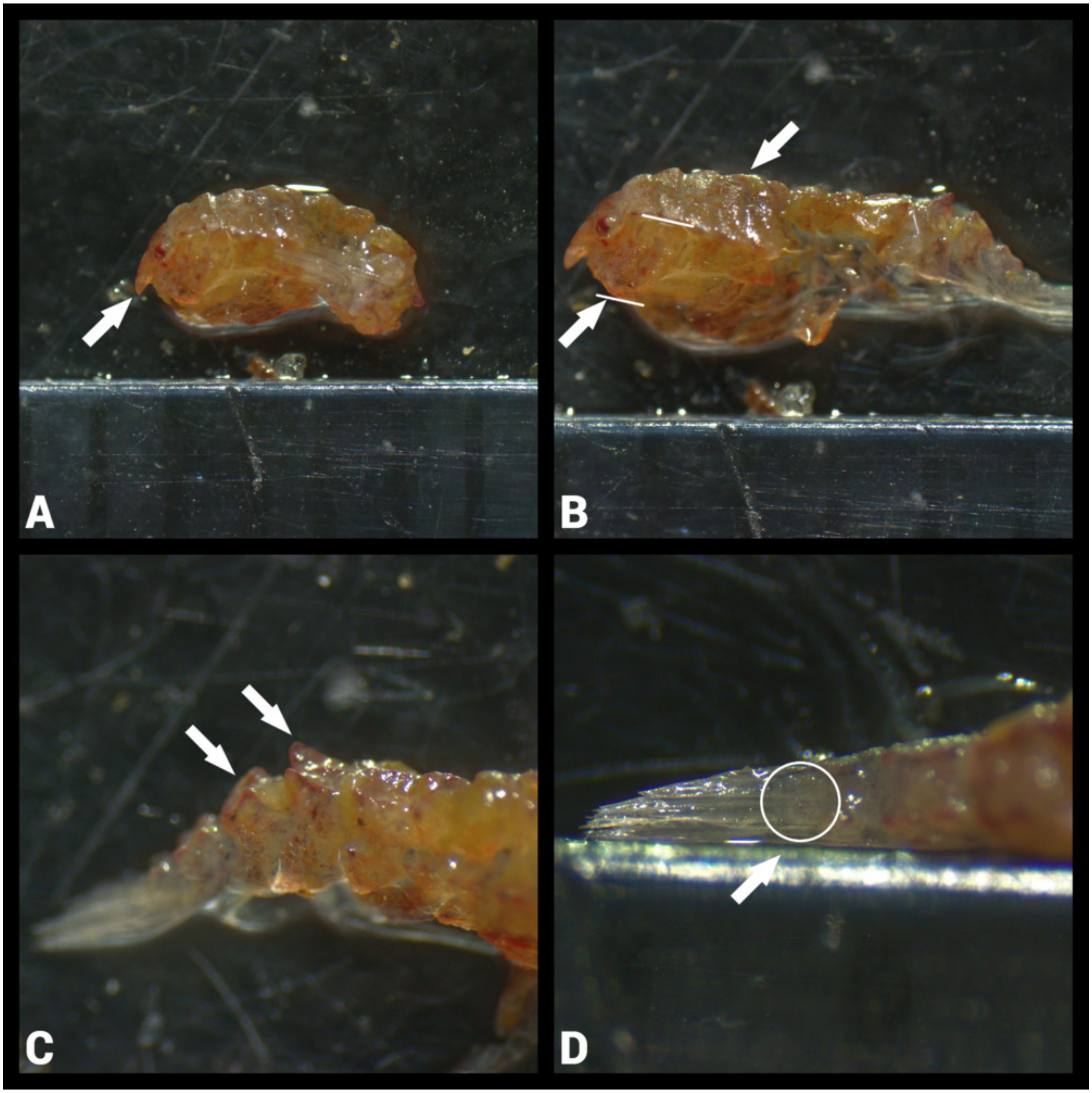


Figure 41. **Pleustidae**. A) *cf. Pleustes panoplus*. A snail mimic species that doesn't look like a typical Pleustidae species. Long, narrow, robust rostral hood. Smooth body, large abdomen, powerful pleon, coxal plates moderately deep. B) Deep body with armoured appearance. Pleon is carinate. Coxal plates very deep and narrow. C) Closeup of posterior region. Urosomes with dorsal raised ridges. D) Short, rounded, entire telson.

3.21 Stenothoidae (Family) - AphiaID: 101409

Description:

This family is distinguished by a small and smooth body (occasionally carinate), urosome segments are free, coxal plates 2-4 very large, shield-like, covering appendages, coxa 4 not posteriorly excavate, coxal 1 is small and hidden, very short rostrum, eyes round and lateral, antennae are medium size, subequal, accessory flagellum is lacking or vestigial, and telson is entire and rounded (Figure 42).

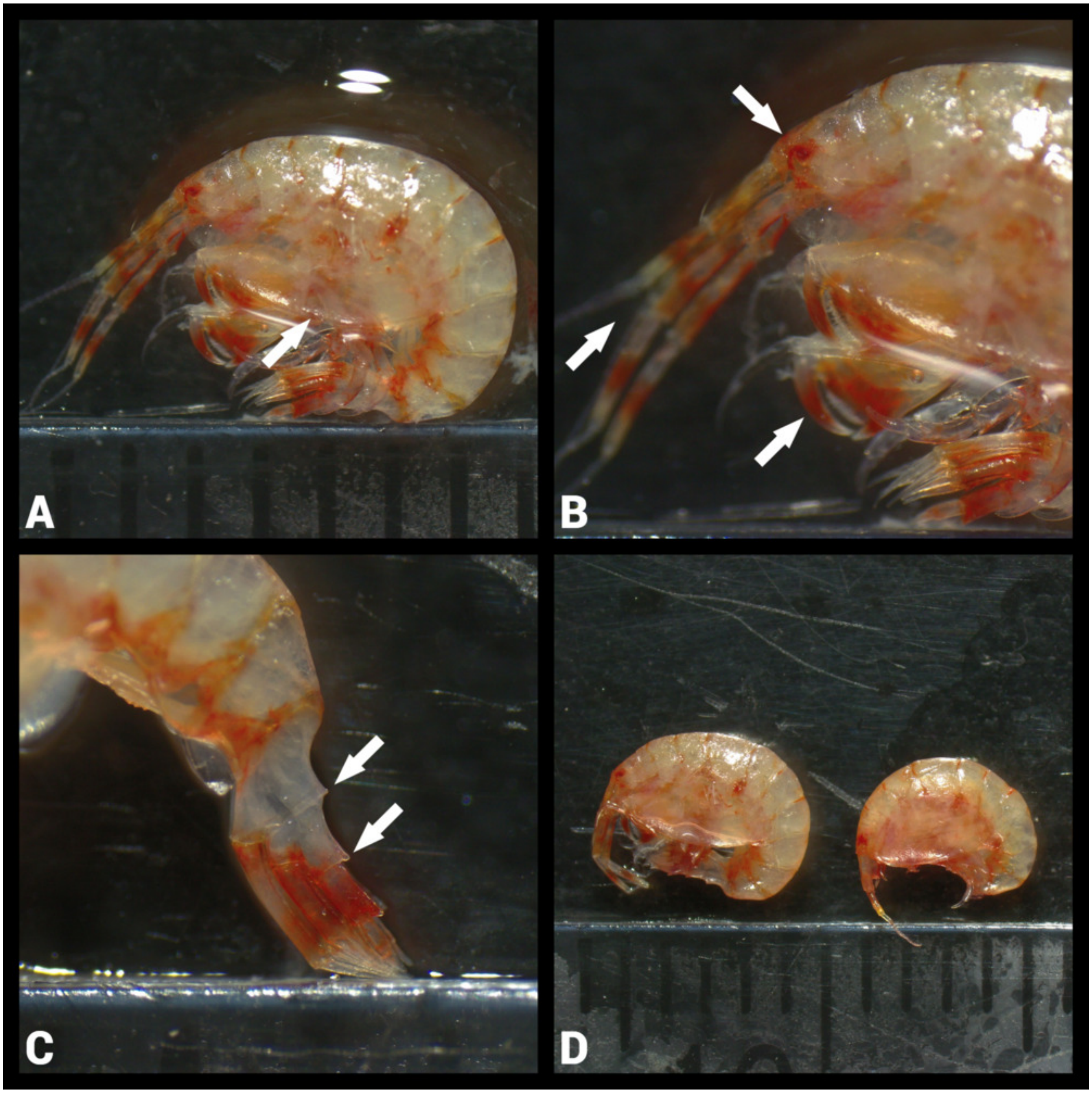


Figure 42. **Stenothoidae**. A) *Parametopella cypris*. Body small, smooth. Fourth coxal plate very large and subovate, extending anteriorly to first coxal plate, and posteriorly to seventh coxal plate (shield-like covering). B) Head short and deep, large eyes located laterally. Antennae slender and subequal. Second gnathopods moderately powerful, complexly subchelate, palm nearly straight, oblique, irregularly serrate near hinge. C) Urosomes are posteriorly carinate, hind quarter of last pleon segment is nearly square. Second uropod nearly reaching tip of first uropod, rami subequal, smooth. Telson long-ovate. D) Different sizes of Parametopella cypris.

3.22 Cumacea (Order) - AphiaID: [1137]

Description:

An order of small crustaceans that are characterized by their enlarged cephalothorax (fused head and thorax), skinny abdomen, and forked tail. Most species possess a pair of eyes that are located at the front end of its shielded head, this pair of eyes is often fused into one single dorsal lobe (Figures 43, 44). They tend to prefer sandy soft substrates which they hide in during the day and emerge at night. Most commonly encountered species in the southern Gulf of the St. Lawrence include cumaceans from the *Diastylis* genus and *Petalosarsia declivis*. Features to look at when trying to identify to genus or species in this group include the telson (shape and number of spines present), shape and appearance of head and rostrum.

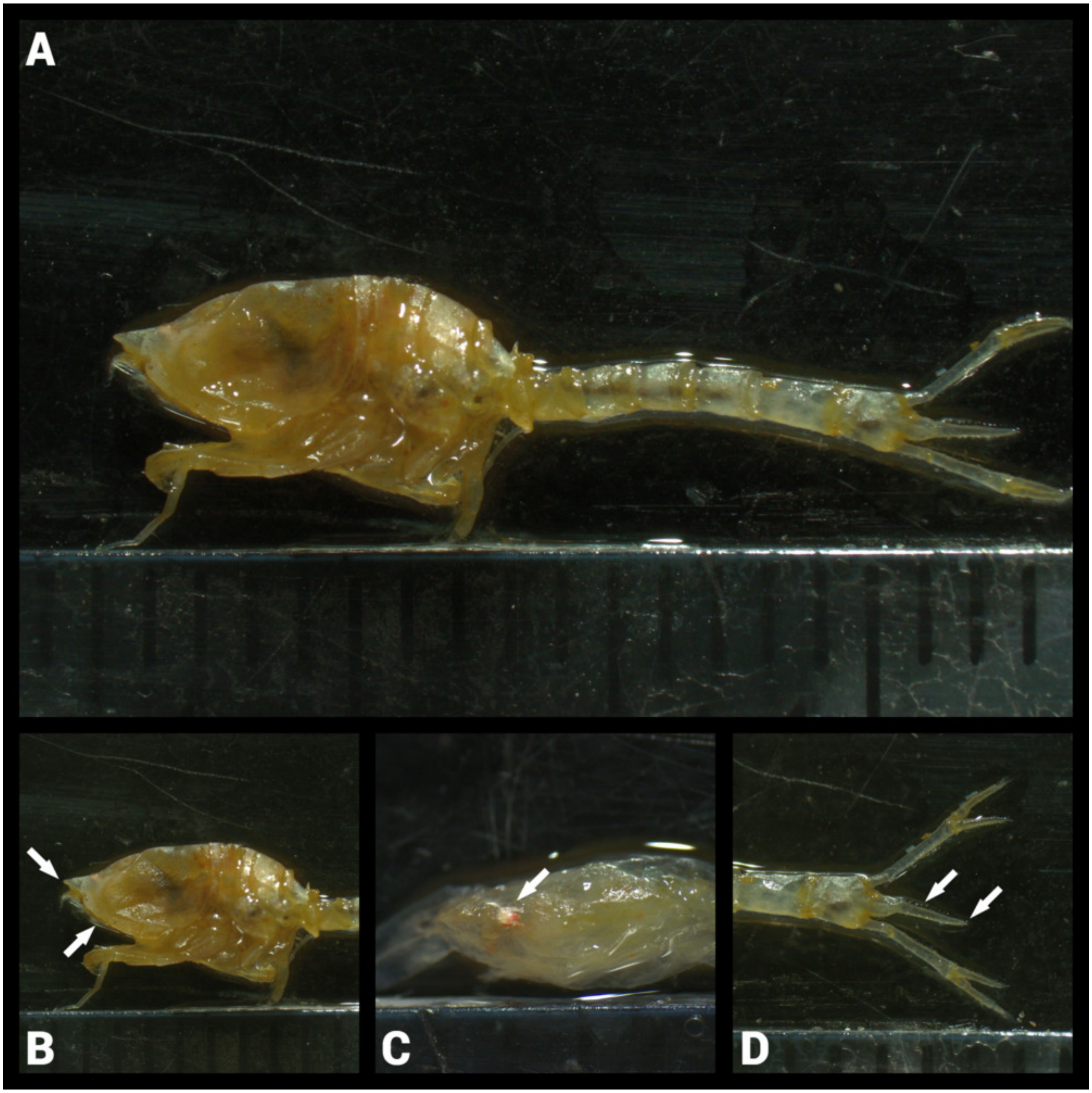


Figure 43. **Cumacea**. A) *Diastylis sculpta*. B) Straight, pointed rostrum with sculptured anterior end of carapace. C) Dorsal view of anterior end. Pair of eyes fused into one dorsal lobe. D) Telson ends in a point bearing two terminal spines with eight spines along each side.

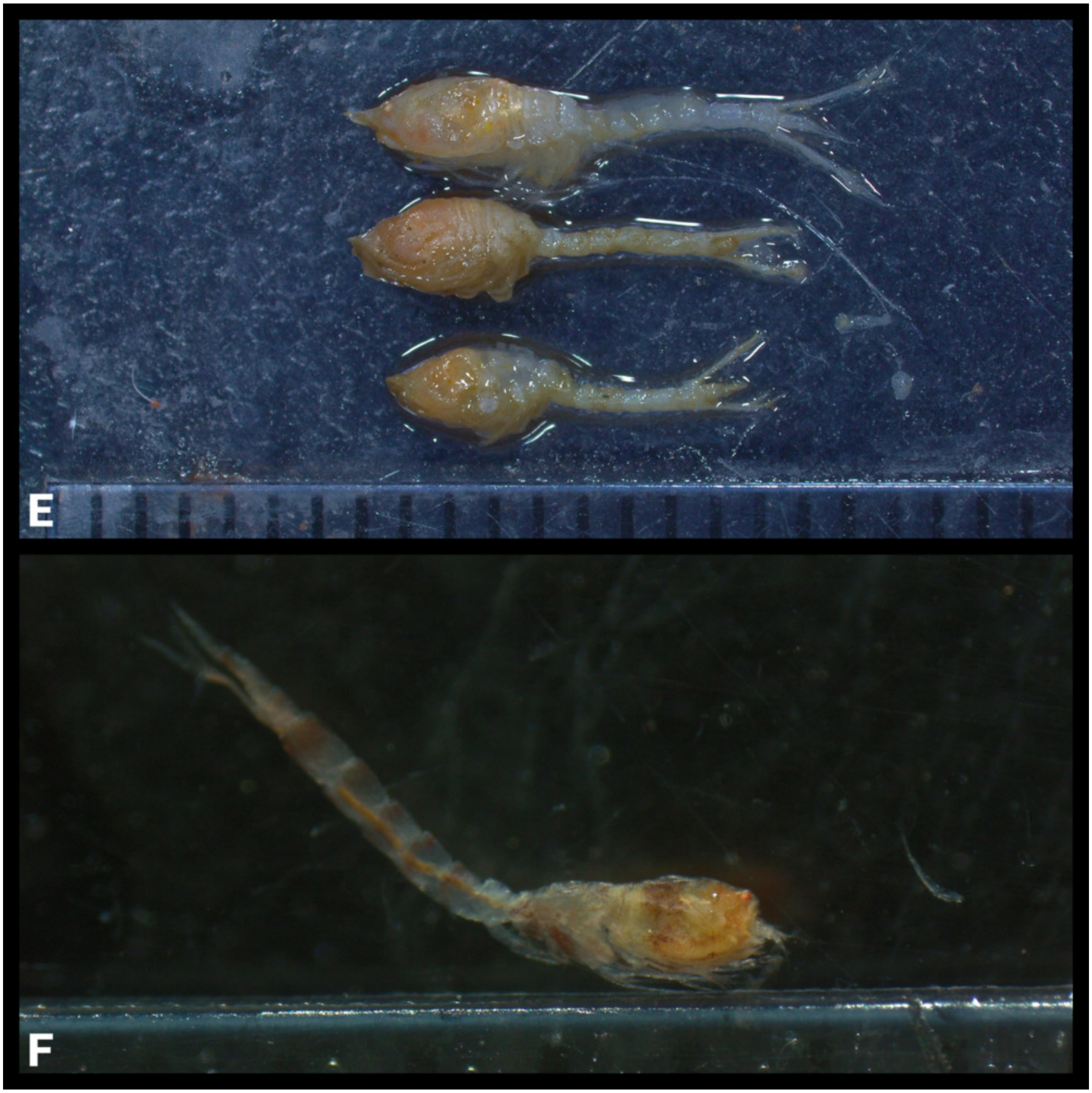


Figure 44. E) Several sizes of Cumacea. F) Juvenile Cumacea.

3.23 Decapoda (Order) - AphiaID: 1130

Description:

This familiar group includes crabs, lobster, shrimp, and prawns. They can have as many as 38 appendages, however as the name suggests they have 10 that are considered legs. Most decapods are considered scavengers and typically consume dead organisms and detritus. This order contains roughly 15,000 extant species, with approximately half of these being crabs. The majority of the remaining species are shrimp and hermit crabs, porcelain crabs, and squat lobsters from the the infraorder Anomura.

3.24 Megalops (Decapoda Life Stage) - AphiaID: 1130

Description:

The postlarva stage of crabs or Decapoda have a wide, rounded thorax with a small abdomen, and 8 thoracic legs (Figure 43 B). Look for the presence of chelate legs (legs with pincers on the ends) (Figure 43 A), and uropods (terminal legs) at the sides of the telson. See Figure 101 for main characters used in the identification of brachyuran megalopae (Korn and Kornienko 2010).

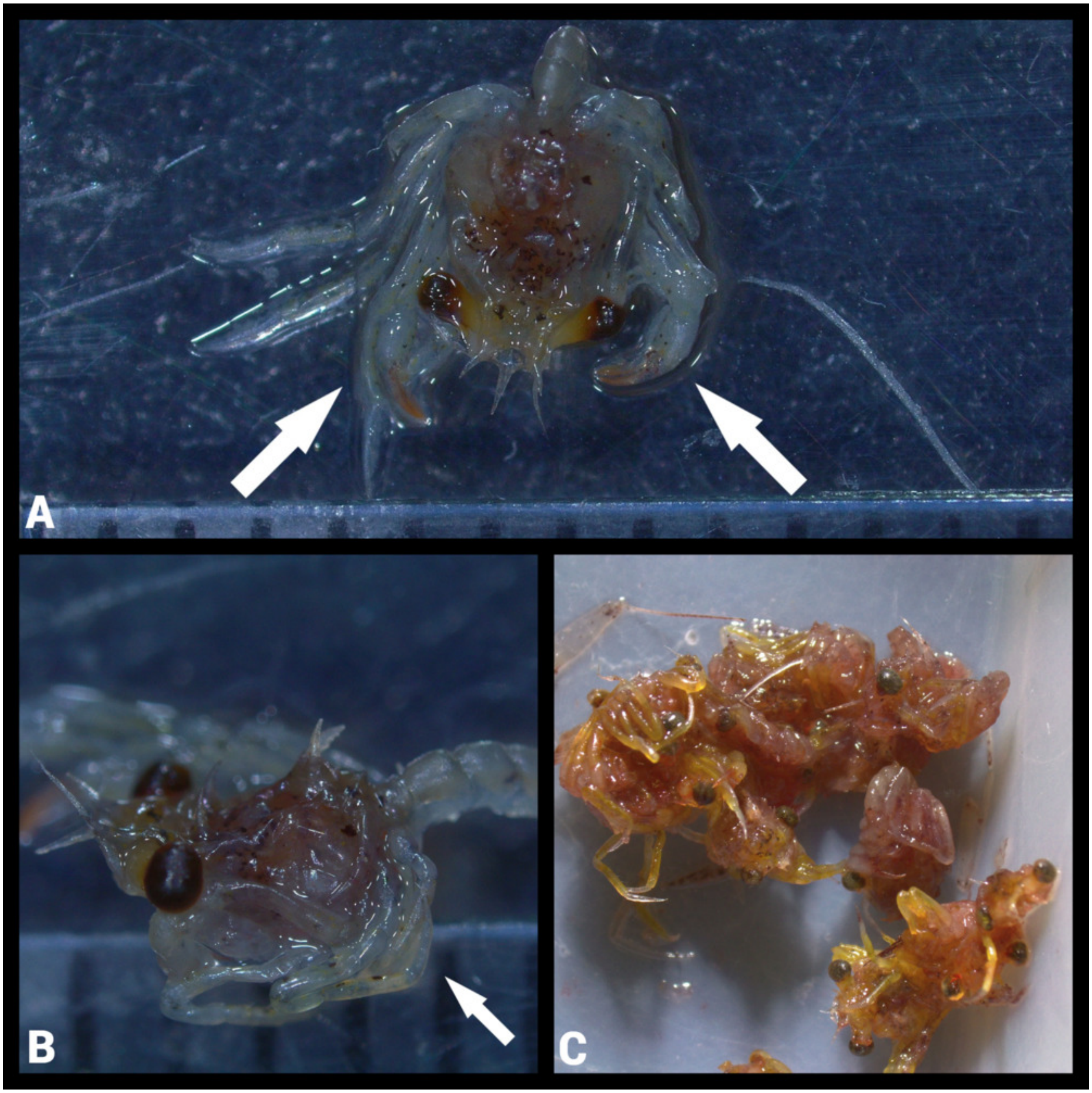


Figure 45. **Megalops**. A) Megalops larva (*Chionoecetes opilio*). Note the presence of chelate legs (pincers). B) Lateral view of Megalops larva (*Chionoecetes opilio*). Small curved abdomen that resembles a tail, and 4 thoracic legs on each side. 2 posterodorsal spines present on carapace (*Hyas* species have 1 posterodorsal spine). C) Group of several Megalops larva.

3.25 Brachyura (Infraorder) - AphiaID: 106673

Description:

This group of “true crabs” are decapod crustaceans that have a tail (mostly hidden by thorax) and a pair of claws (chelae). The most commonly encountered species in this group are the Greater (*Hyas araneus*) and Lesser toad crab (*Hyas alutaceus*; formerly known as *Hyas coarctatus alutaceus*) (Figure 46), Atlantic rock crab (*Cancer irroratus*), and Snow crab (*Chionoecetes opilio*) (Figure 47).

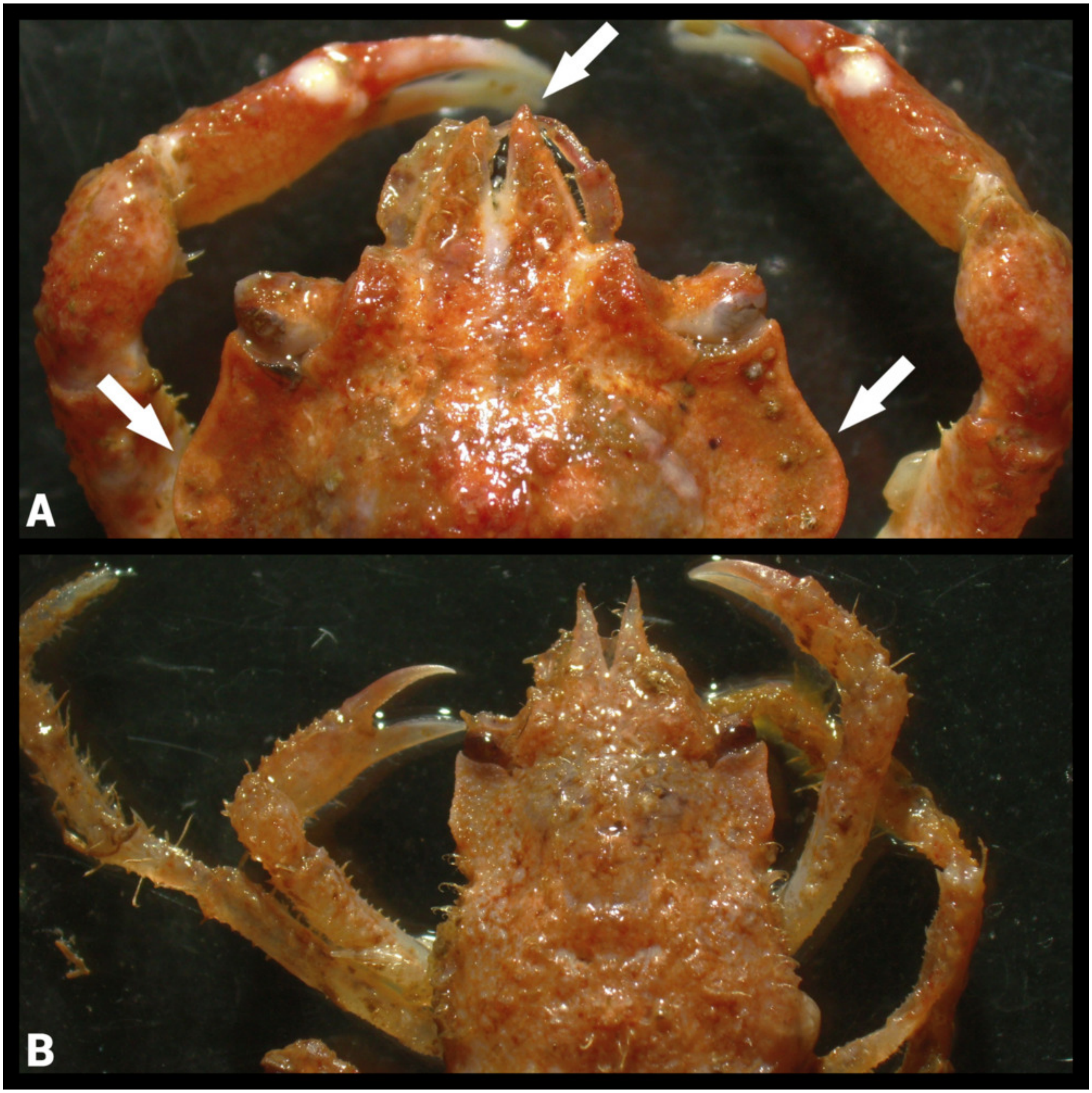


Figure 46. **Brachyura**. A) Lesser toad crab (*Hyas alutaceus*—species revision, coarctatus was split into 2, with the former in Bay of Fundy). Large convex "ears", and sharply pointed rostrum. B) *Hyas alutaceus* (juvenile).

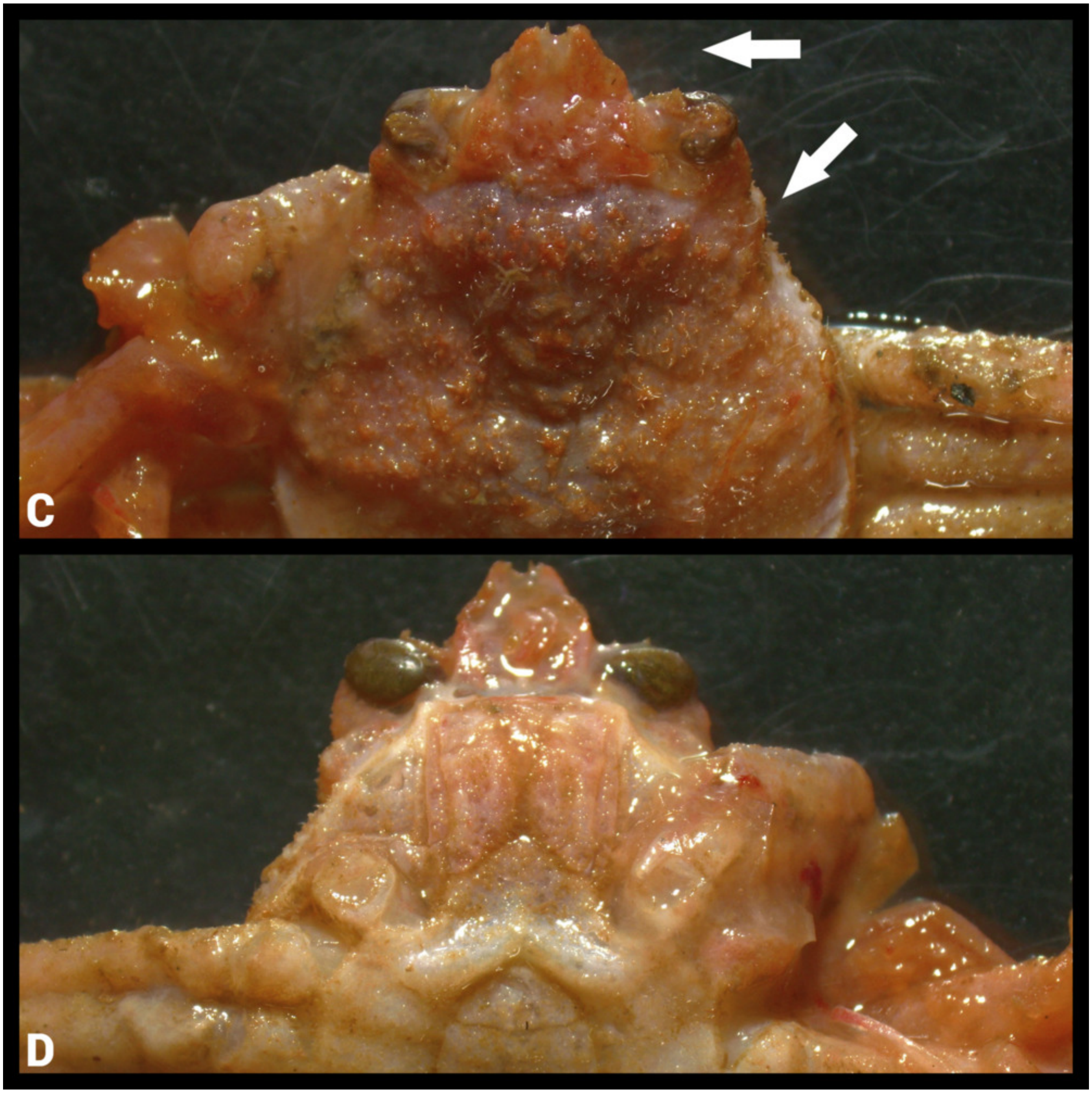


Figure 47. C) Snow crab (*Chionoecetes opilio*). Lack of “ears”, rounded carapace with serrations on anterior end, and shorter rostrum than Hyas species. D) Chionoecetes opilio (ventral view).

3.26 Crangonidae (Family) - AphiaID: 106782

Description:

A family of Caridean shrimp that includes the Crangon, Sclerocrangon, Pontophilus, and Sabinea genus. Some commonly encountered species in the southern Gulf of the St. Lawrence include the Sevenspine bay shrimp (*Crangon septemspinosa*) (Figures 48, 49) and Sevenline shrimp (*Sabinea septemcarinata*) (Figure 50). Key features to look at in this family are the number of middorsal spines along the carapace (1-5), projection of the rostrum relative to the eyes (equal to, extending, or shorter than the eyes), details of the rostrum (presence of basal spikes and/or middorsal keel), and the shape of the terminal tip of the telson (pointed or blunt).

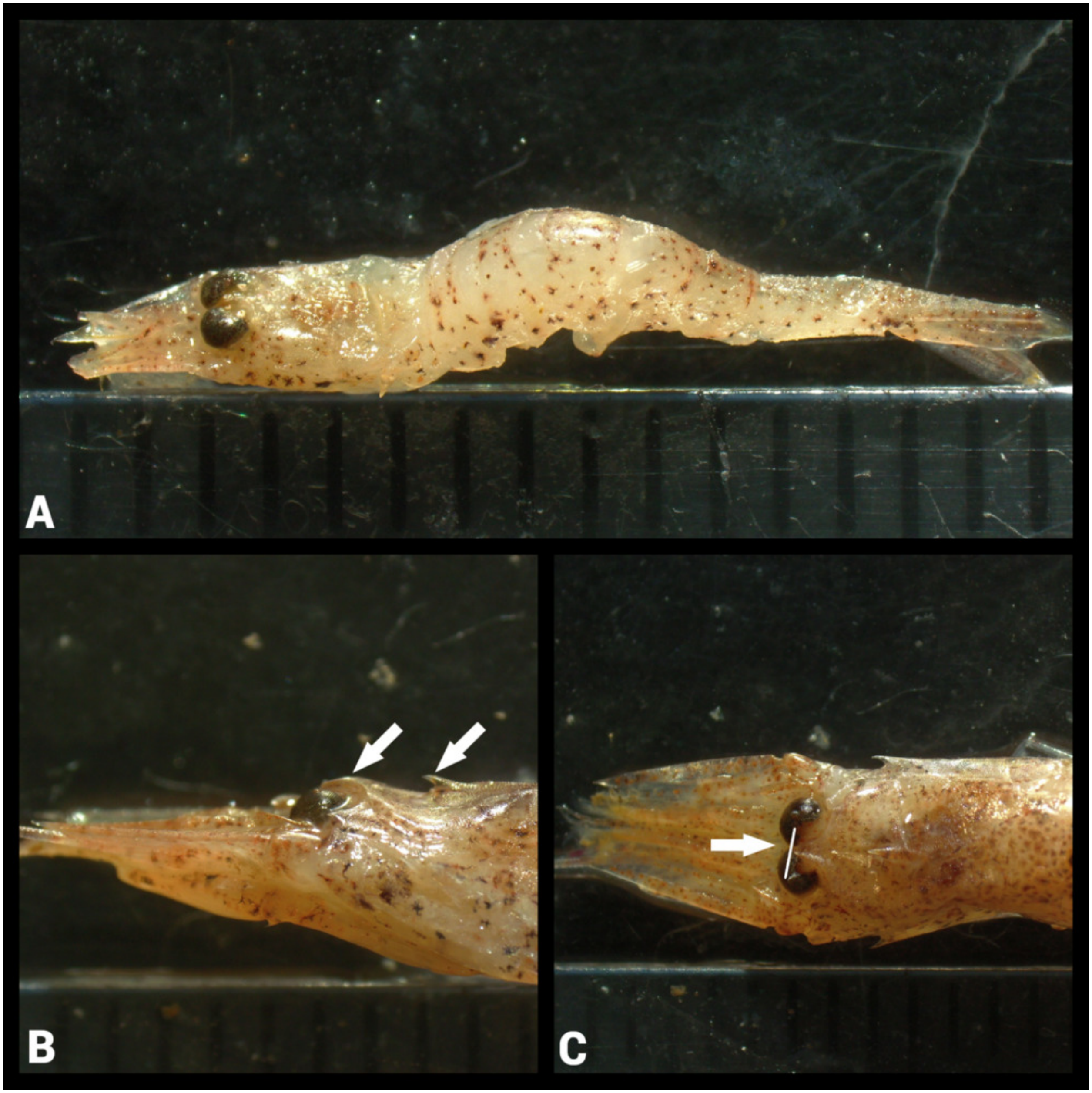


Figure 48. **Crangonidae**. A) Sevenspine Bay Shrimp (*Crangon septemspinosa*). Carapace is gray with dark speckles that look like sand. B) One middorsal spine along the carapace, basal spikes and dorsal keel absent on rostrum. C) Rostrum is shorter than the eye length.

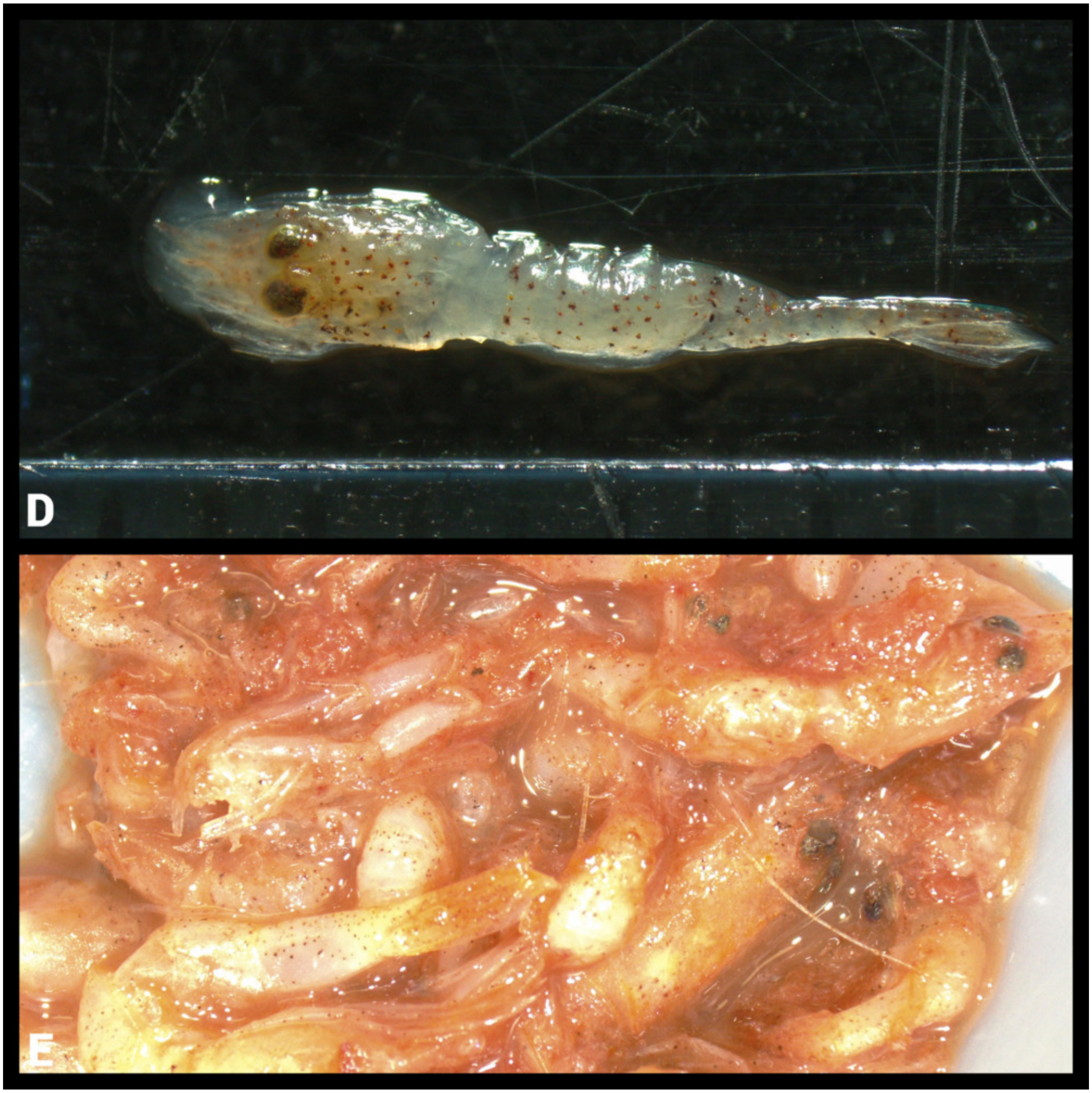


Figure 49. D) *Crangon septemspinosa* (juvenile). E) A grouping of slightly digested *Crangon septemspinosa*.

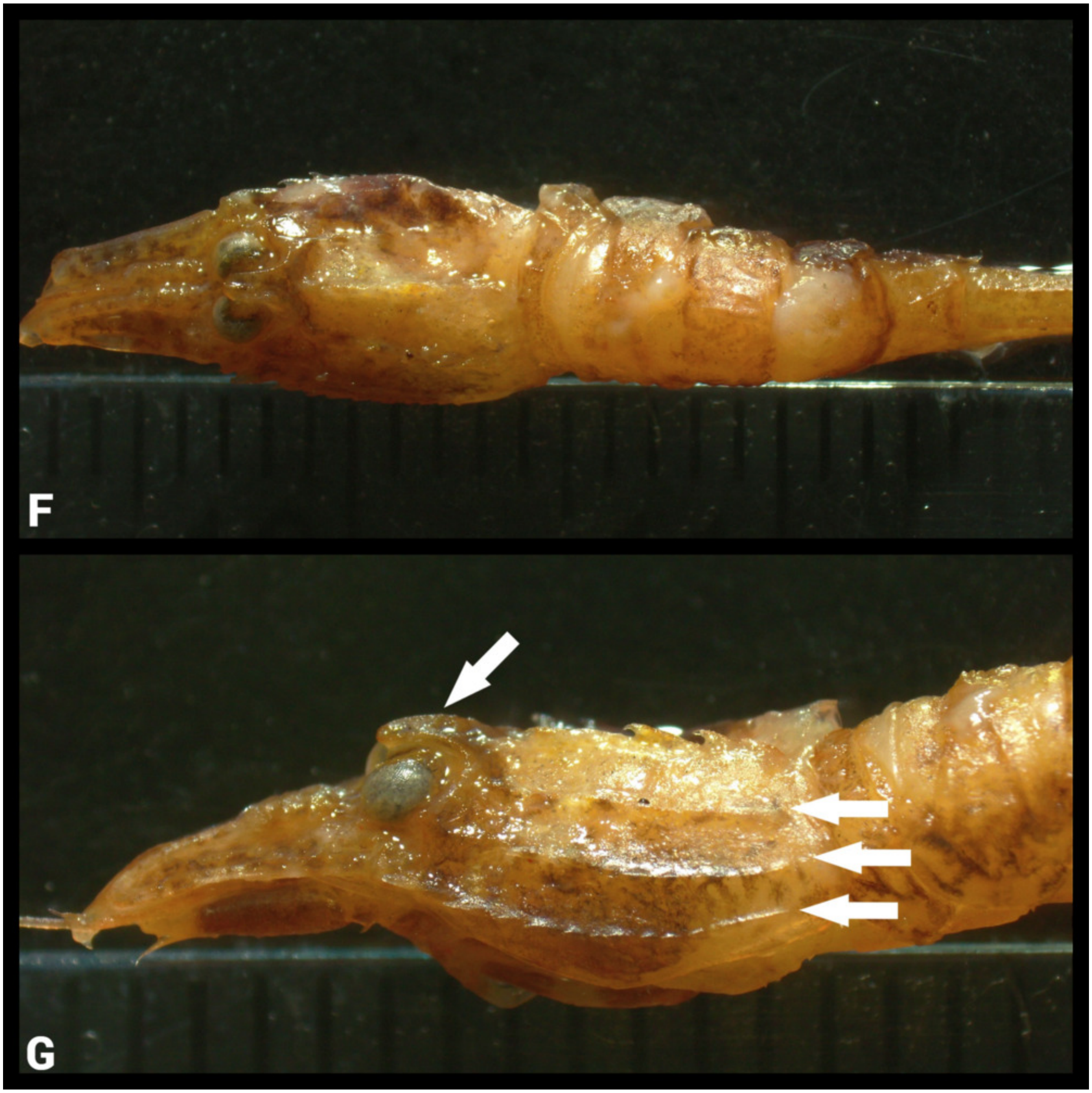


Figure 50. F) Sevenline Shrimp (*Sabinea septemcarinata*). G) Rostrum with a middorsal raised keel, and three rows of carina on side of head.

3.27 Paguridae (Family) - AphiaID: 106738

Description:

The crabs in the superfamily Paguroidea are commonly referred to as hermit crabs, the Paguridae family is the only one that you would encounter in the southern Gulf of the St. Lawrence region, with 4 species of genus Pagurus: *acadianus, arcuatus, longicarpus, pubescens* (Figure 51). Being decapods they have five pairs of walking legs, but the fifth pair is curled over their back and used to hold onto the gastropod shell that they utilize for protection. Several features are used to identify species; shape and colour of larger chela (pinching claw), contour of smaller chela, length of spines on second antennae and eyestalk, and amount of hairs on legs.

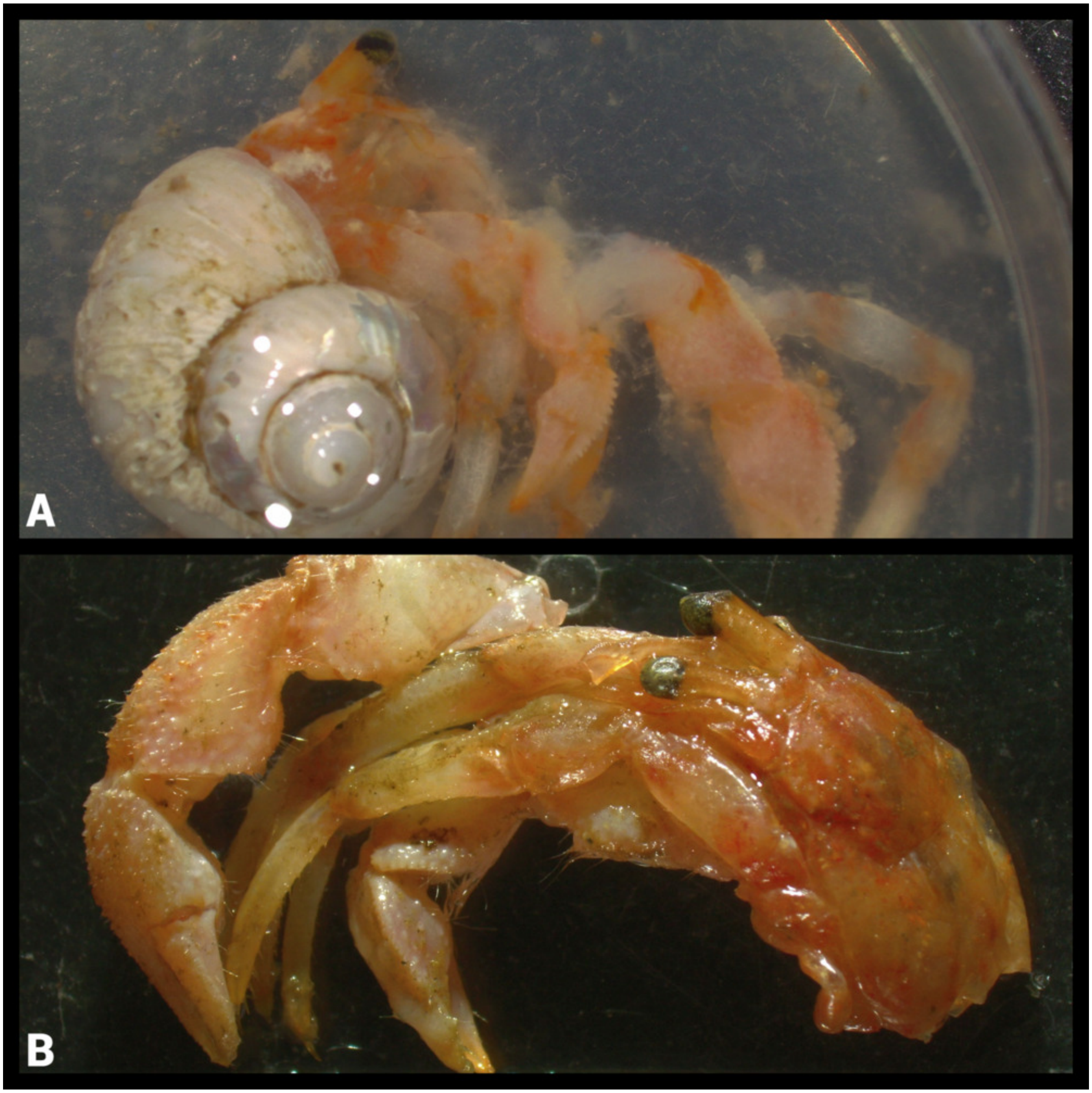


Figure 51. **Paguridae**. A) Pagurus species with gastropod shell. B) Pagurus species without shell.

3.28 Pandalidae (Family) - AphiaID: 106789

Description:

A commonly encountered group of Caridean shrimp that includes a large commercially important species in the Gulf region; Northern shrimp (*Pandalus borealis*) (Figure 53). This group also includes Aesop shrimp (*Pandalus montagui*) (Figure 52) and *Dichelopandalus leptocerus* which are commonly encountered in the southern Gulf of the St. Lawrence region, often found together, and look very similar to one another, along with *Atlantopandalus propinqvus* and *Plesionika martia* when near deep channels. Main features of this group include a second pereiopod with a subdivided carpus, and more importantly the first pereiopod has no chelae (pincers). The rostrum is usually very long and thin in this group (also has an upward curve to it).

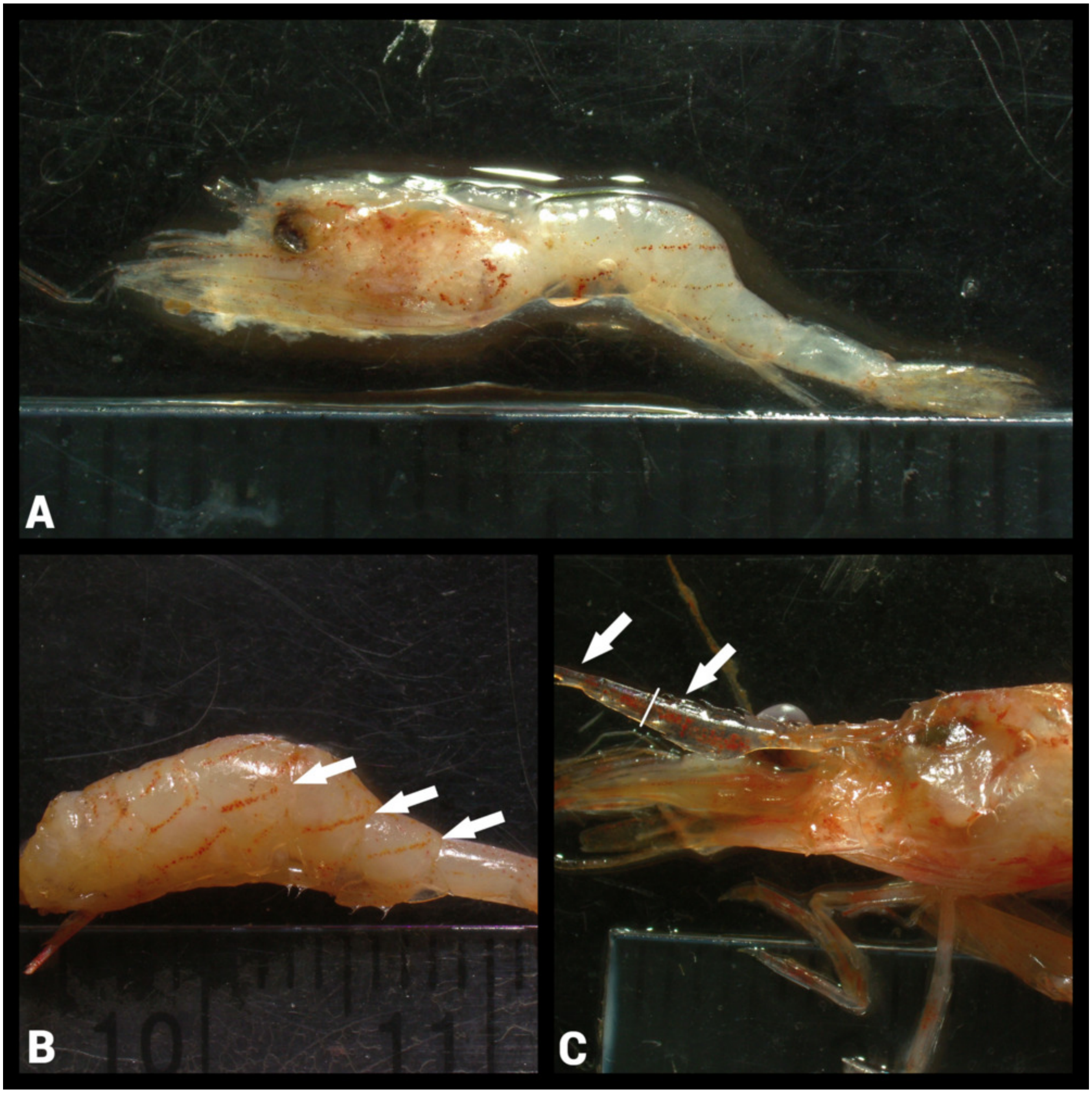


Figure 52. **Pandalidae.** A) Aesop shrimp (*Pandalus montagui*). B) *Pandalus montagui*; note placement and angle of red lines on body. C) *Pandalus montagui*; rostrum curves upwards, teeth on dorsal edge of the rostrum only extend halfway to rostral tip (anterior portion is smooth).

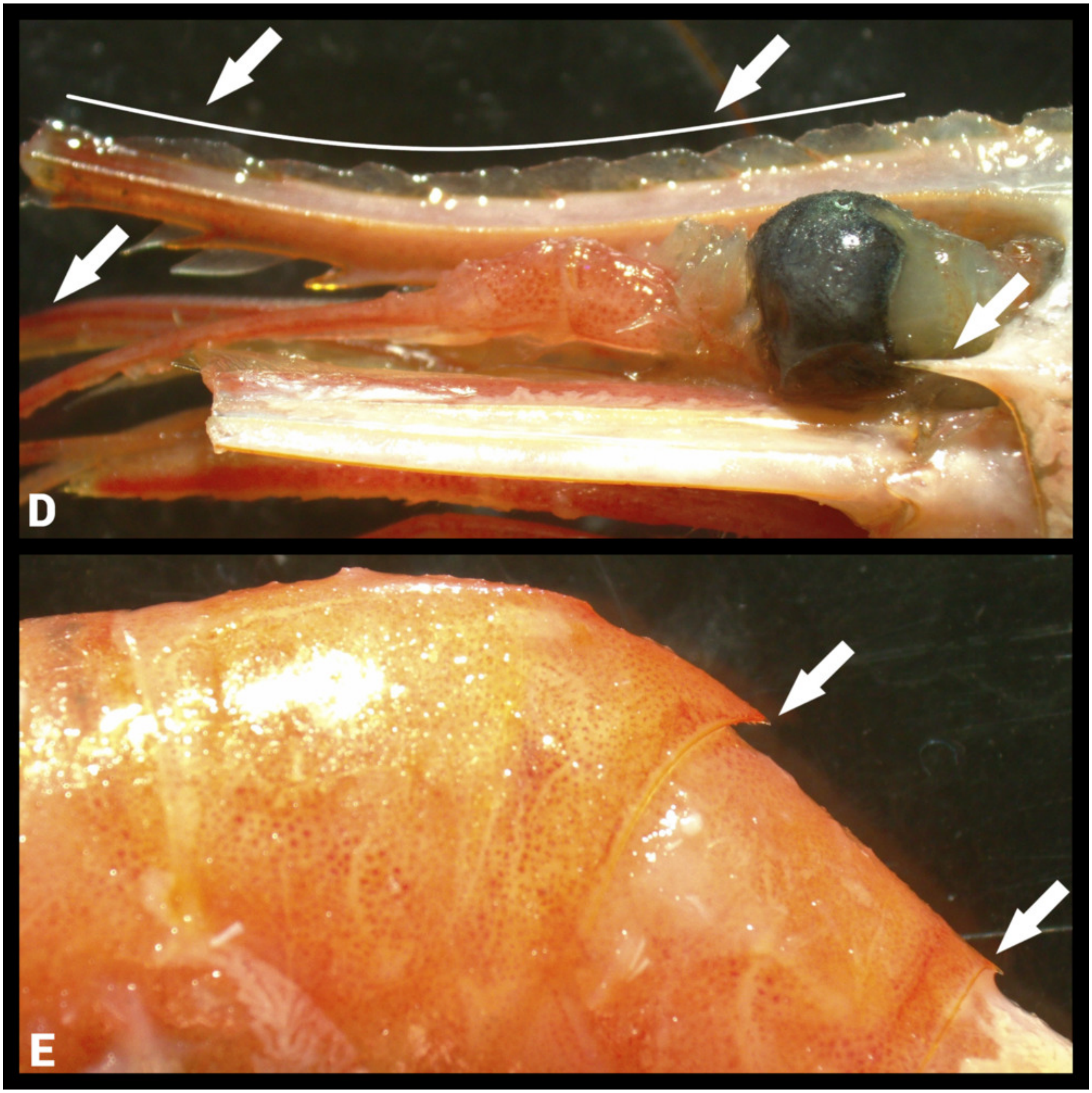


Figure 53. D) Northern shrimp (*Pandalus borealis*). Large species that can grow to a length of about 15 centimetres. Dark red antennae, long upward curved rostrum with 12-16 dorsal teeth, and presence of supraorbital spine. E) Presence of dorsal hooks on posterior segments.

3.29 Thoridae (Family) - AphiaID: 883967

Description:

This family of shrimp is represented by the genera Lebbeus (Figures 55, 56), Spirontocaris (Figure 54), and Eualus. This group is identified by their bladelike rostrum, overlapping abdominal segments, first pair of walking legs that have chela (pincers) on the terminal end but without bristles or combs on both fingers of the chela, and a second pair of walking legs with several short segments (subdivided) just below the chela.

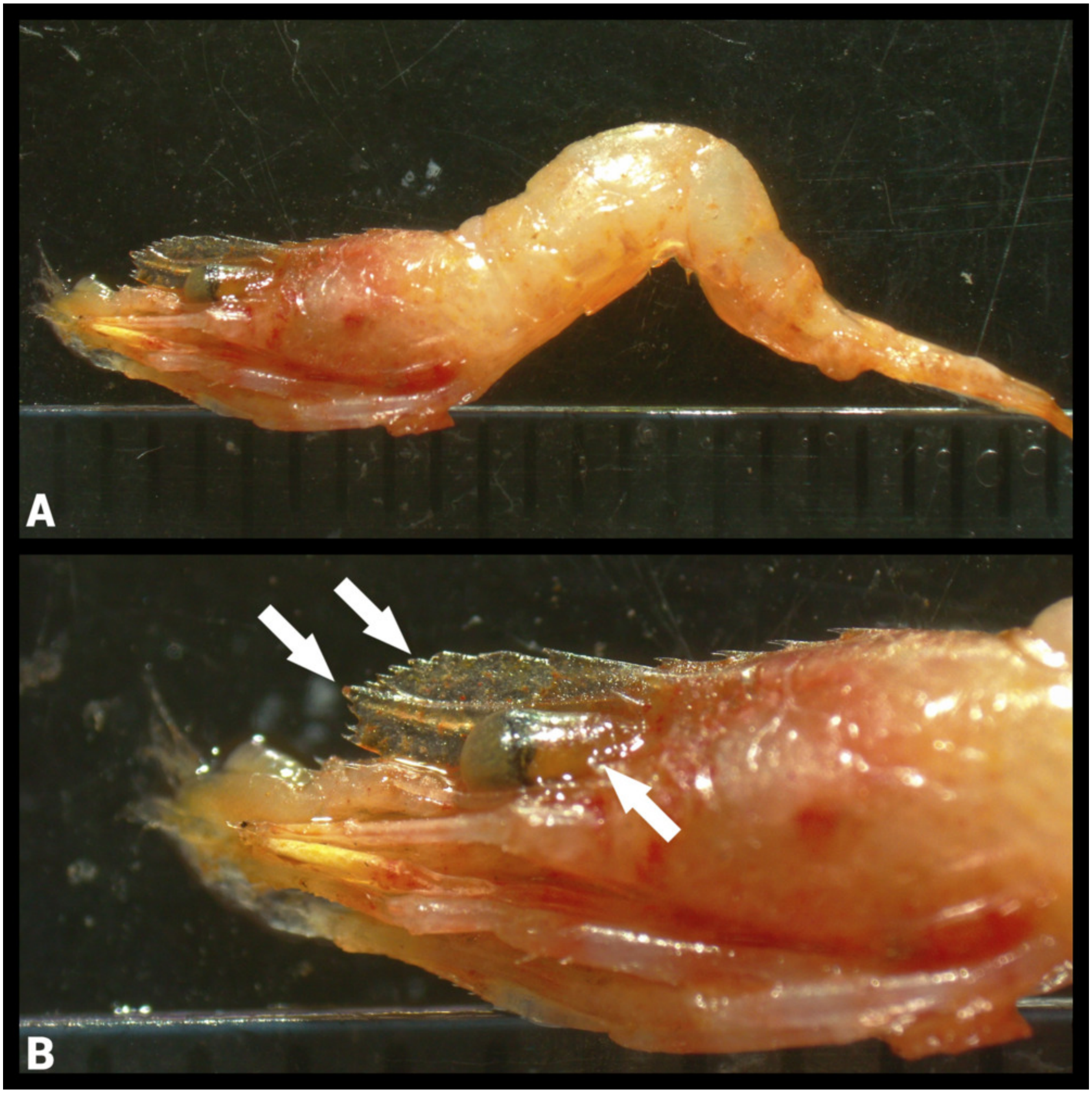


Figure 54. **Thoridae.** A) Friendly blade shrimp (*Spirontocaris liljeborgii*). B) Relatively short and wide rostrum with many (>10) teeth along the dorsal edge, and 2 supraorbital spines present.

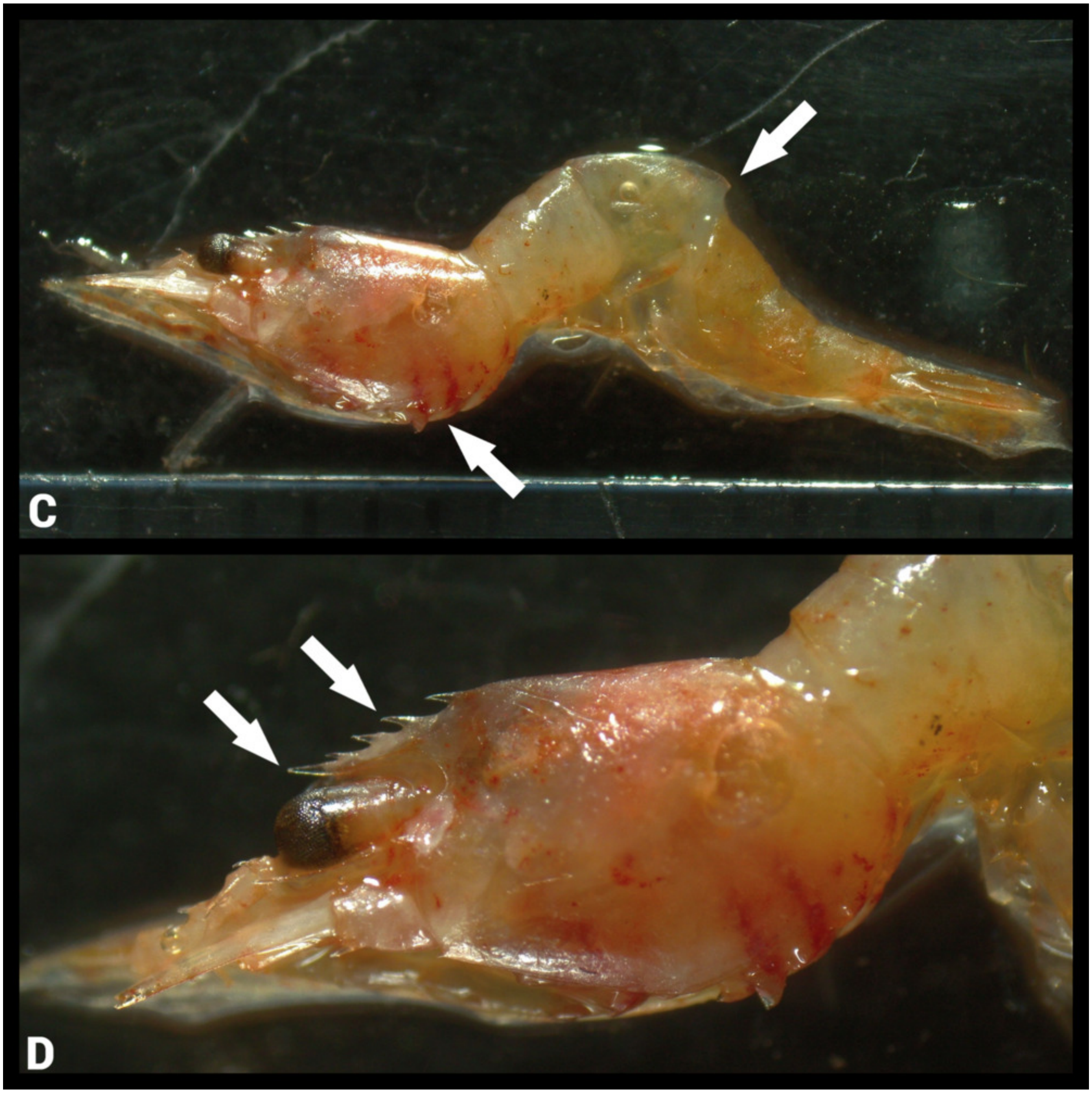


Figure 55. C) *Lebbeus microceros*. Red bands on body with a middorsal hook on posterior end of carapace. D) Short pointed rostrum (not extending past eye) with four dorsal teeth that extend posteriorly just past base of eye.

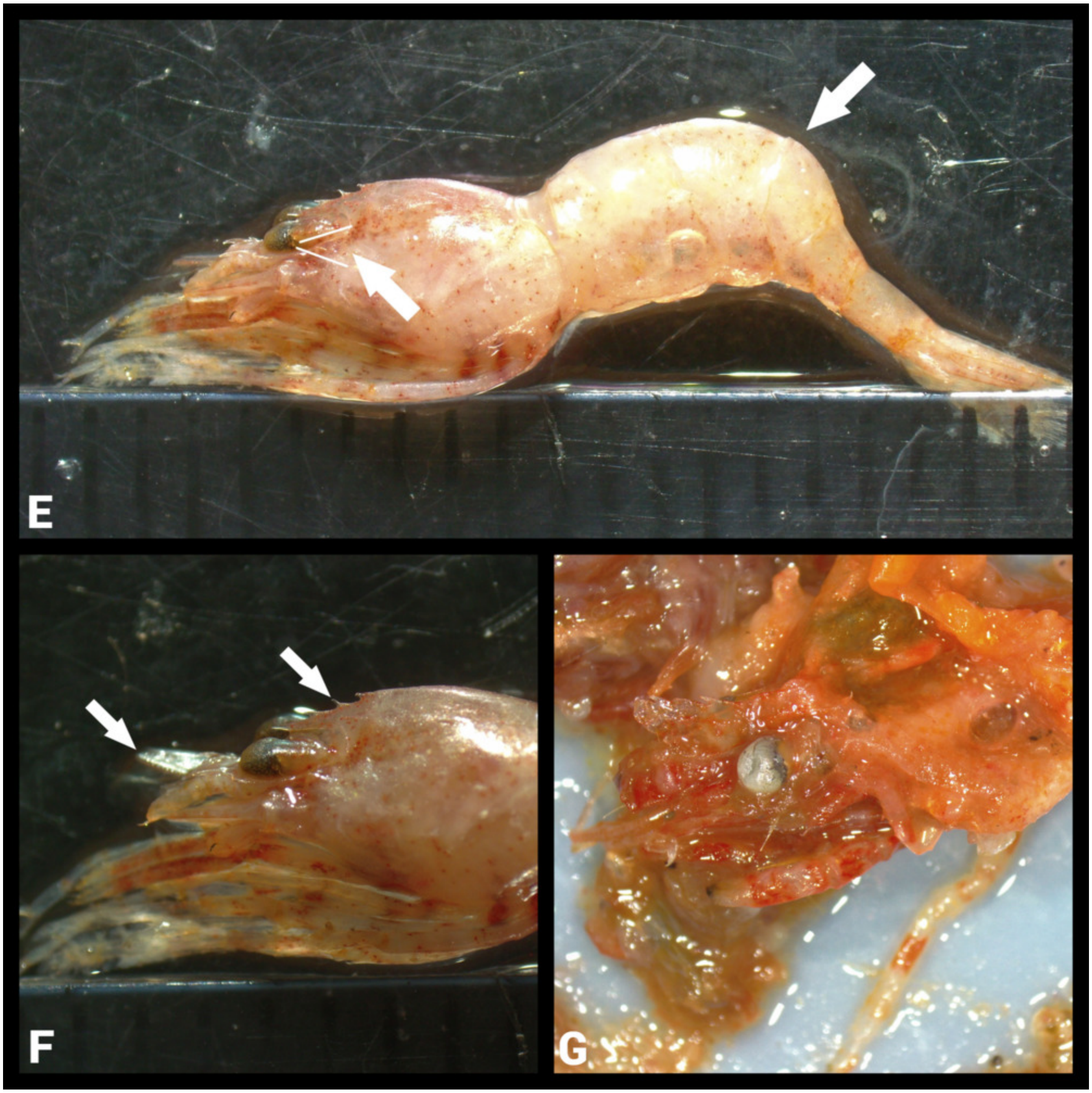


Figure 56. E) Polar Lebbeid (*Lebbeus polaris*). Light coloured with reddish-orange dots, no middorsal hook. F) Medium length sword-shaped rostrum with several teeth at posterior end extending almost halfway along carapace. Rostrum itself has a few gradual spines on top and bottom. Note that the entire rostrum can't be seen in this image (is bent back and below eyes). G) Well digested *Lebbeus polaris*—robust yellow banded legs.

3.30 Euphausiidae (Family) - AphiaID: 110671

Description:

Commonly referred to as krill, these shrimp-like crustaceans have the typical decapod anatomy consisting of three parts; the cephalothorax (fused head and thorax), the pleon (contains the ten swimming les), and the telson/tail fan. Krill can be distinguished from other decapods like true shrimp by the presence of visible external gills (found on the ventral side just before the first set of swimming legs). Average size for an adult krill is 1-2 centimetres, although some deeper water species can get larger (6-15 cm). *Meganyctiphanes norvegica* (Figure 58) and species from the Thysanoessa genus (Figure 57) are the most commonly encountered genera you would encounter in the southern Gulf of the St. Lawrence region.

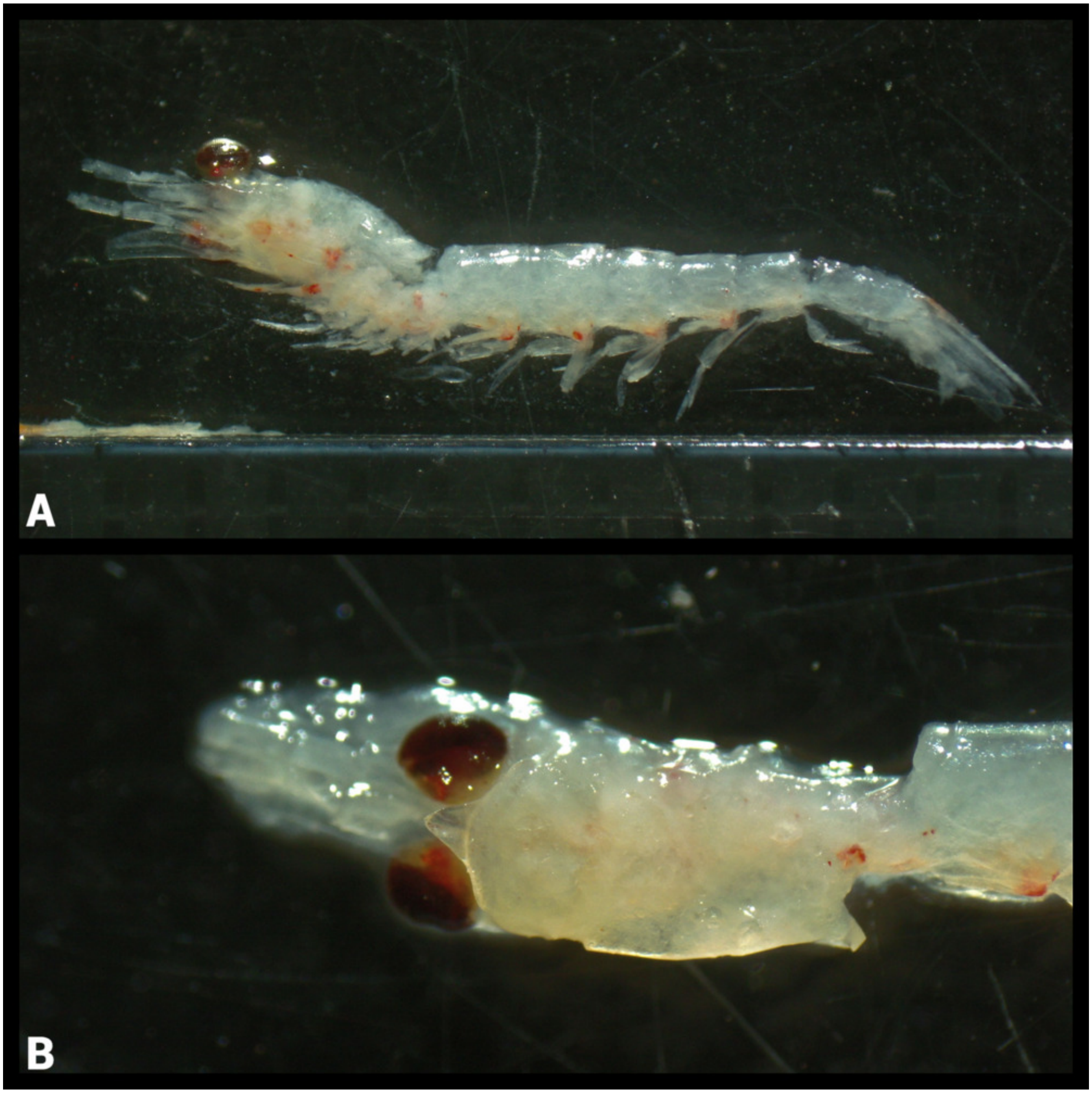


Figure 57. **Euphausiidae**. A) *Thysanoessa*. B) Short rounded rostrum that extends to mid-eye or beyond.

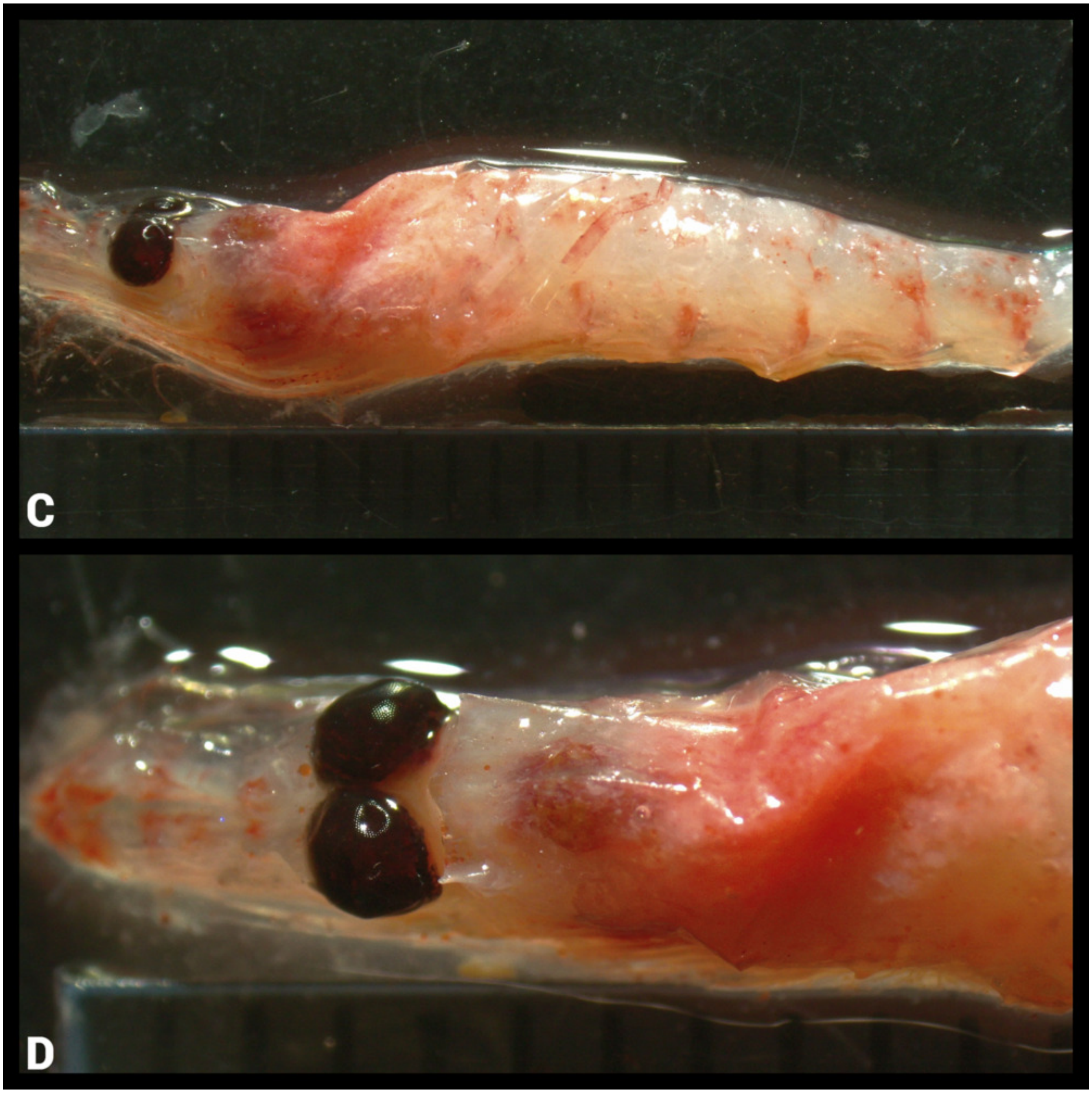


Figure 58. C) Horned krill (*Meganyctiphanes norvegica*). D) Very short, almost flat rostrum that does not reach eyes.

3.31 Isopoda (Order) - AphiaID: 1131

Description:

Isopods generally have bodies that are dorsoventrally flattened with thoracic segments that are highly visible just behind the head. The thorax has seven (sometimes five) pairs of walking legs (pereiopods), and the smaller abdominal segments are attached to fewer and more varied legs (pleopods, including the uropods which are closest to the tail. The location of the last pair of abdominal legs, the uropods, and the shape of the telson are key identification features to look at in this group (Figures 59, 60, 61). Isopods often inhabit areas with vegetation, particularly in nearshore areas such as inter tidal zones and tidal pools.

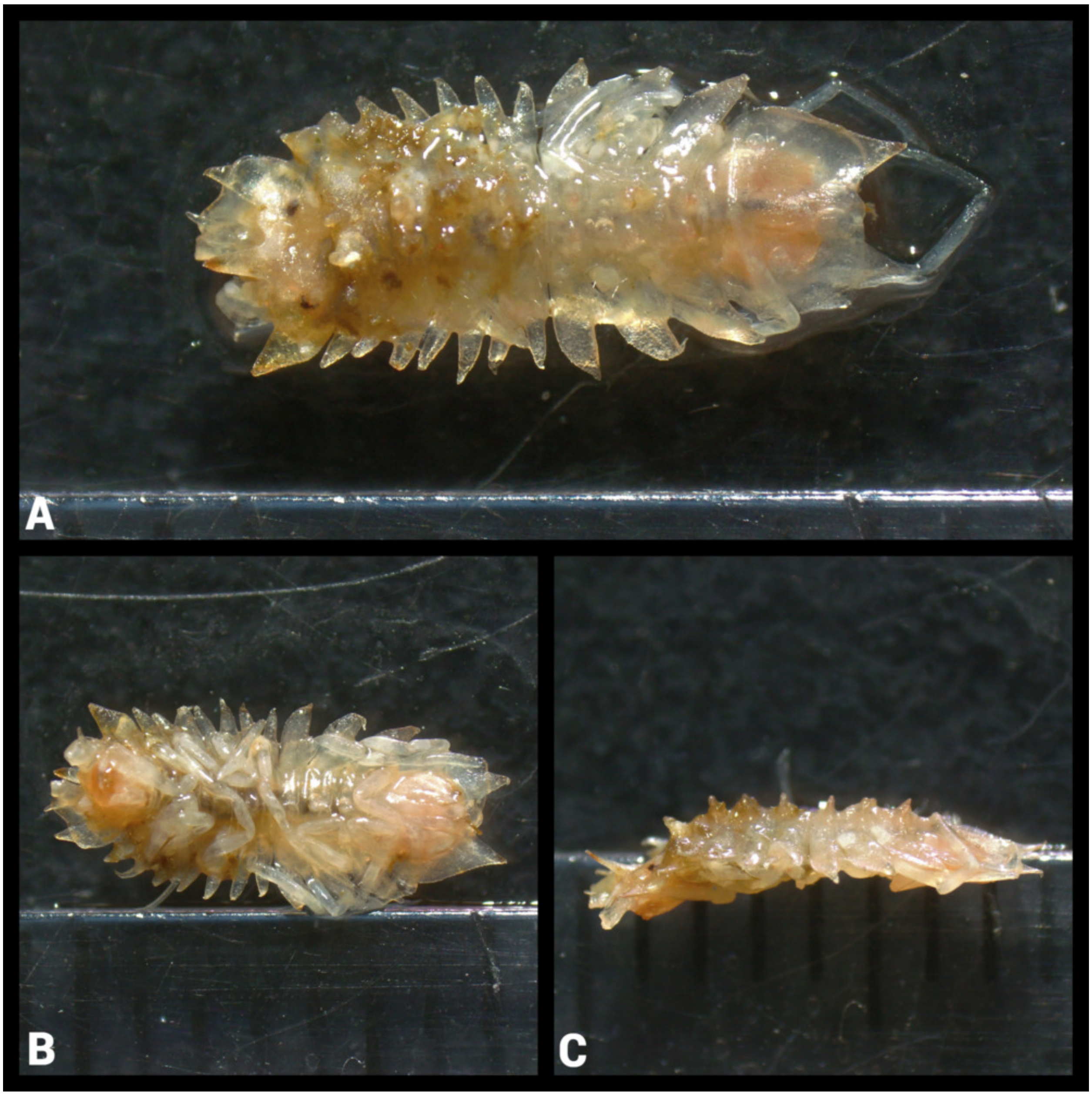


Figure 59. **Isopoda.** A) Dorsal view of *Tole spinosa*. B) Ventral view. C) Lateral view.

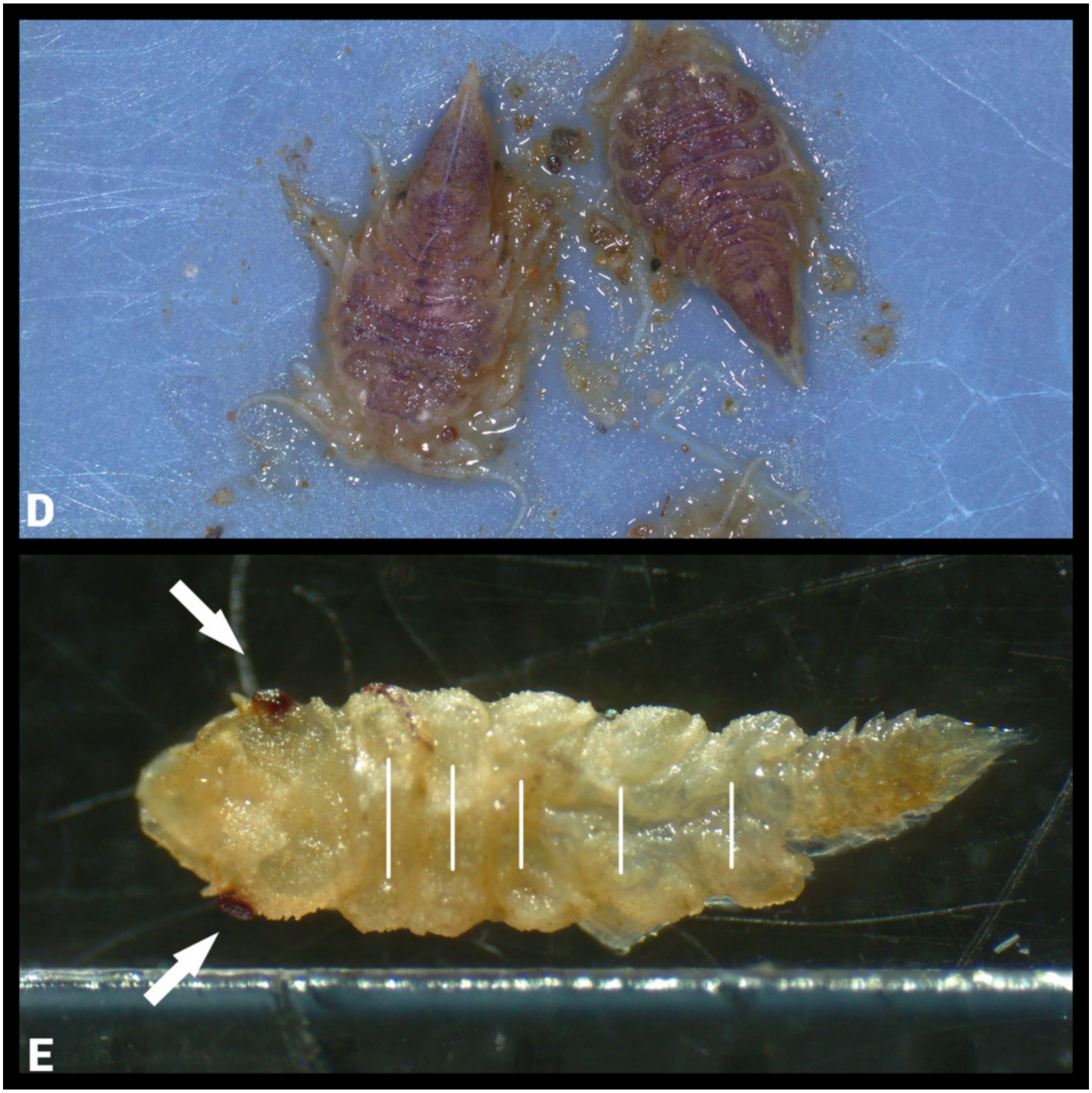


Figure 60. D) *Chiridotea tuftsi*. Body is reddish-brown in colour and mottled, sides of telson straight edged to pointed tip with setae. E) *Gnathia cerina* (Gnathiidae) (Stimpson, 1853). Eyes located on sides of head, five thoracic segments with five pairs of walking legs, and terminal uropods.

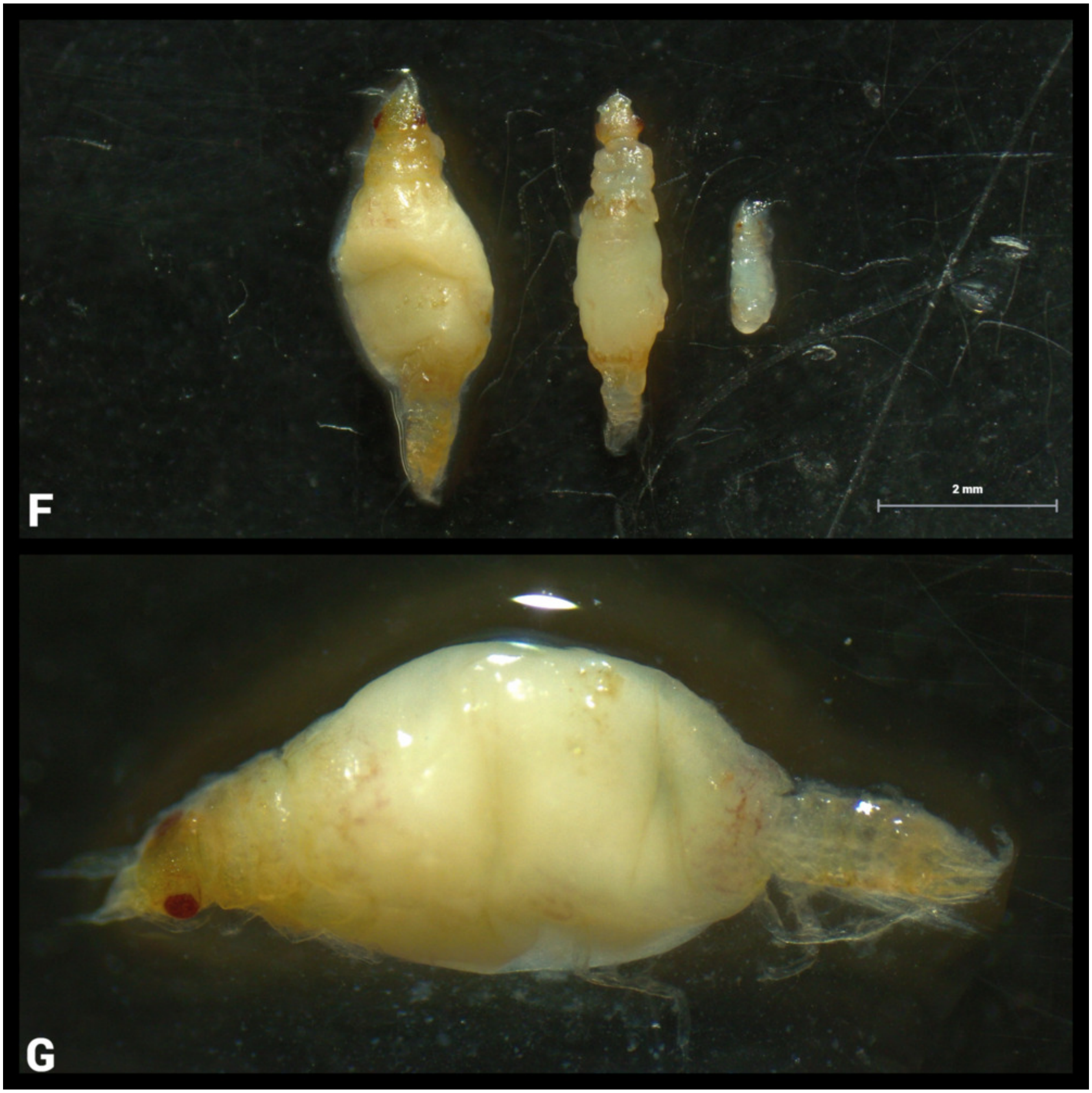


Figure 61. F) Larval form of Gnathiidae isopods. Juvenile form is referred to as a “praniza” and is a temporary parasite of marine fish. G) Swollen larvae of Gnathiidae species.

3.32 Mysidae (Family) - AphiaID: 119822

Description:

Mysid shrimp are small, slender, translucent shrimp-like arthropods that have small, spherical sensory structures called statocysts in the base of their uropods (terminal pair of appendages). The gills are covered by the carapace and the thorax is nearly covered (carapace is only attached to first four thoracic segments). Typically found in large numbers in shallow areas, often associated with seaweed or tidal pools. Some important features to look at when identifying mysids are the shape of the bladelike antennal scale on the second antennae, the shape and spination of the telson (middle piece in the tail fan) (Figures 62, 63, 64). Identifications are difficult, may require use of a dissecting microscope, and detailed literature should always be referenced for confirmation.

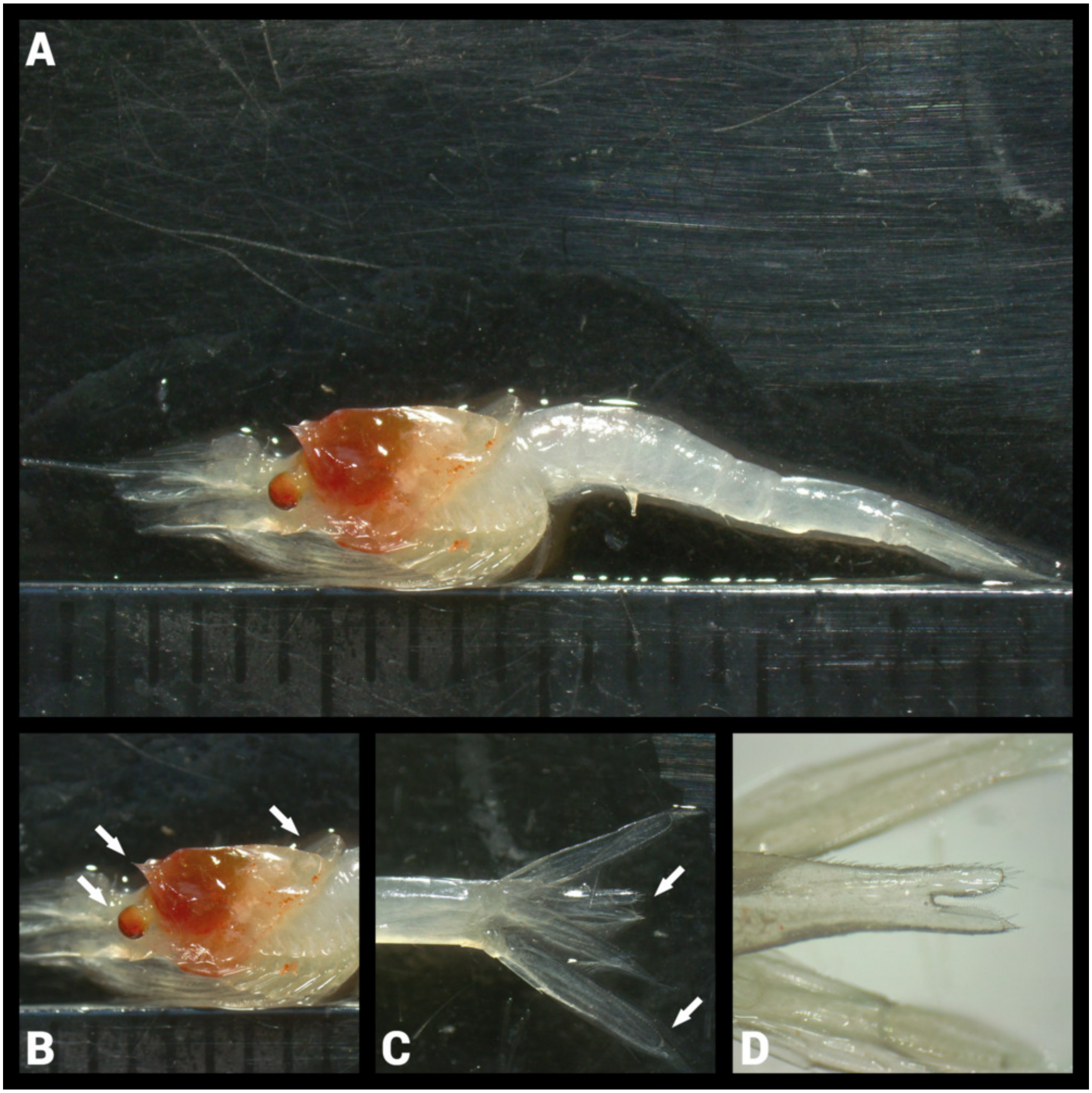


Figure 62. **Mysidae.** A) *Boreomysis. cf. arctica*, of deepwater subfamily Boreomysinae (to distinguish shallow water ones below). B) Red eyes, short pointed rostrum, carapace covers gills and most of thorax. C) Posterior end with tail fan and telson. D) Notched telson with spines along lateral margins and tip.

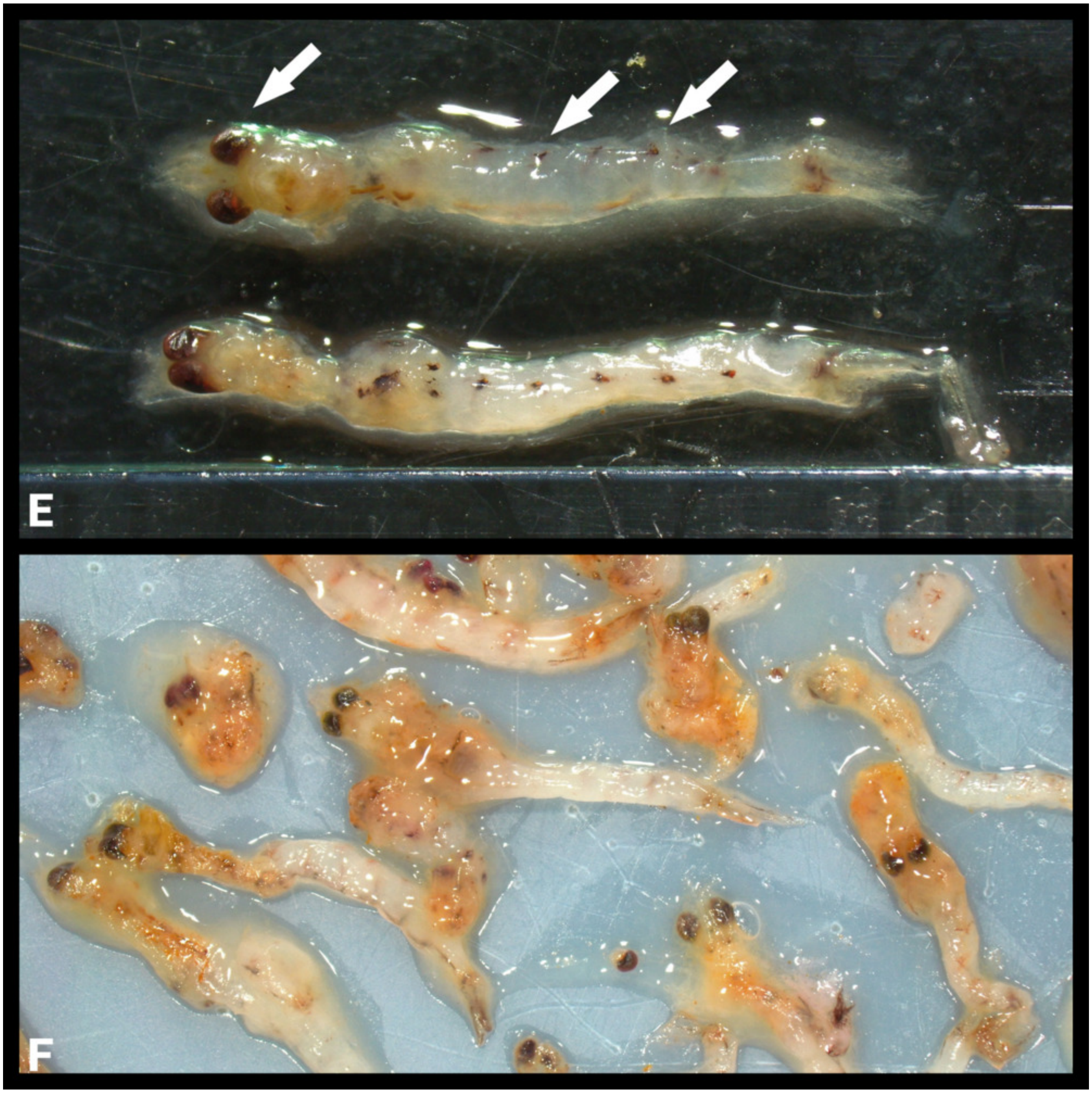


Figure 63. E) Mysis species. Note black eyes and dark star-shaped spot on each body segment. F) Partially digested Mysis species or subfamily Mysinae.

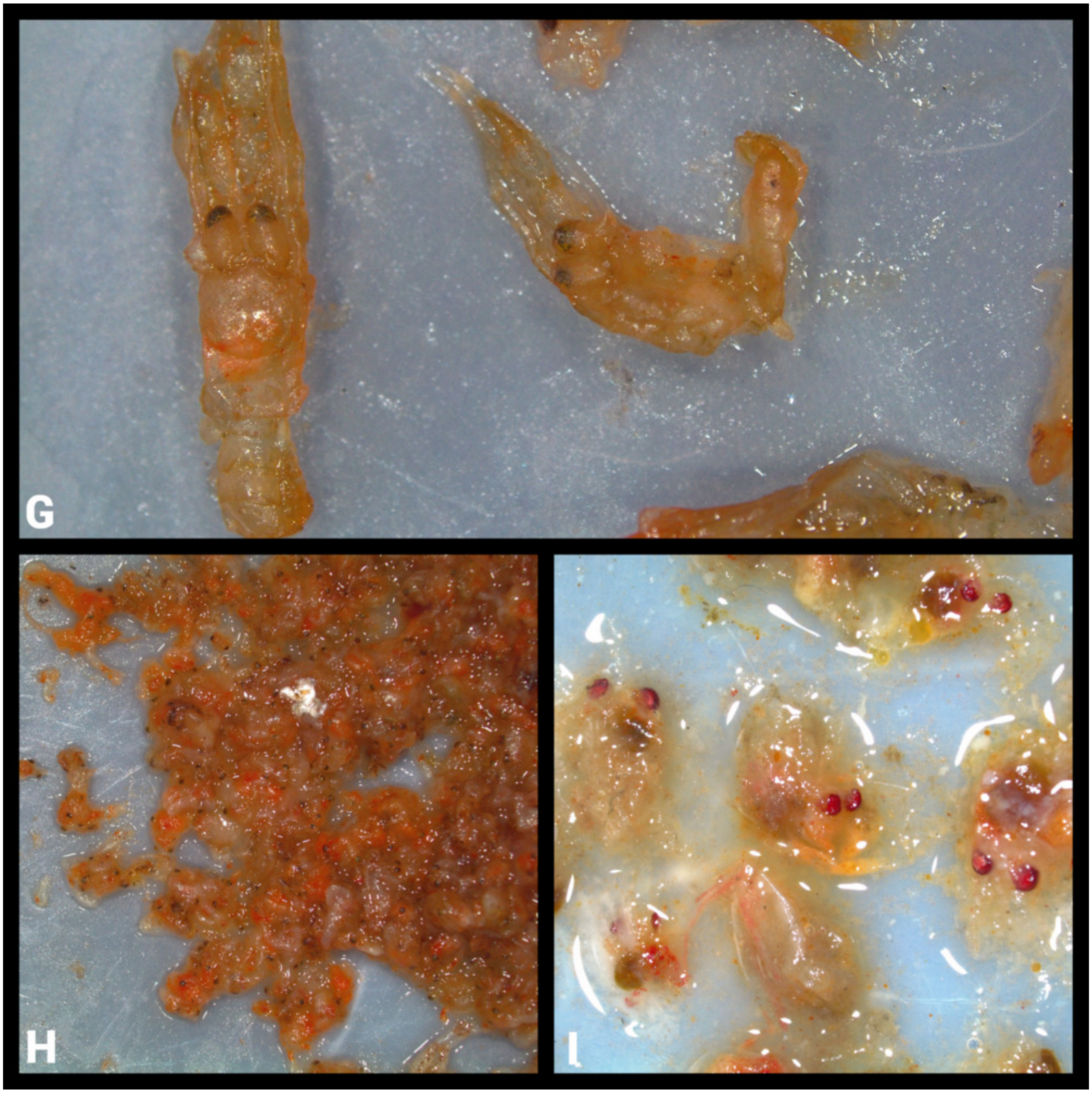


Figure 64. G) Mysidae species. H) Partially digested Mysidae. I) Partially digested Mysidae. cf. *Boreomysis*.There are other red-eyed mysids, not just *Boreomysis*. Important to examine telson shape to confirm.

3.33 Tanaidacea (Order) - AphiaID: 1133

Description:

This crustacean order of tanaids make up a small group in the class Malacostraca, they are small shrimplike animals that are typically 2 to 5 mm in length. They are usually light coloured and their carapace covers the first two segments of the thorax. Tanaids have three pairs of limbs on the thorax, a small pair of maxillipeds, a pair of large clawed gnathopods, and a pair of pereiopods that are specialized for burrowing into the substrate (Figure 65). An uncharacteristic trait of Crustaceans, this group has no appendages on the last six thoracic segments. They are mostly bottom-dwellers that are commonly found in shallow water and associated with seagrasses and algae, although there are some species that live in very deep waters. Most common genera are Leptochelia and Tanais. See Sieg and Winn (1978) for identification keys.

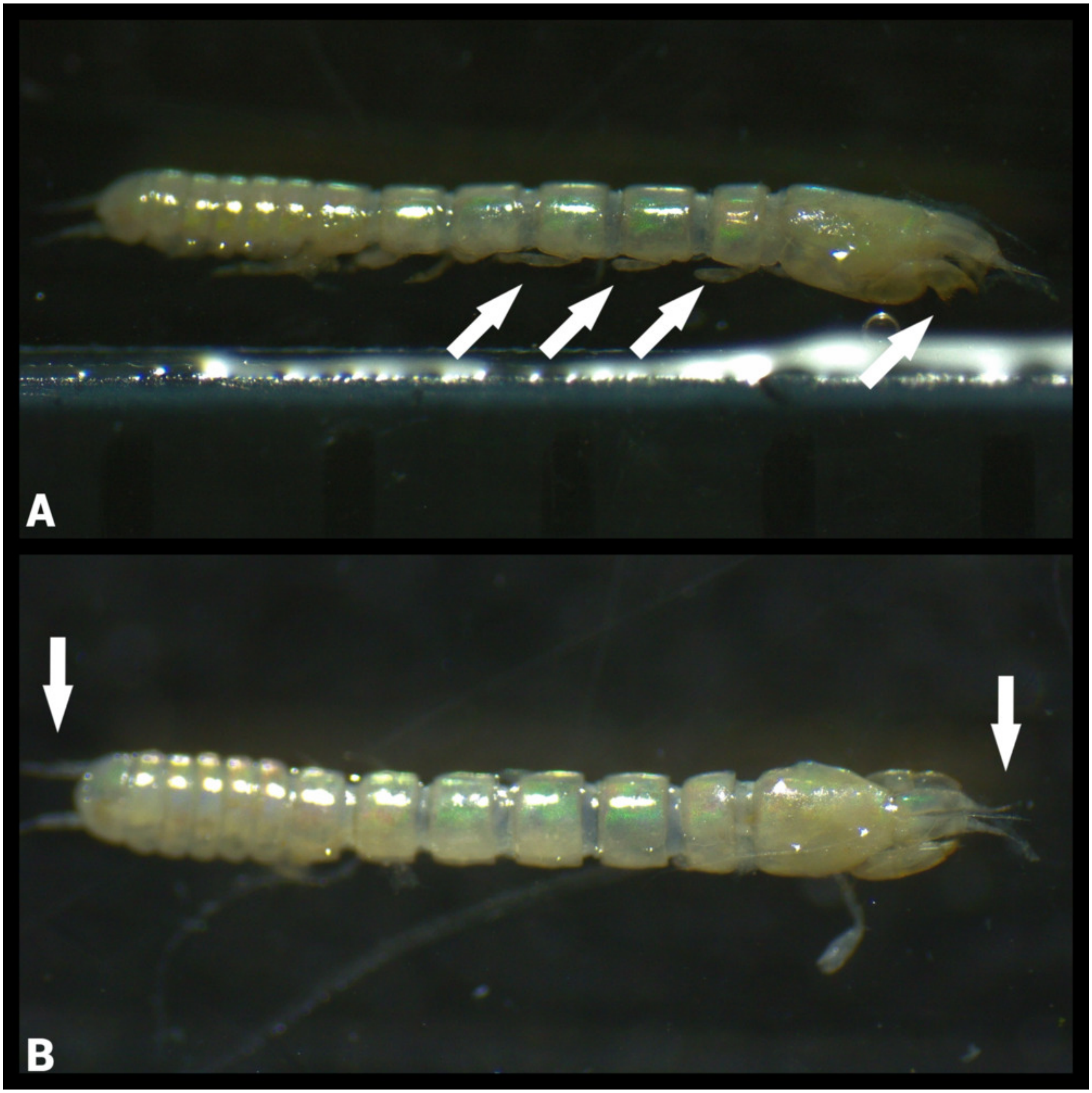


Figure 65. **Tanaidacea**. A) Lateral view: Light coloured segmented body, three pairs of limbs on the thorax, and a pair of large subchelate gnathopods. B) Dorsal view: Final segment of body fused to telson and carries a pair of uropods, last six segments of thorax have no limbs, small pair of maxillipeds for feeding.

3.34 Ostracoda (Class) - AphiaID: 1078

Description:

Also known as “seed shrimp”, these small crustaceans (on average ~2 millimeters in length, can range from 0.2 to 30 mm in size) are laterally flattened with a bivalve like shell (hinge is on the dorsal part of the body) (Figure 66). Unlike other crustaceans, the body is not clearly divided in segments. Ostracods do not usually have gills, they take in oxygen through branchial plates on the body. Fairly distinct anatomy but can be confused with Cypris larvae of barnacles (both ends are rounded and major appendages are anteriorly placed in ostracods, whereas the anterior is rounded, posterior is pointed and major appendages are posteriorly placed in Cypris larvae).

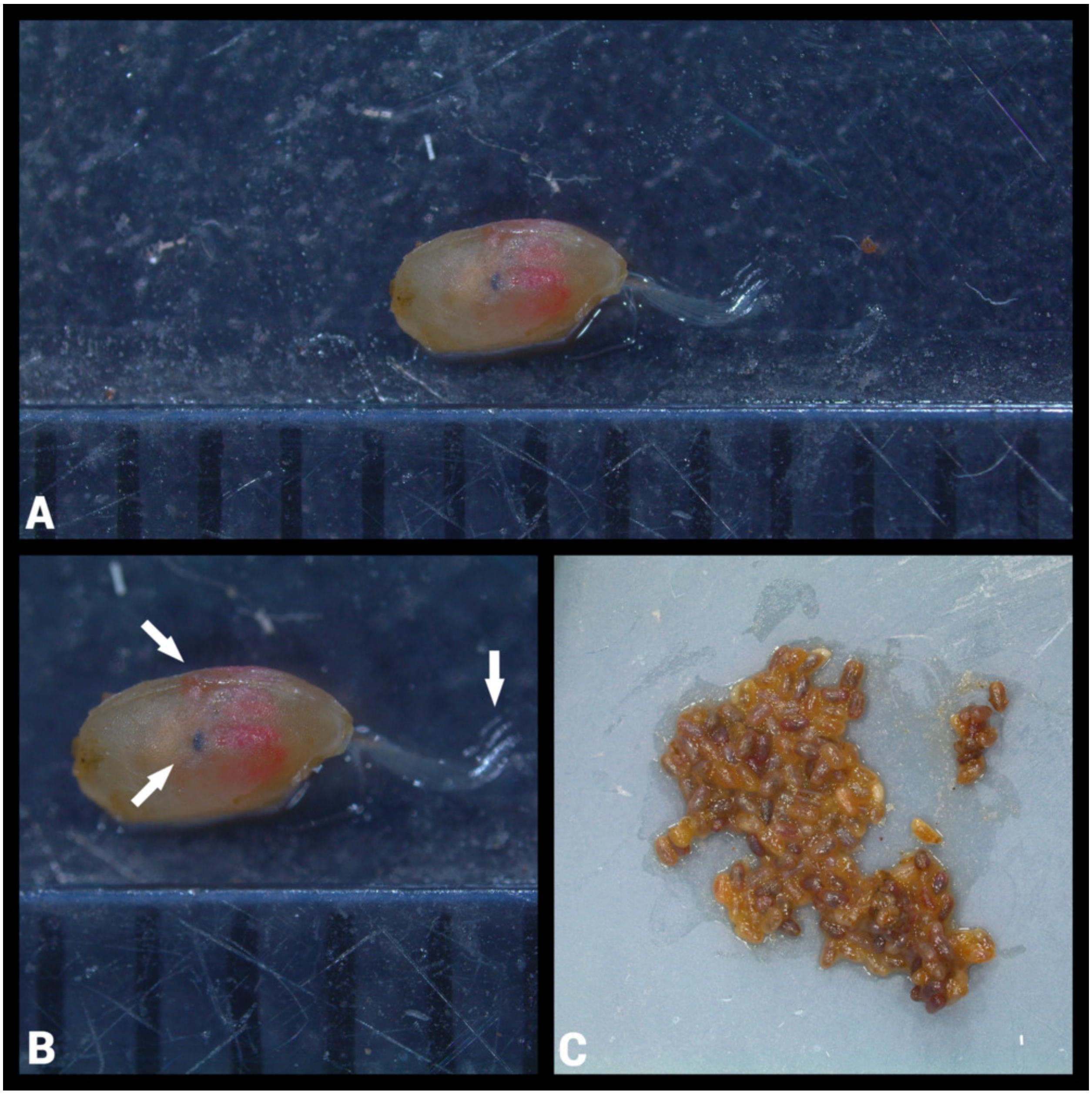


Figure 66. **Ostracoda**. A) Ostracoda. B) Bivalve like shell that is rounded at both ends and has a hinge on the dorsal edge. Antennae and appendages are located on the anterior. Visible eyespot beneath shell. C) Partially digested Ostracoda

3.35 Cnidaria (Phylum) - AphiaID: 1267

Description:

This group includes both sessile (polyps) and swimming forms (medusae). They are characterized by specialized cells that are utilized for capturing prey items. Jellyfish (Scyphozoa), sea anemone (Actiniaria), soft corals (Malalcyonacea), and stony corals (Flabellum). are all included in this phylum (Figure 67). Unless the item was freshly consumed before specimen collection, this group is usually very well digested and often unidentifiable.

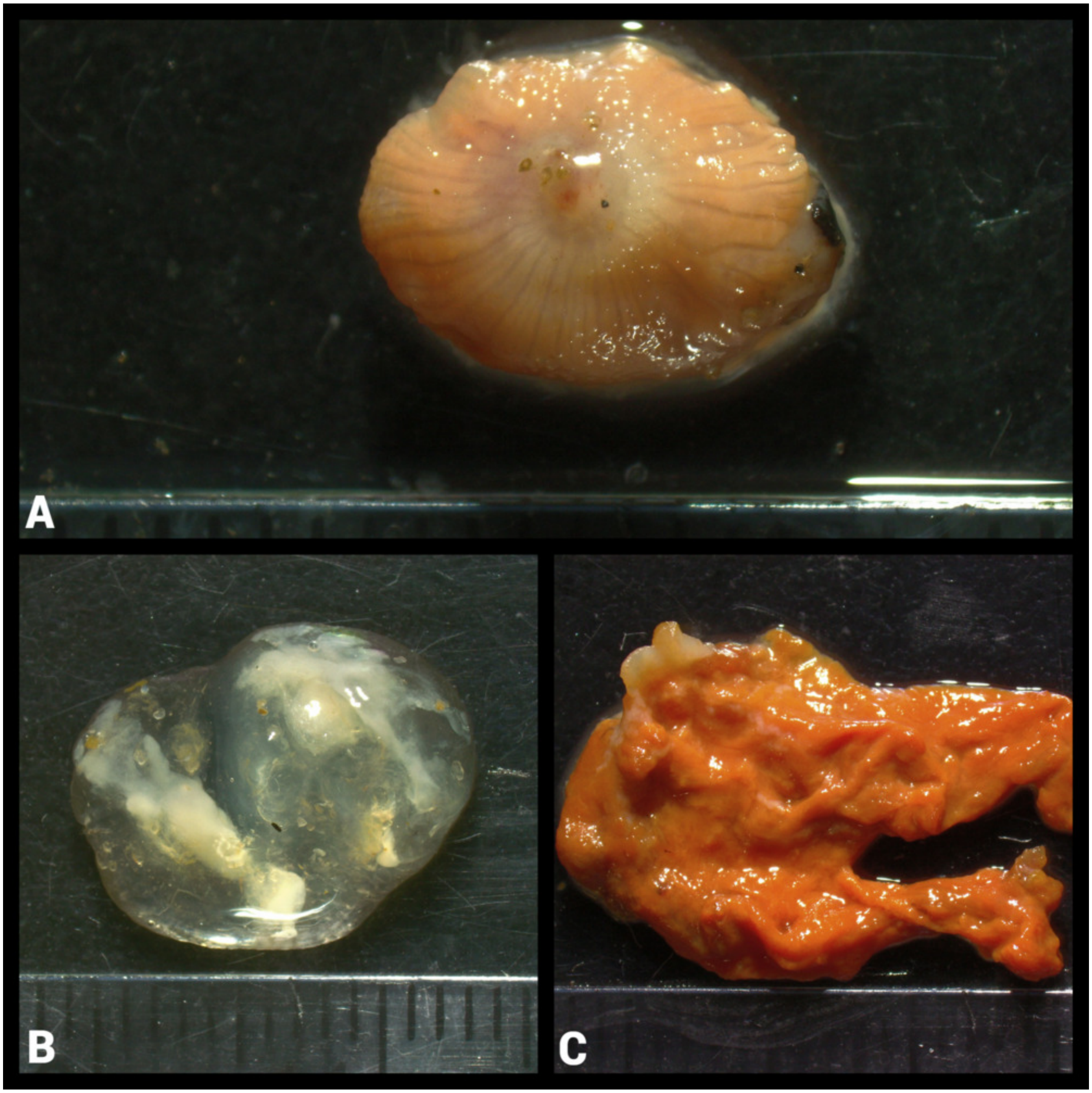


Figure 67. **Cnidaria**. A) Actiniaria. B)Scyphozoa or hydromedusa (Hydrozoa) which are often clear and white. C) Partially digested Actiniaria.

3.36 Echinodermata (Phylum) - AphiaID: 1806

Description:

Recognized by their radial symmetry (usually five-point), this group includes sea stars (Asteroidea), brittle stars (Ophiuroidea), sea urchins (Echinoidea), sea cucumbers (Holothuroidea) and sea lilies (Crinoidea).

3.37 Asteroidea (Class) - AphiaID: 123080

Description:

Starfish or sea stars are quite distinct due to their unique pentaradial symmetry (five wide and hollow rays that touch each other are arranged around a central body disc). Their skeletons are made up of ossicles (calcareous structures) that make up a firm yet flexible internal mesh network. Their arms or rays house hundreds of tube feet on the ventral surface that are utilized for locomotion. The grooves that house these feet are called ambulacral grooves, and are a noticeable feature when looking at the underside of this group. Most sea stars are covered with spines and their surfaces often include pedicellariae (very small pincers) as well. Species identifications are generally based on shape of the body, the characteristics of marginal plates that line the edge of each arm, texture and size of the spines, and the colour of their body and other features (Figure 68).

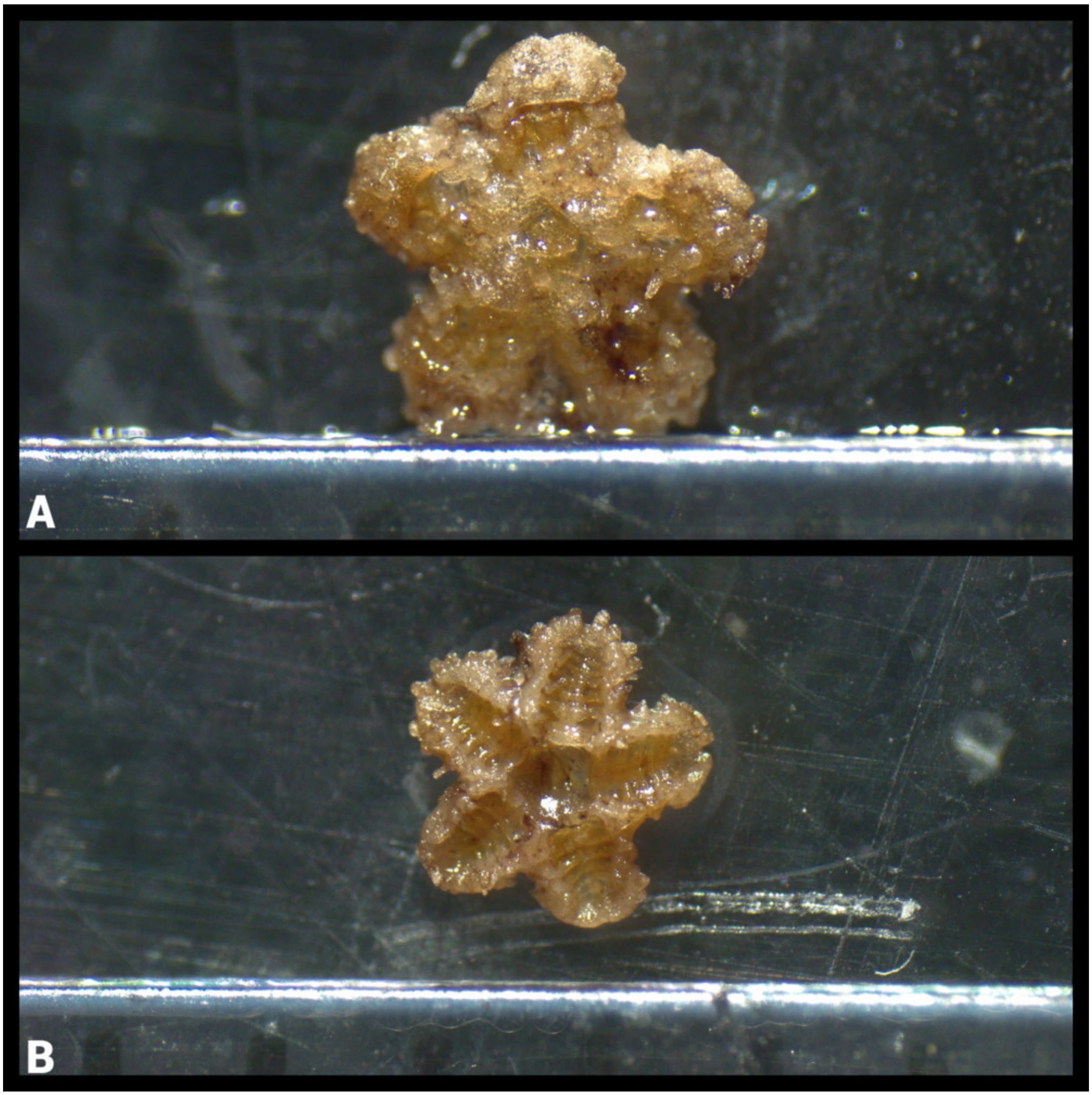


Figure 68. **Asteroidea**. A) Asteroidea (juvenile) (dorsal view). B) Asteroidea (ventral view).

3.38 Echinoidea (Class) - AphiaID: 123082

Description:

This group commonly referred to as sea urchins are globular, spiny echinoderms with fivefold symmetry. Sand dollars are included in this class and are basically flattened burrowing sea urchins. The most commonly encountered echinoderms found in stomach content were Strongylocentrotus species (*S. droebachiensis, S. pallidus*) (Figure 69), and *Echinarachnius parma* (Common sand dollar) (Figure 70).

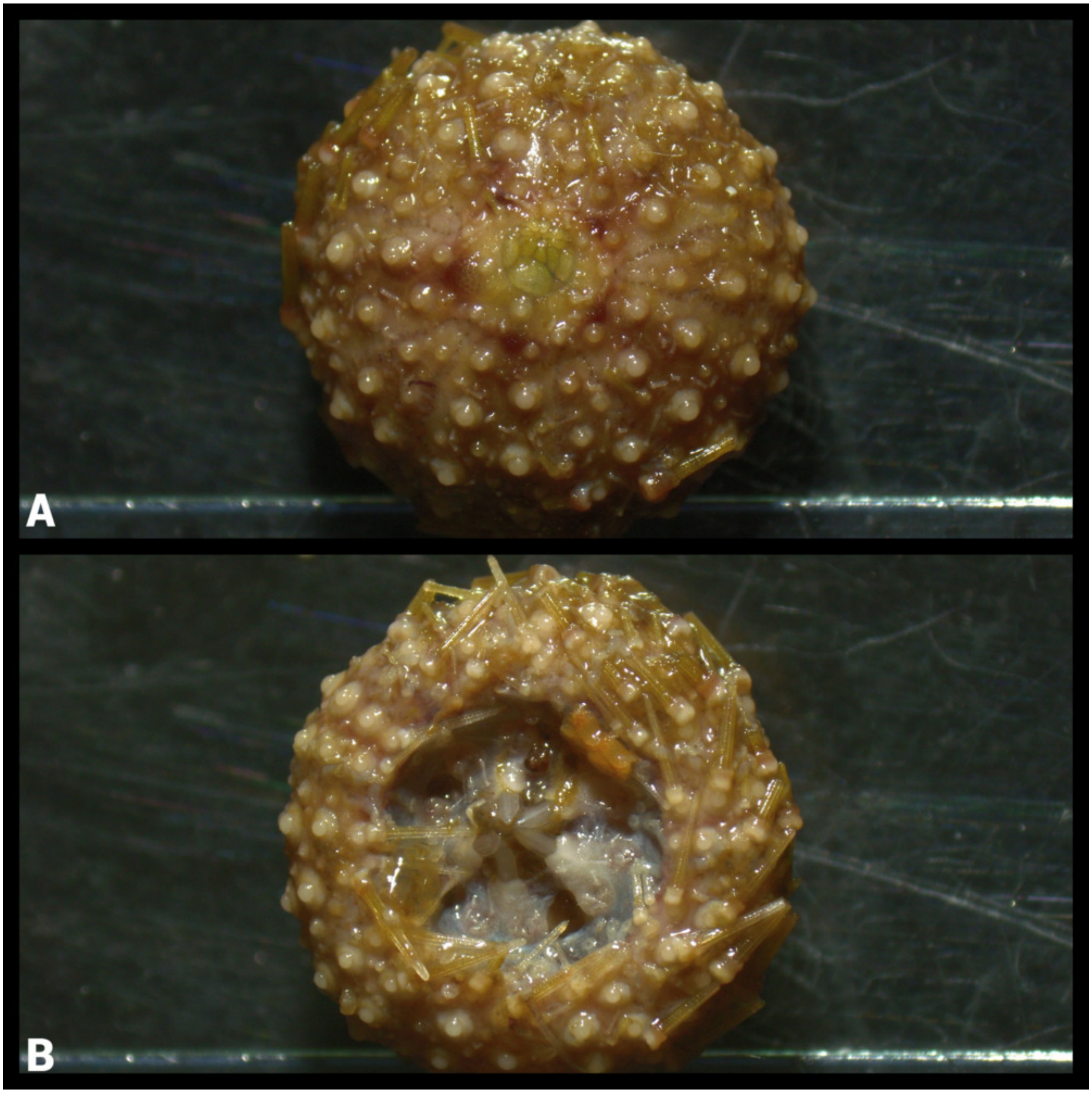


Figure 69. **Echinoidea.** A) *Strongylocentrotus.* B) *Strongylocentrotus* (ventral view). Short, stout spines.

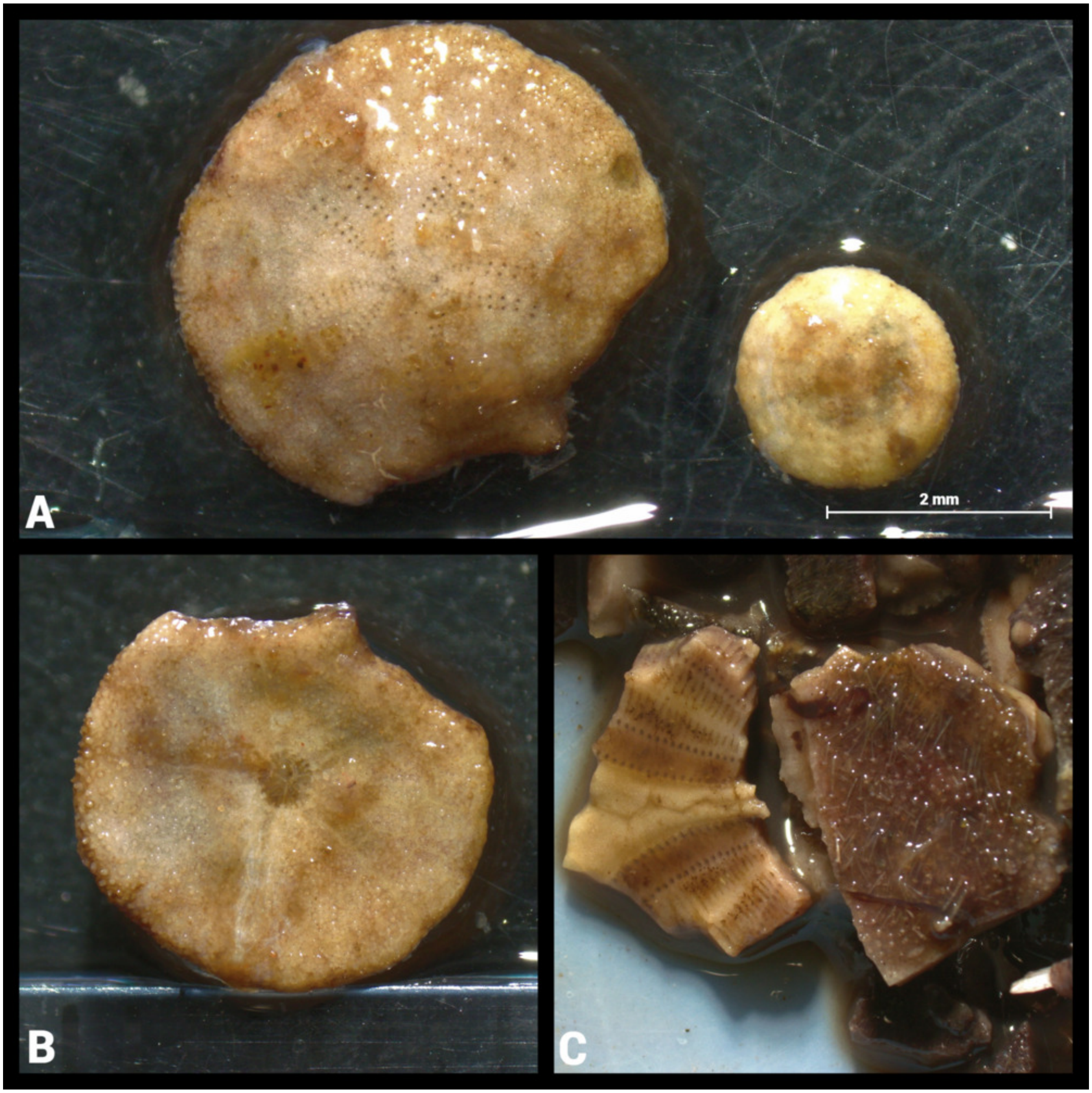


Figure 70. C) Sand dollar (*Echinarachnius parma*)(dorsal view). D) *Echinarachnius parma* (ventral view). E) Crushed and partially digested Echinoidea.

3.39 Holothuroidea (Class) - AphiaID: 123083

Description:

This class of echinoderms are commonly referred to as sea cucumbers because of their resemblance to the fruit of a cucumber plant. They lack the typical arms found in most echinoderms like sea stars, although the classical fivefold symmetry associated with echinoderms is still structurally present. They possess an exoskeleton that is located just below the skin and typically consists of ossicles that are joined by connective tissue, in some species (*Psolus*) these can be enlarged to flat plates that act as armor (Figure 71).

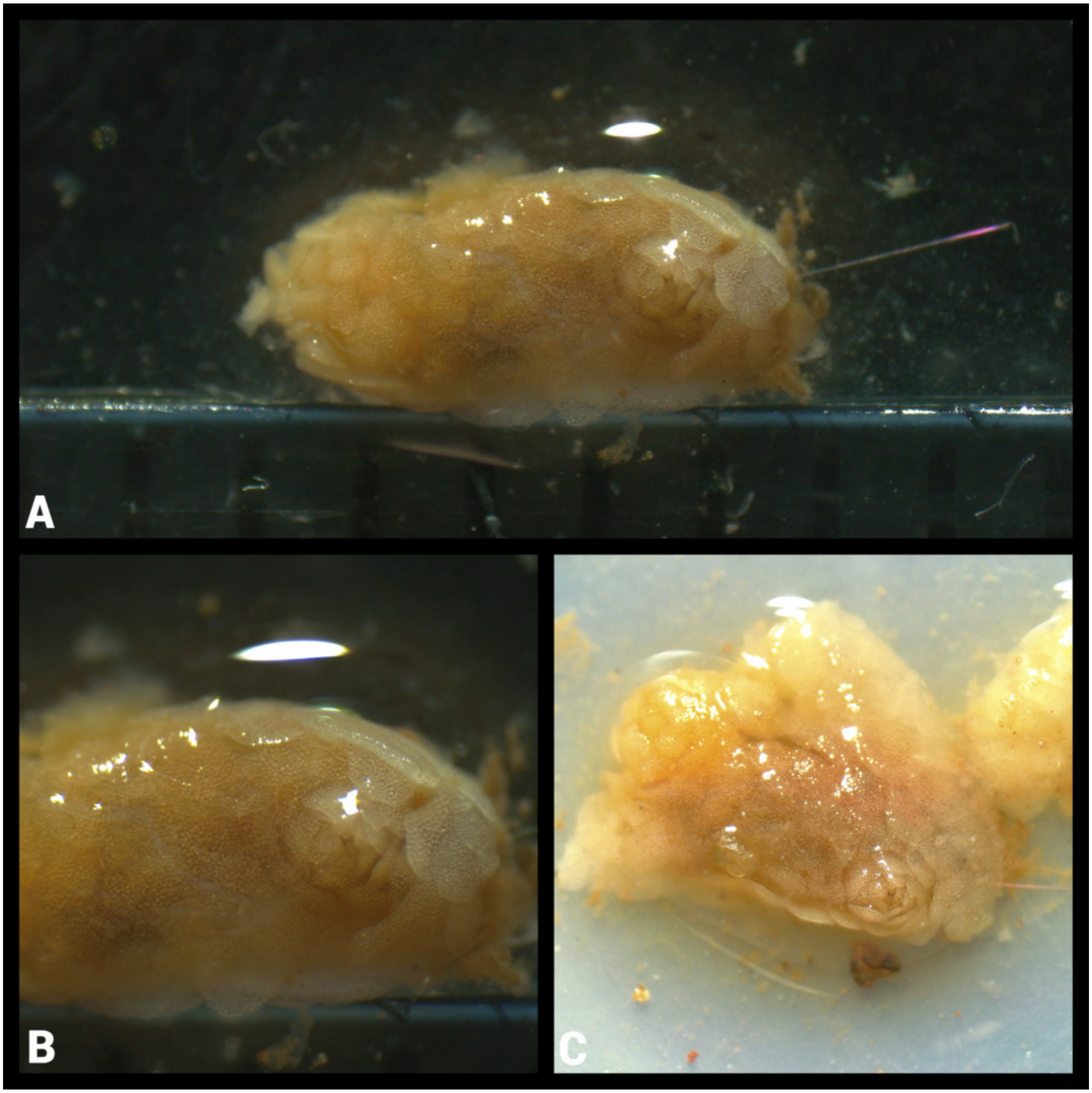


Figure 71. **Holothuroidea**. A) Brown Psolus (*Psolus phantapus*). B) *Psolus phantapus*. Domed dorsal surface with scales and flattened ventral surface. White (young) to black (adults) in colour. C) Partially digested *Psolus*.

3.40 Ophiuroidea (Class) - AphiaID: 123084

Description:

This group is commonly referred to as brittle stars. The have fragile arms that are easily broken and use these arms for locomotion as opposed to tube feet like other members of the Echinodermata phylum. Difficult to determine species level identification. Pay close attention to the length of the arms themselves, the length of spines that border the arm joints, and the location and shape of scales on the upper and lower surface of the body. The upper scales are called radial shields and are located where the arms meet the body. The lower scales are called oral shields and are positioned next to the mouth and in between the base of the arms. *Ophiacantha, Amphiura* and *Ophiura robusta* are delicate kinds of brittle stars, *Ophiura sarsii* is crunchy like dog kibble or cereal (Figure 74), while the larger segments and robust short spines of *Ophiopholis* makes it the 'crunchiest' of all when partially digested (Figures 72, 73). Although this characteristic is helpful for identifications, one should rely on the features noted above, as well as identifying and counting central discs (Figures 75, 76) .

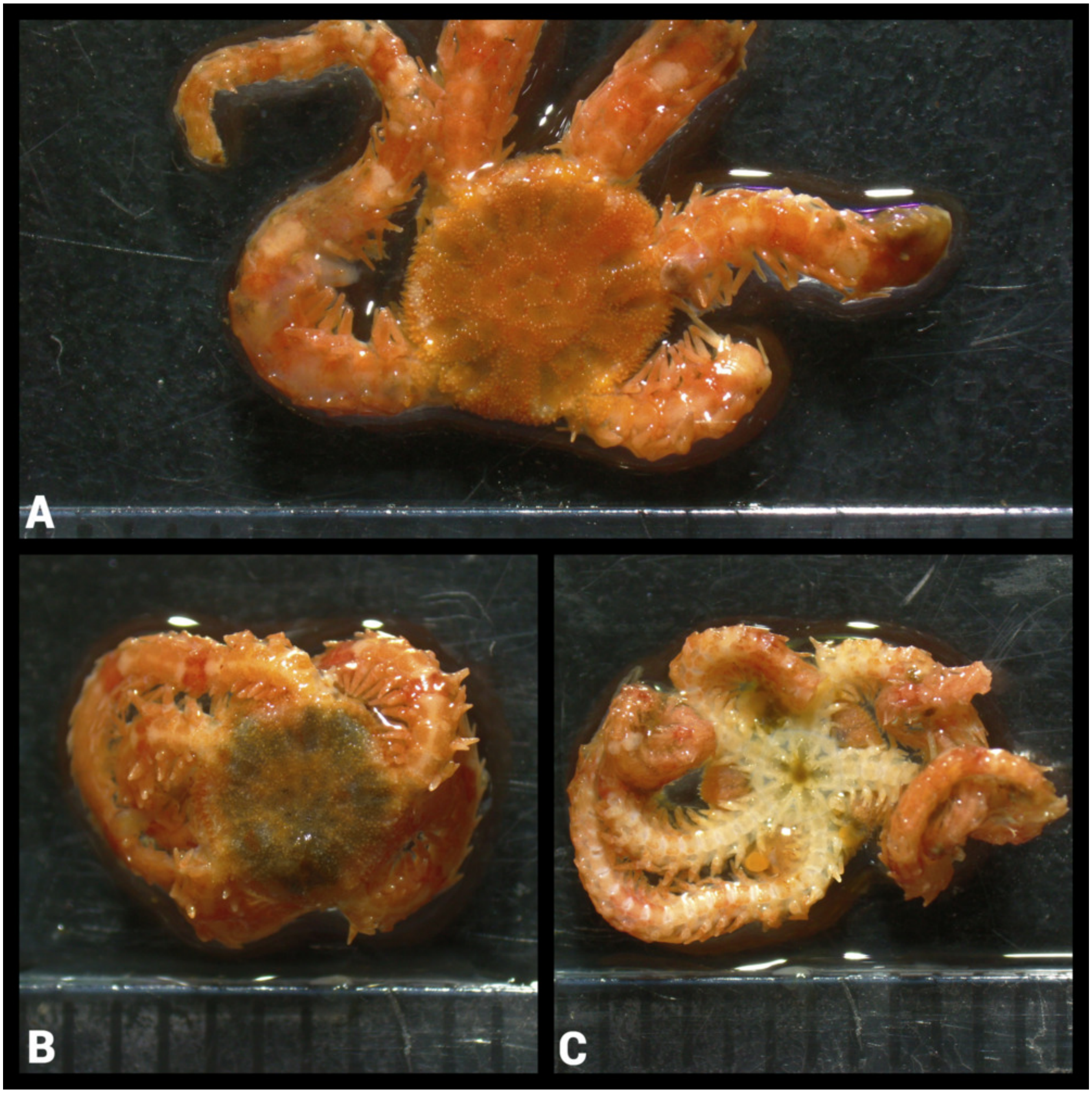


Figure 72. **Ophiuroidea**. A) Daisy brittle star (*Ophiopholis aculeata*). B) *Ophiopholis aculeata* (dorsal view). Mottled and colourful with banded arms. C) *Ophiopholis aculeata* (ventral view). Spines on arms are short and robust.

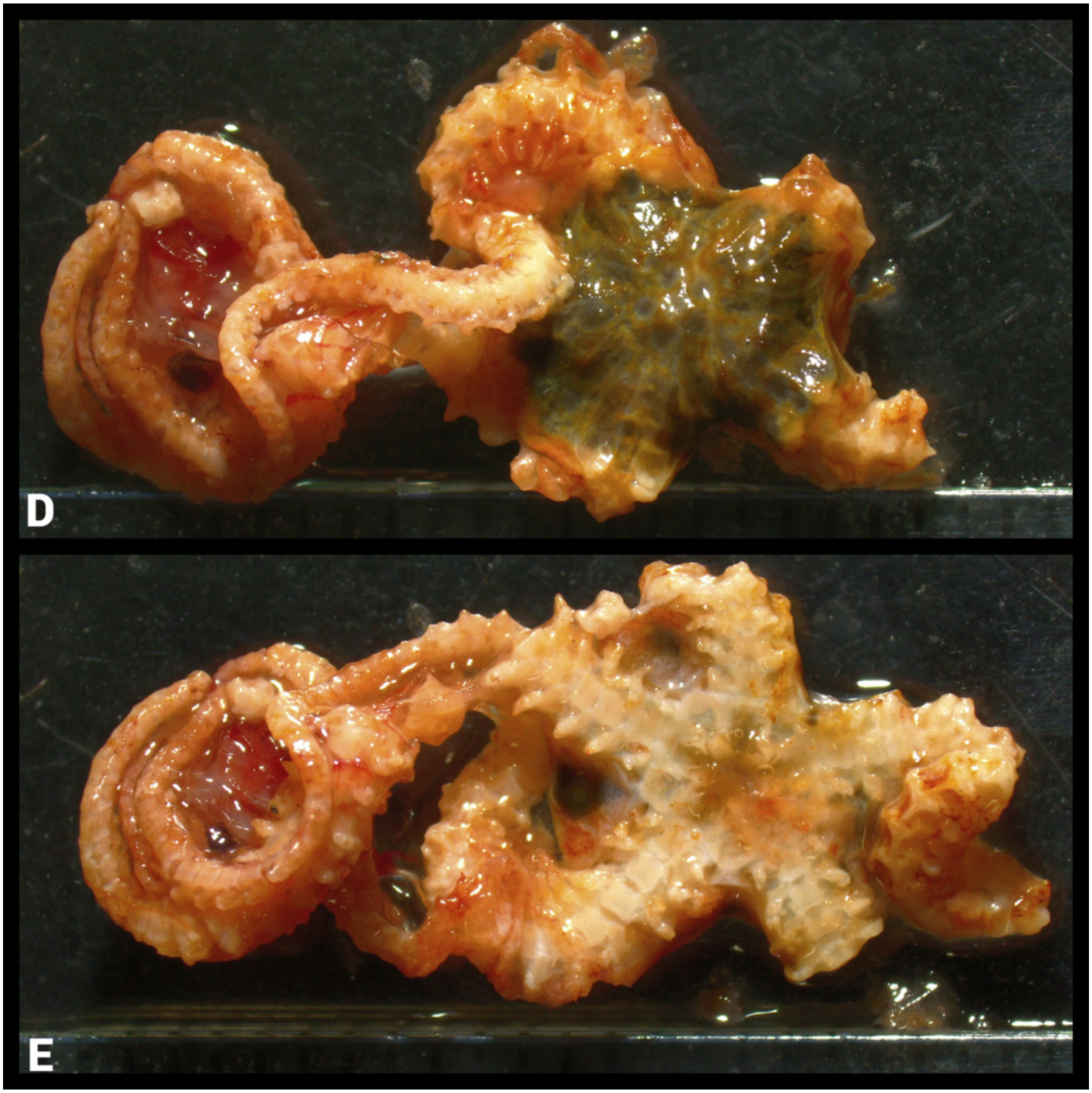


Figure 73. D) partially digested *Ophiopholis aculeata* (dorsal view). E) *Ophiopholis aculeata* (ventral view).

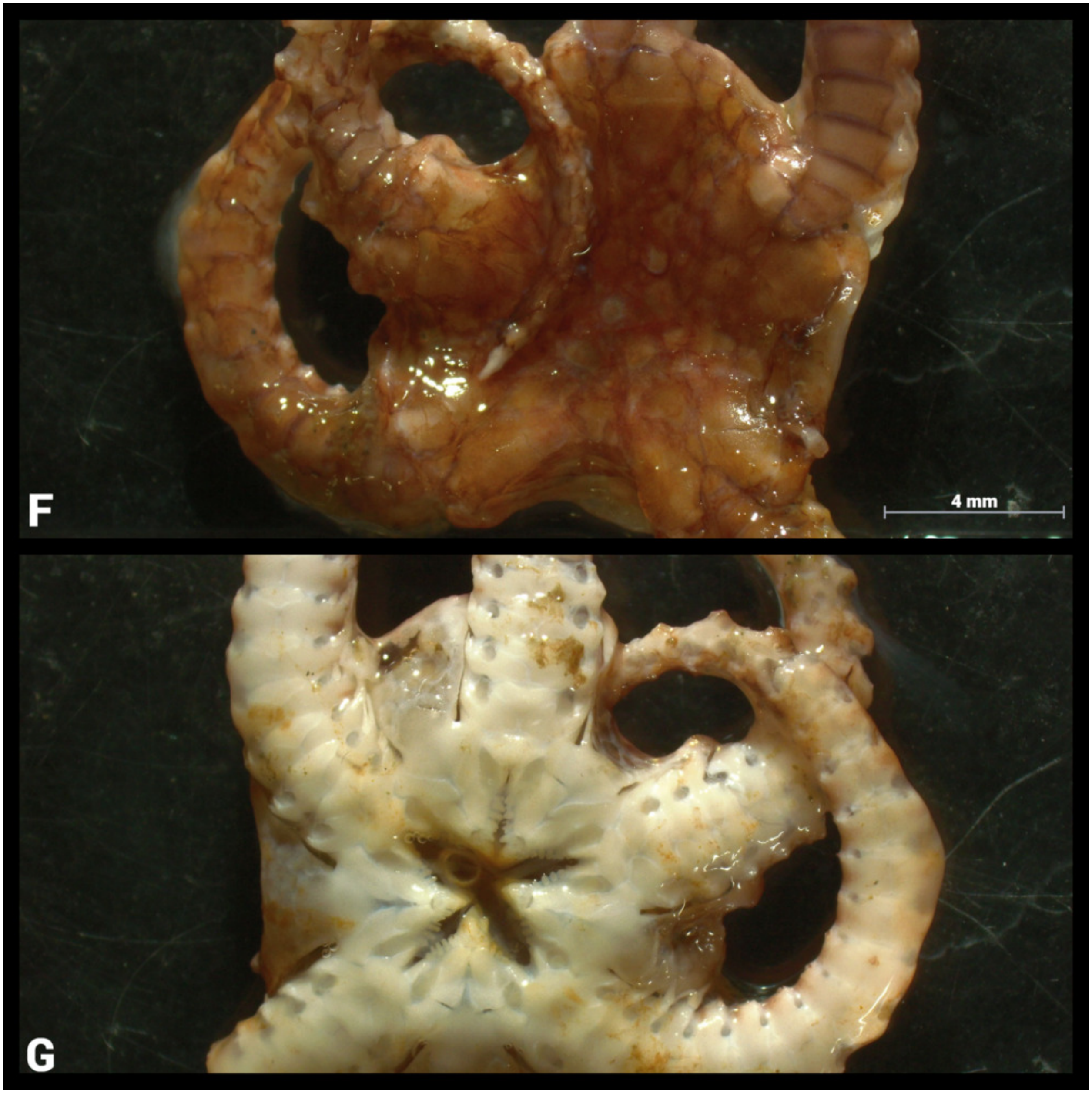


Figure 74. F) *Ophiura sarsii*. Purplish red in colour, large radial shields (length greater than width), arms with a generally smooth appearance (spines lie flat), and moderate in length. G) *Ophiura sarsii* (ventral view). Oral shield width equal to or clearly less than length.

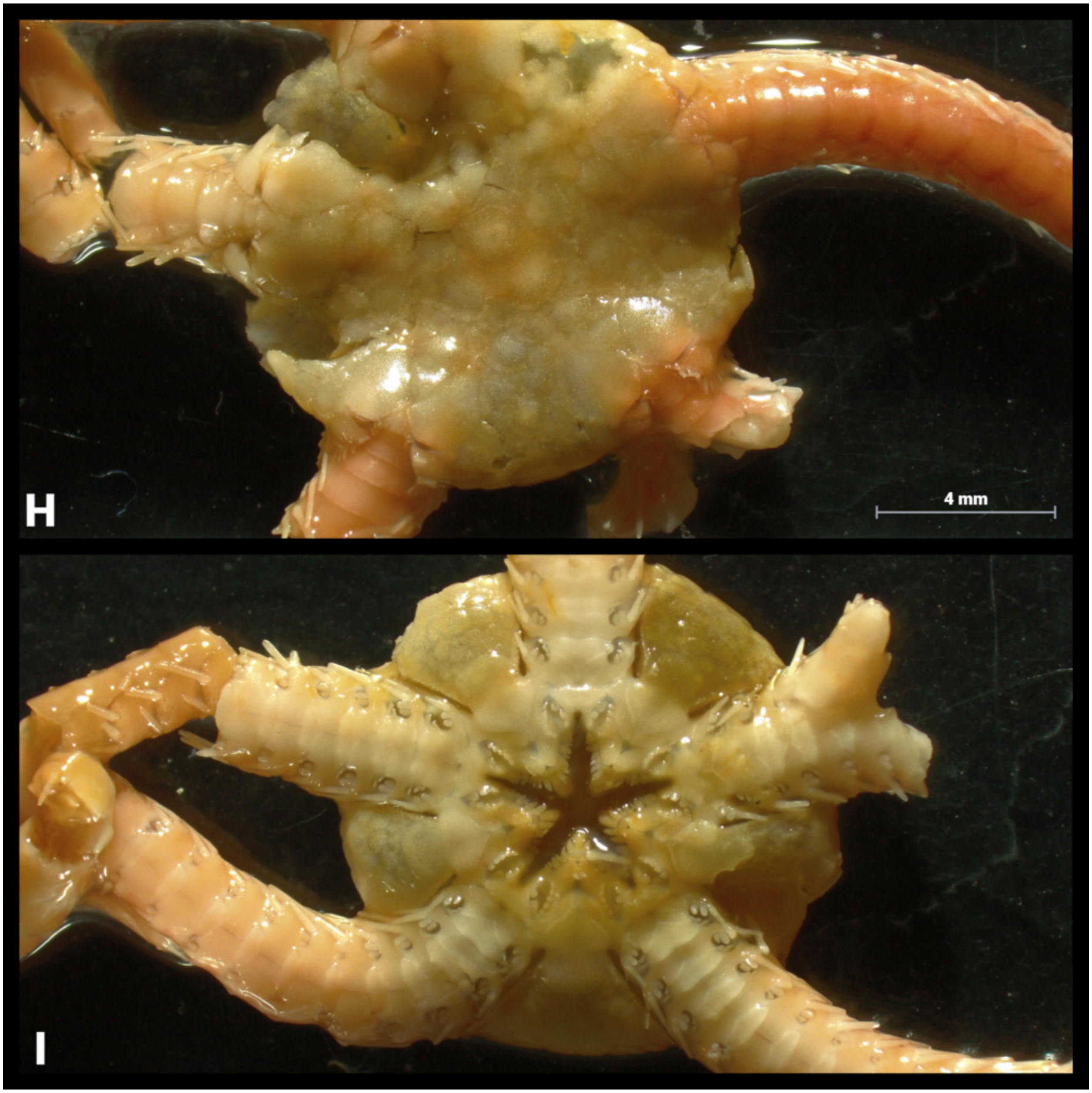


Figure 75. H) Ophiuroidea (dorsal view). Circular pale disc plate with pinkish colored smooth arms. I) Ophiuroidea (dorsal view).

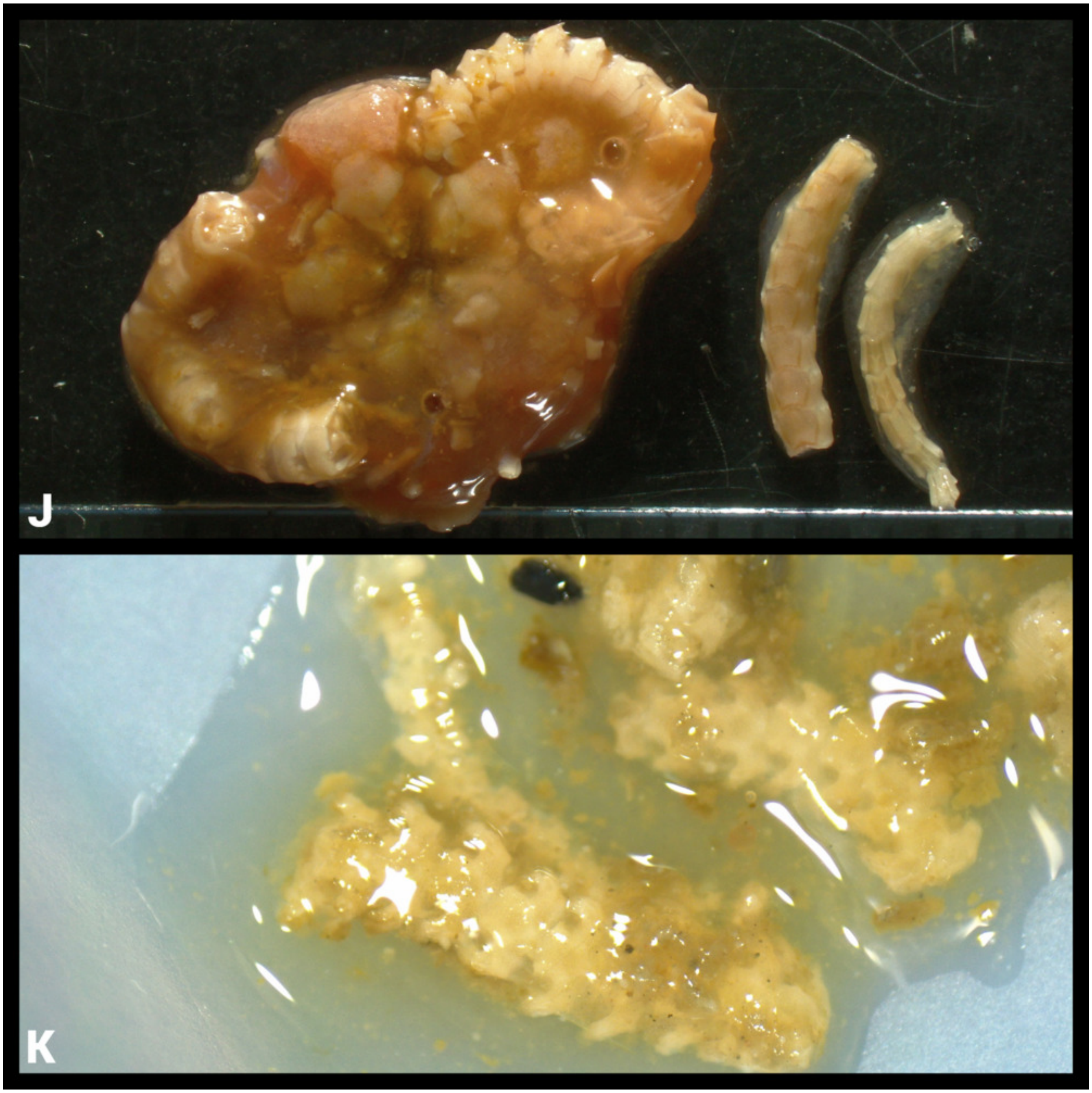


Figure 76. J) Partially digested Ophiuroidea. K) Partially digested Ophiuroidea. Internal structure of arms is visible in this image.

3.41 Mollusca (Phylum) - AphiaID: 51

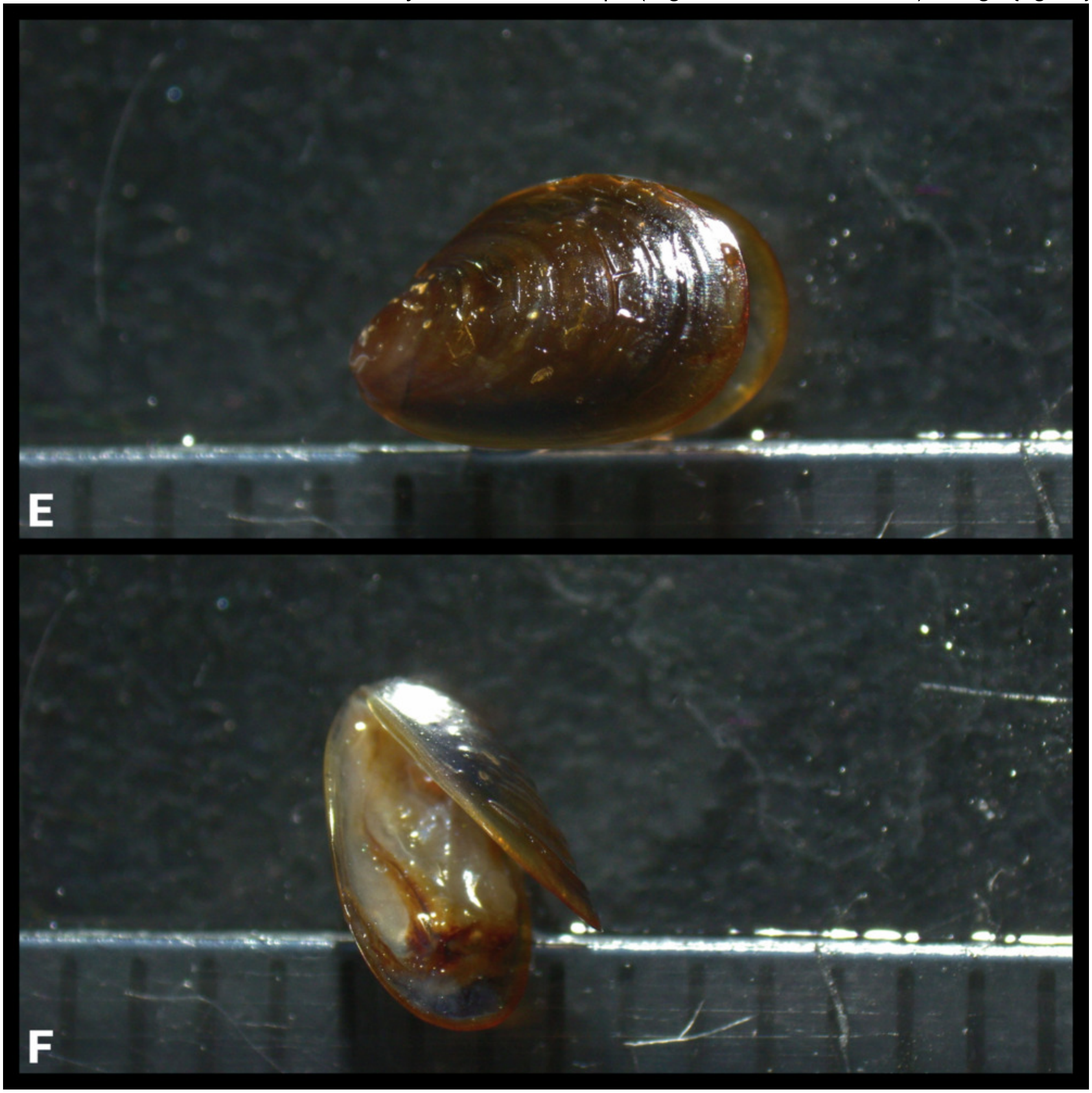
Description:

This is the second largest phylum next to Arthropoda and the largest marine phylum (making up twenty-three percent of all named species). A highly diverse group not only in form and function, but also in habitat and behaviour. The phylum is divided into seven or eight classes, of which two are completely extinct. Molluscs have more varied forms than any other animal phylum. They include snails, slugs and other gastropods; clams and other bivalves; squids and other cephalopods; and other lesser-known but similarly distinctive subgroups. Gastropods are the most abundant molluscs and make up eighty percent of total classified species. The three most universal features of modern molluscs are (1) the presence of a mantle used for breathing and excretion, (2) a radula which is s scraping mouth part (absent in bivalves), and (3) the structure of the nervous system.

3.42 Bivalvia (Class) - AphiaID: 105

Description:

Represented in both marine and freshwater environments, this group is characterized by a laterally compressed body that is encased by a shell that has two hinges. This phylum includes clams, mussels, cockles, oysters, and scallops (Figures 77, 3.42, 78, 79). \begin{figure}



\caption{E) *Mytilus] species. Most likely Blue mussel (*Mytilus edulis*). Younger specimens are brighter-greenish, banded, or rayed. Umbo occupies entire pointed end. F)* Mytilus *(interior view). Inside surface toward rounded end of shell is dark blue, purple, or black.* \end{figure}

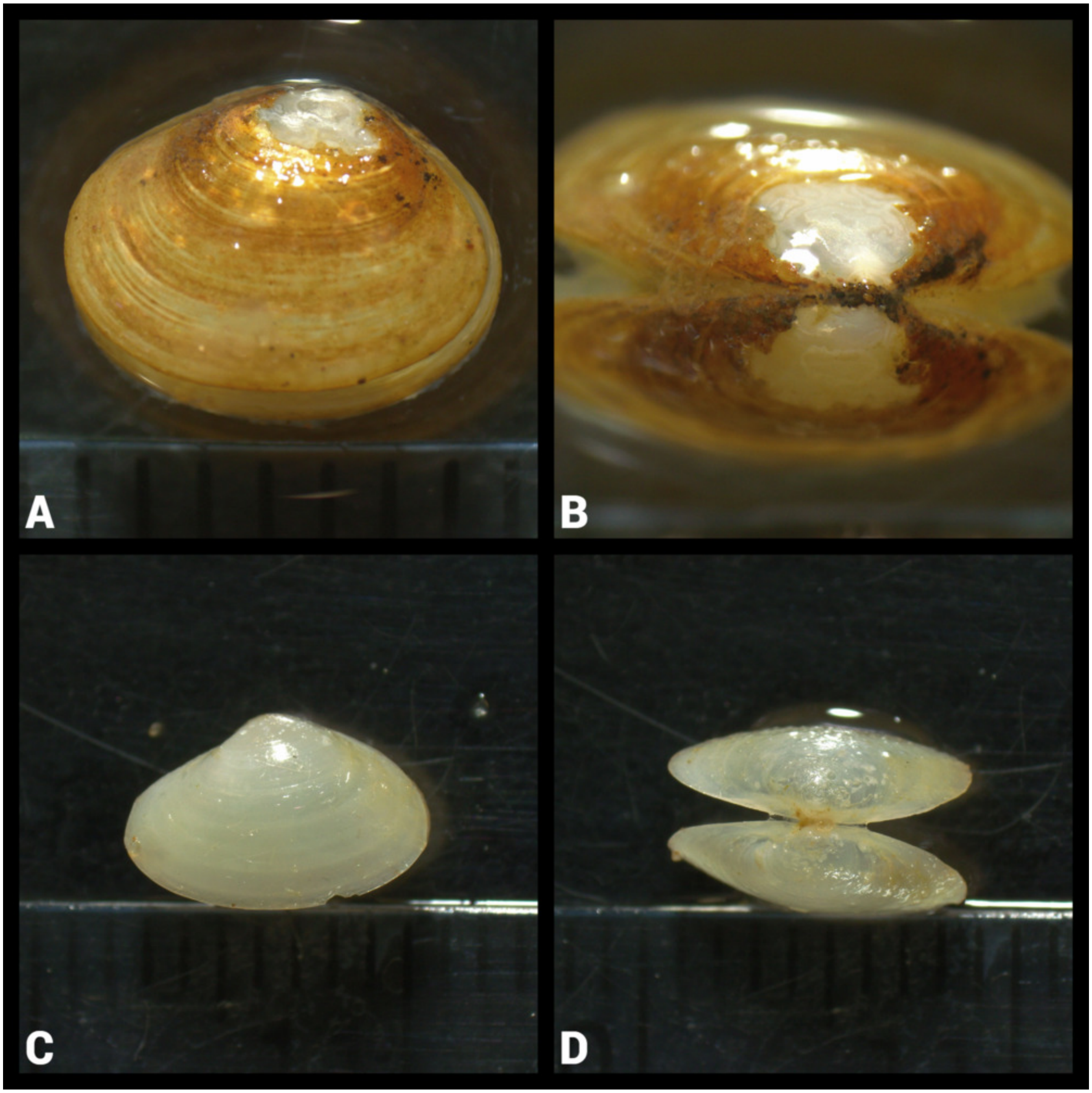


Figure 77. **Bivalvia**. A) *Spisula solidissima*. Rounded shell with central umbo. B) *Spisula solidissima* (umbo view). C) *Spisula solidissima*. Rounded triangular shell with well-developed central umbo. D) *Spisula solidissima* (lateral view).

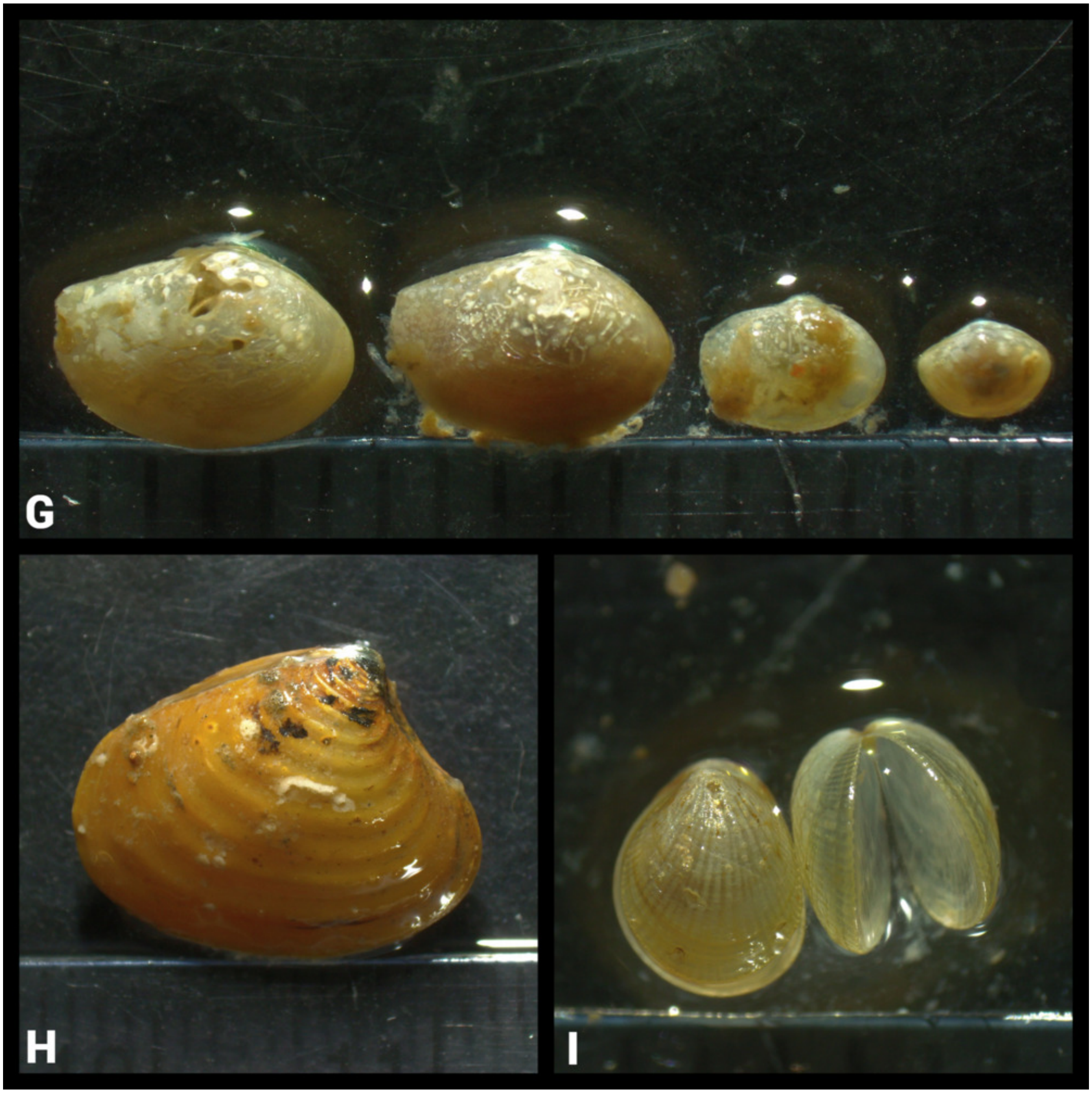


Figure 78. G) *Portlandia arctica*. Laterally compressed shell, anterior end of shell is rounded, posterior end is flattened at top and comes to a slight point. H) *Astarte*. Solid triangular shell, light yellowish brown in colour with ringed sculpture. I) *Solamen*. Inflated shell with radiating ribs, margins scalloped, gapes at one end.

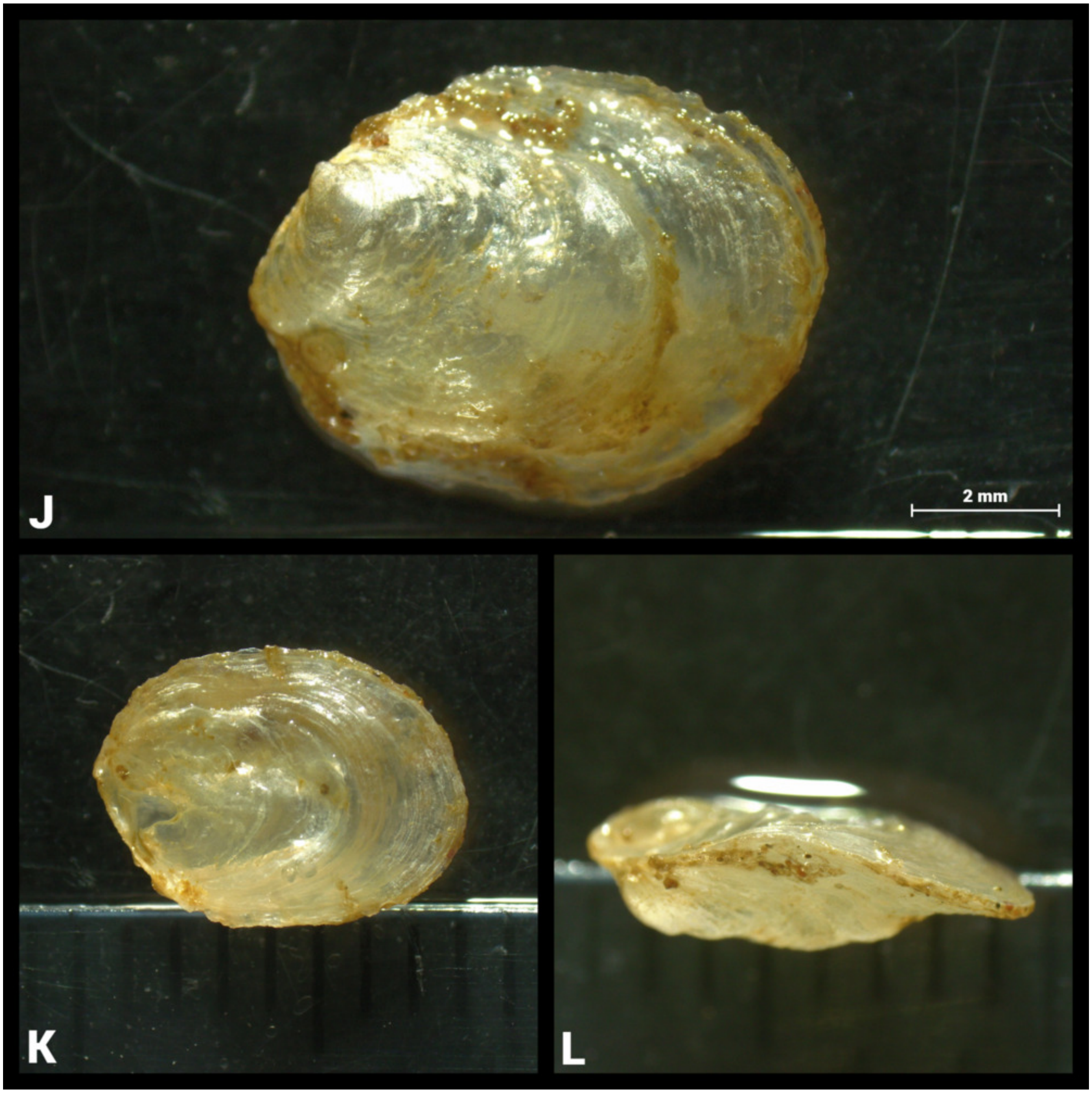


Figure 79. J) Probably Prickly jingle (*Heteranomia squamula*), but Common jingle (*Anomia simplex*) is possible. Have to compare muscle scars inside valves to distinguish (*Heteranomia squamula* has two furrowed muscle scars on the upper valve that are joined). Semi-translucent, pearly, strong, thin shell. Roughly circular with slightly wrinkled or smooth surface that lacks spines or hairs. K) Anomiidae (lower valve). Opening in asymmetrically flattened ventral valve. L) Anomiidae (lateral view). Distinct "S"-shaped curve.

3.43 Cephalopoda (Class) - AphiaID: 11707

Description:

A group that includes octopus, squid, and sepiolids (bobtail squid). Characterized by their bilateral body symmetry, a distinct head, and presence of tentacles/arms. The beak is often the only identifiable piece that is left of these prey items, as it is not easily digested (Figures 80). In regard to squid as a prey item, you will usually only find squid “pens” remaining. These feather shaped internal structures are made of chitin (same compound that is found in the carapace of lobsters and crabs), which is also hard to digest.

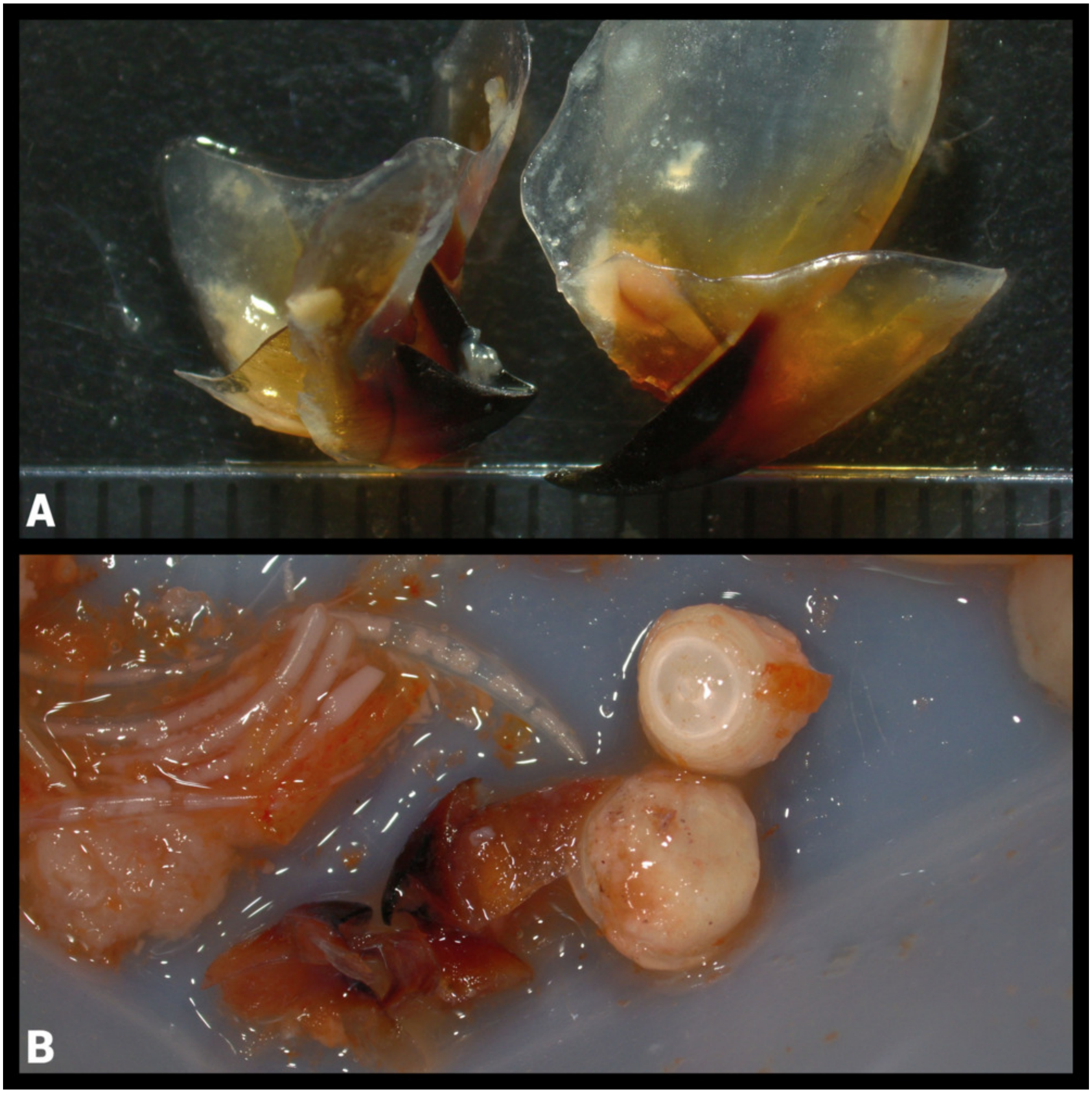


Figure 80. **Cephalopoda**. A) Squid beak (upper and lower mandible). Probably Northern shortfin squid (*Illex illecebrosus*), the common squid here in the Gulf region. B) Squid beak and eyes.

3.44 Gastropoda (Class) - AphiaID: 101

Description:

Commonly known as the slugs and snails, this group has a large number of named species, second only to insects in diversity. As such it is difficult to give a generalized description of their form and function, although there are some common traits. Gastropods typically have a distinguishable head that have two or four tentacles with eyes, and a ventral foot which is where the name Gastropoda comes from. Not all gastropods have shells, but the shelled gastropods typically have a spiral or coil shaped one-piece shell (Figures 81, 82, 83, 84). A large number of species have an operculum, which they can close on themselves, essentially creating a trap door (Figure 81 B).

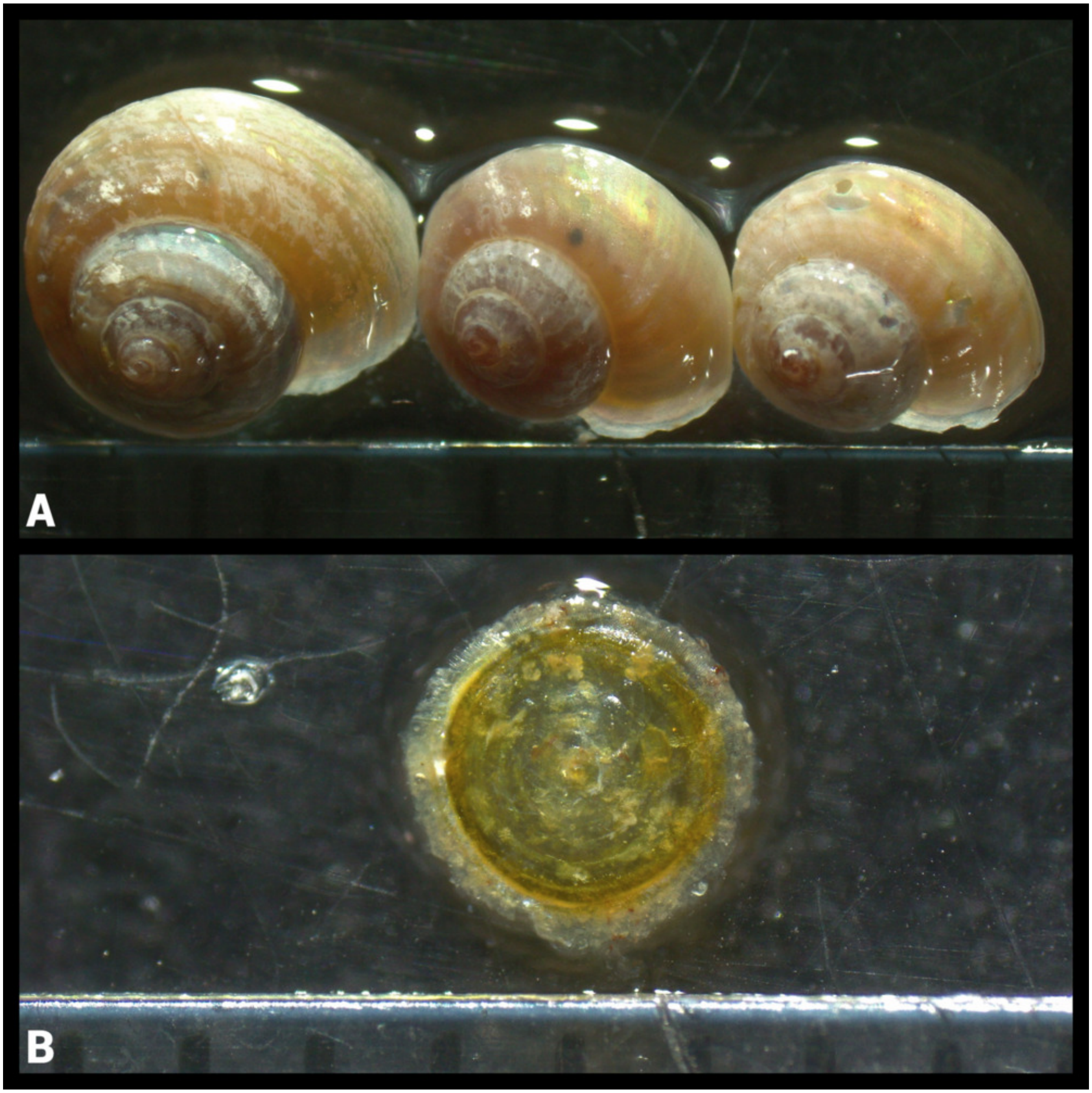


Figure 81. **Gastropoda**. A) *Solariella obscura*. Shell is iridescent and spiraled. B) Gastropod operculum or “trap door”. The shape of the operculum varies greatly from one family of gastropods to another.

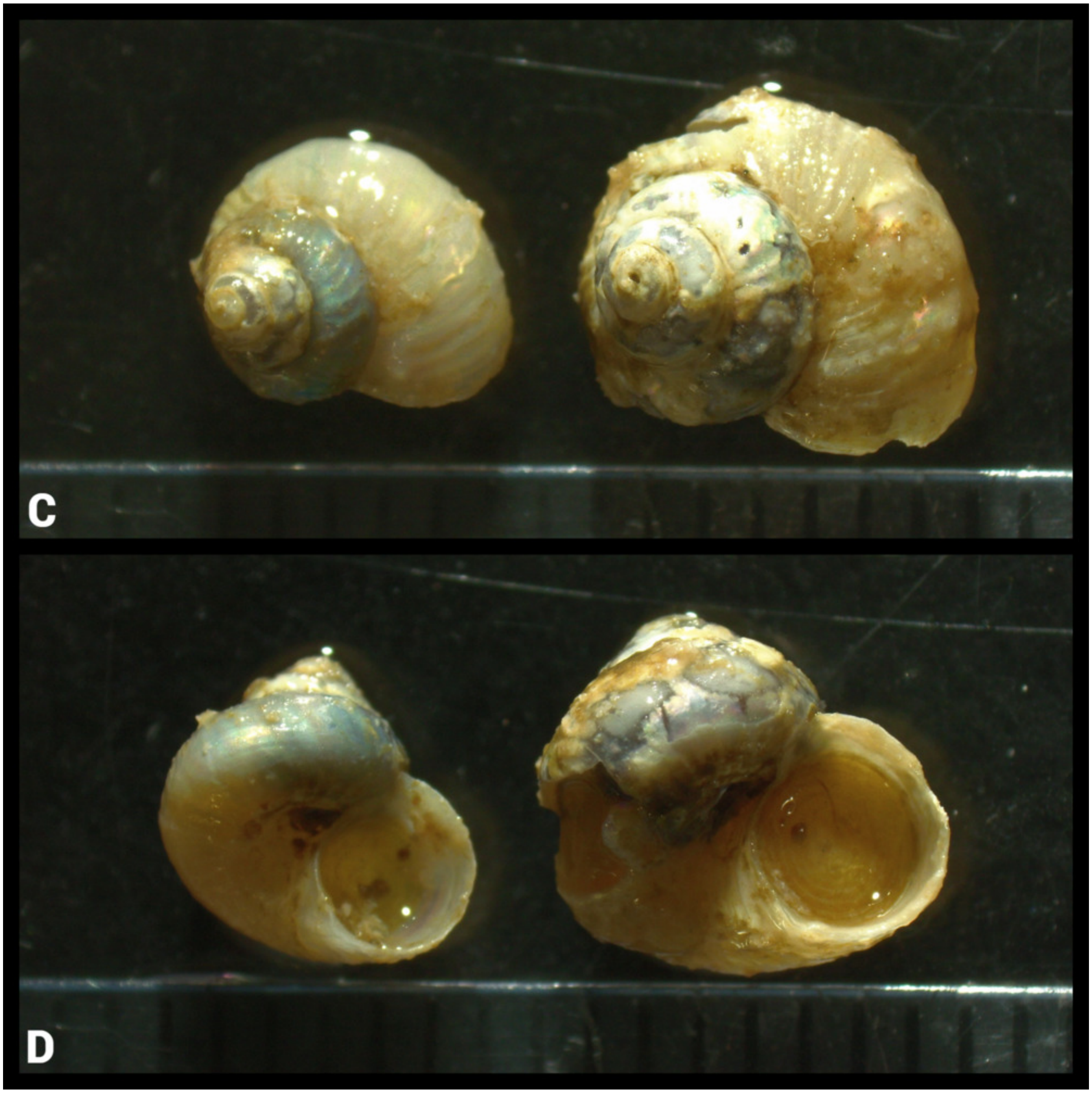


Figure 82. C) *Solariella varicosa*. Spiraled shell that is usually worn or eroded with deep apex. D) *Solariella* species. Circular opening with operculum.

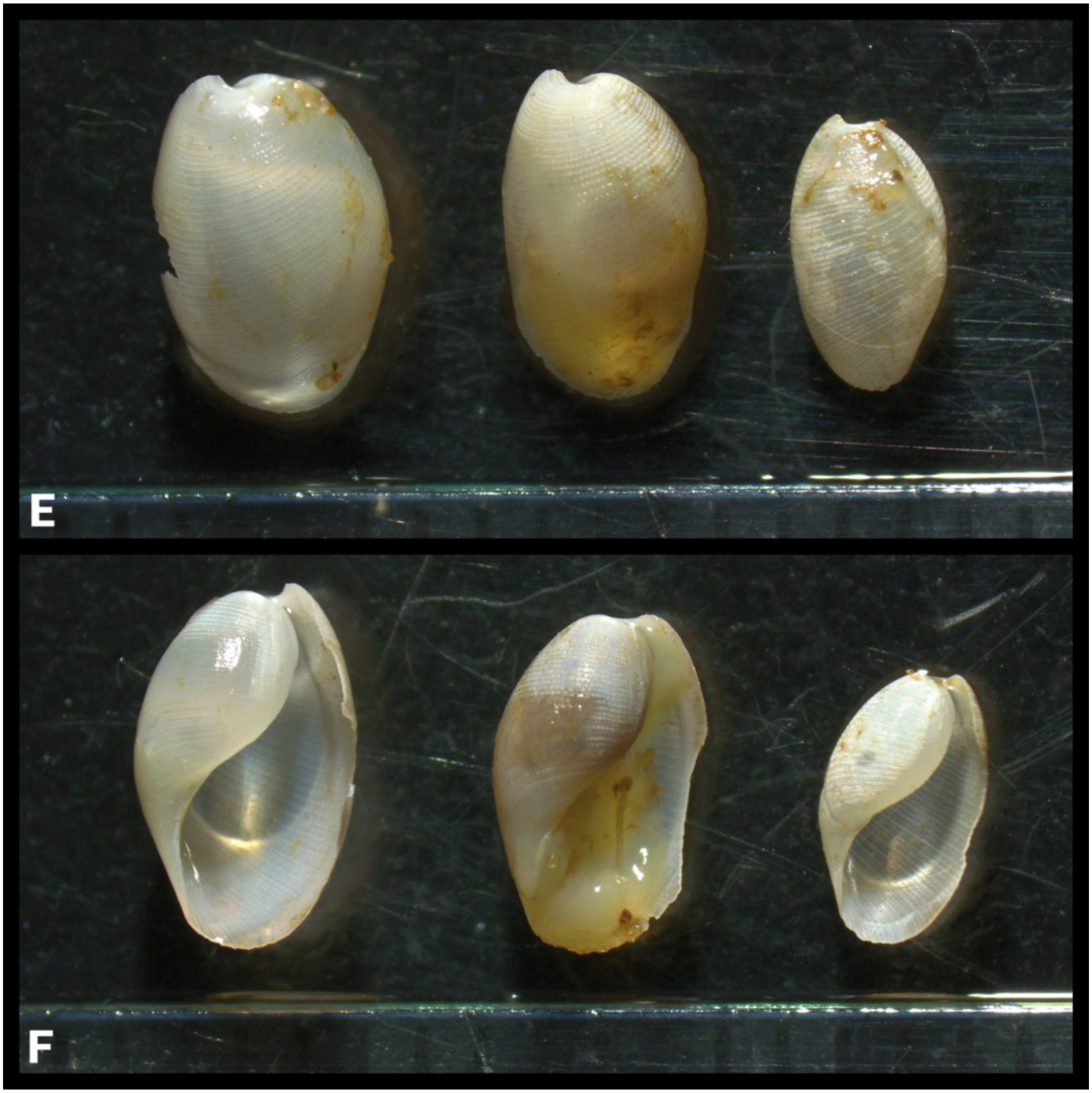


Figure 83. E) Giant canoe bubble (*Scaphander punctostriatus*). Typically the shell is uniform yellow to brown on the outside with many rows of fine spiral striations. F) *Scaphander punctostriatus* (ventral view). Inside of shell is bright white, and spire is covered by body whorl.

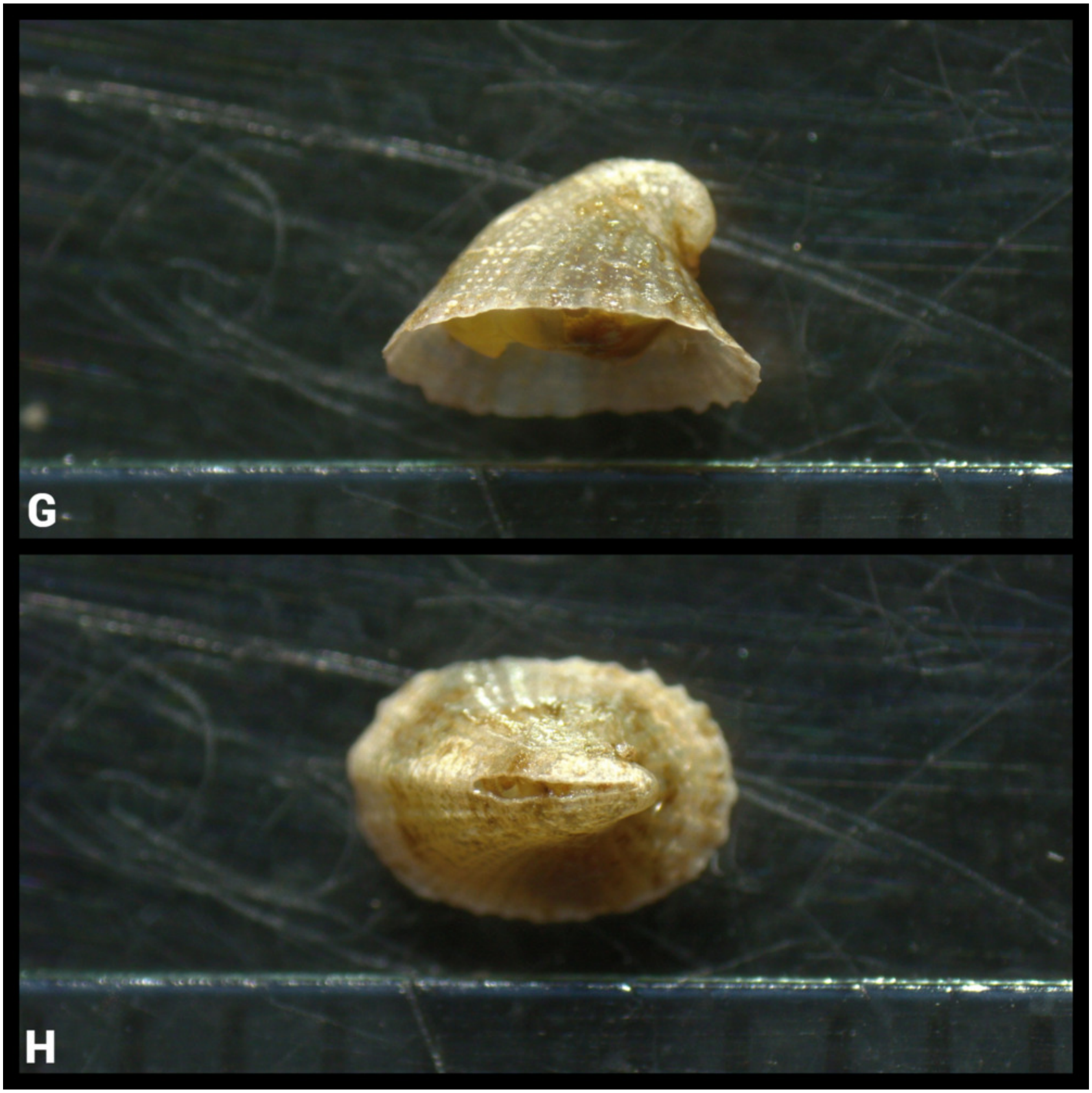


Figure 84. G) Keyhole limpet (*Puncturella noachina*). Conical shell with curved apex and no operculum. Glossy white inside with 20+ prominent ribs on exterior of shell. H) *Puncturella noachina* (dorsal view). Laterally compressed. Raised collar around inside surface of slit-like opening near apex of shell.

3.45 Nematoda (Phylum) - AphiaID: 799

Description:

Commonly referred to as “round worms”, they are not considered part of the Annelida phylum, they are grouped in their own phylum. They are unsegmented, skinny, wormlike organisms that are tapered at both ends, and are typically coiled (Figure 85). The texture of the organism is firm and rigid, while the colour is opaque to semi-translucent. They are often found outside of the stomach (in body cavity of fish) or even embedded in the outside of the stomach. Can be difficult to determine if they are prey or parasites. Parasites are very important trophic indicators, but not of energy contributions as they are not digested.

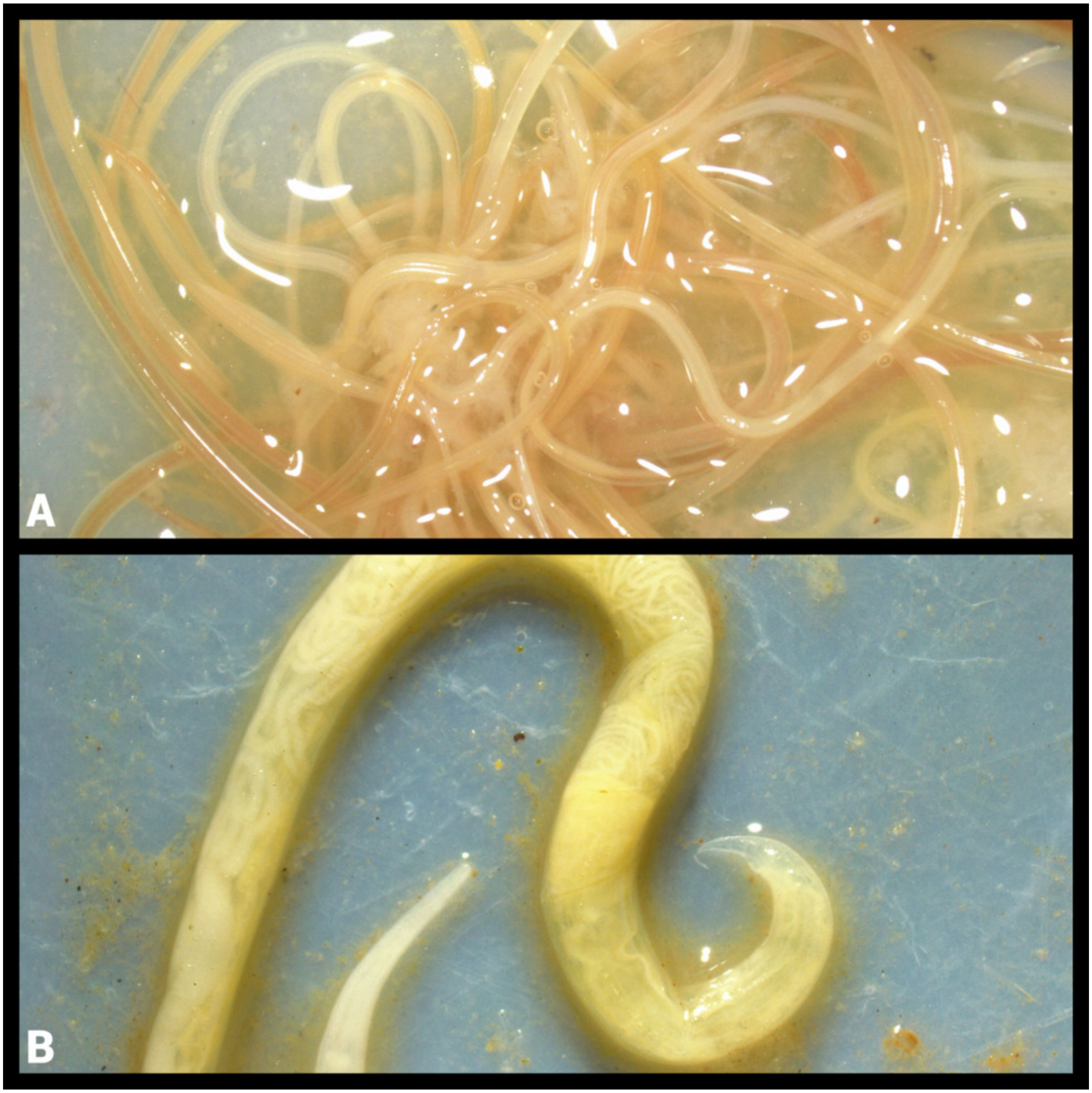


Figure 85. **Nematoda**. A) Colour opaque to semi-translucent. B) Tapered and pointed at each end. No segmentation.

3.46 Teleost Fishes (Class) - AphiaID: 293496

Description:

Several species of fish can be found during stomach content analysis, with sand lance, rainbow smelt, capelin, shannies, and Atlantic cod being the most commonly encountered species in the Gulf region (Figures 86, 87, 88, 89). Specimens are usually well digested and all that remains is often vertebrate, otoliths, fin rays and/or decomposed tissue (Figure 91). If the otoliths are in good condition (not deteriorated) and large enough, the identification guide Photographic Atlas of Fish Otoliths of the Northwest Atlantic Ocean by S.E Campana (2004) can be utilized to try and identify the species or family. Occasionally whole fish specimens are found, and can sometimes be identified to species or at a minimum to family (Figure 90).

Figure 86. **Teleost Fishes.** A) Juvenile cod (*Gadus*).

Figure 87. B) Sand Lance species (*Ammodytes*). There are three known species in the Gulf region.

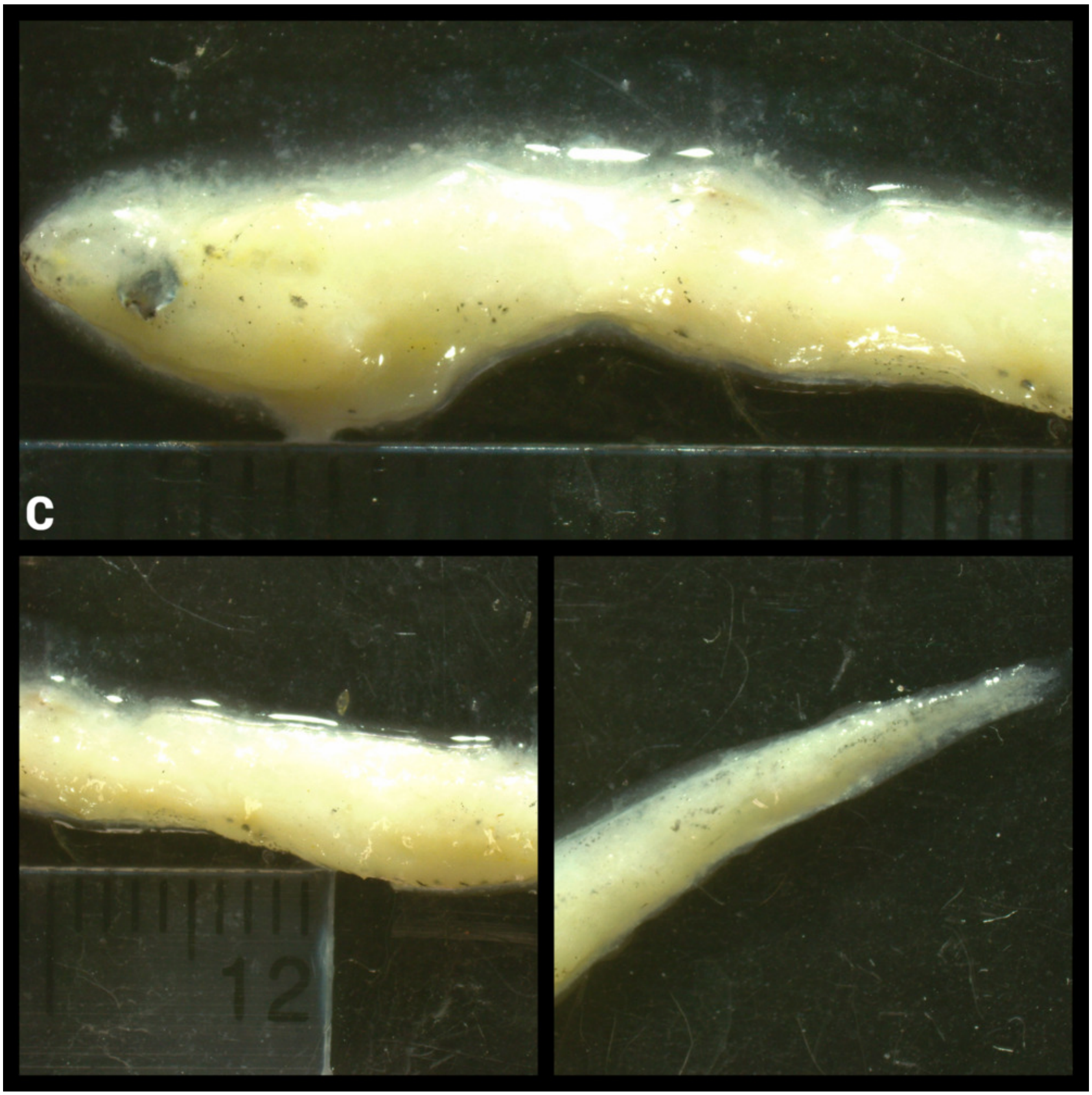


Figure 88. C) Unknown Shanny species (*Stichaeidae* or *Lumpenidae*).

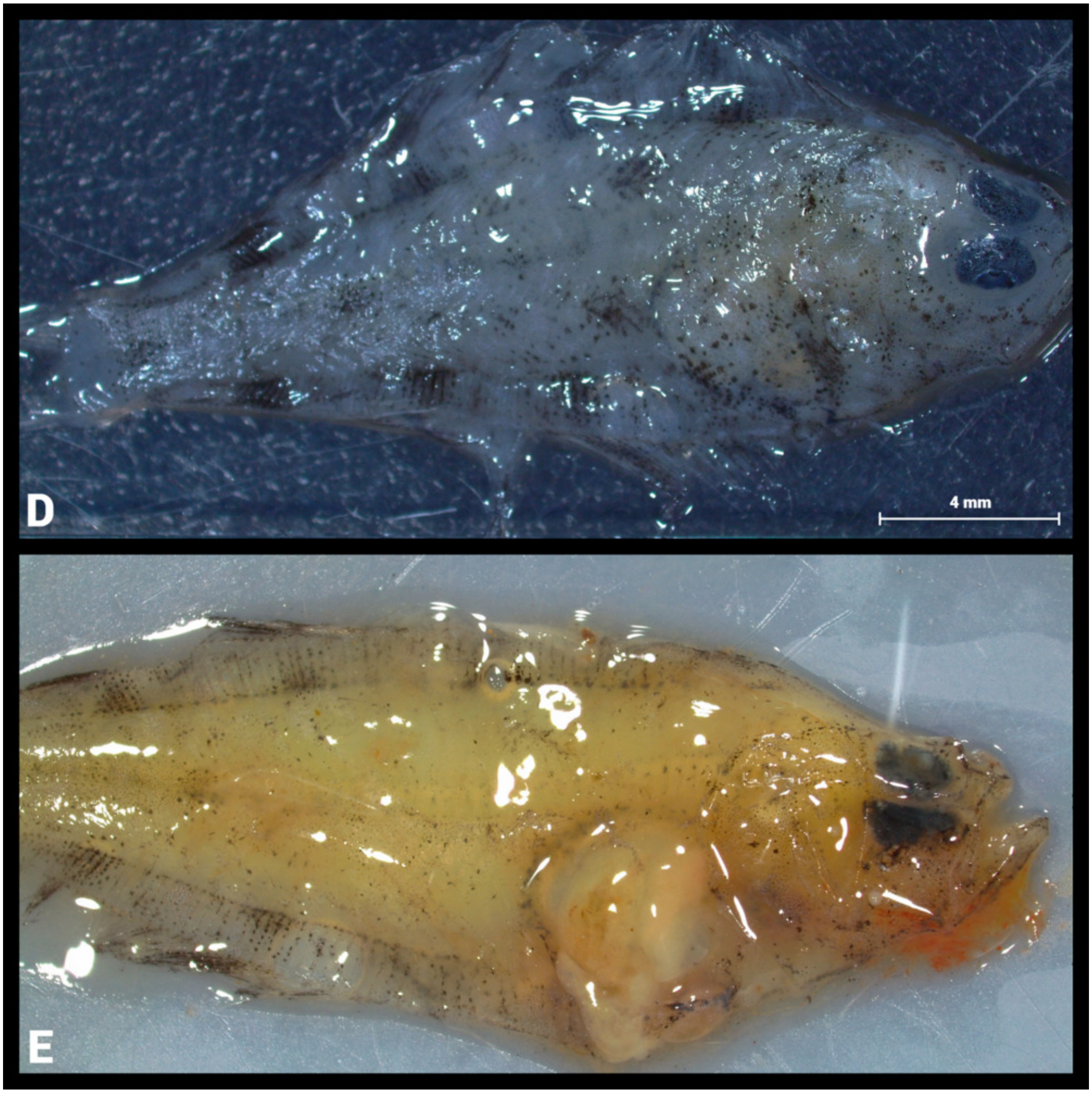


Figure 89. D) Juvenile American plaice (*Hippoglossoides platessoides*). E) Juvenile Greenland halibut (*Reinhardtius hippoglossoides*).

Figure 90. F) Snailfish (*Liparis* species). Gelatinous skin that lacks scales. G) Ventral view of Snailfish species, showing the modified pelvic fins that resemble a disc and are utilized to adhere to surfaces.

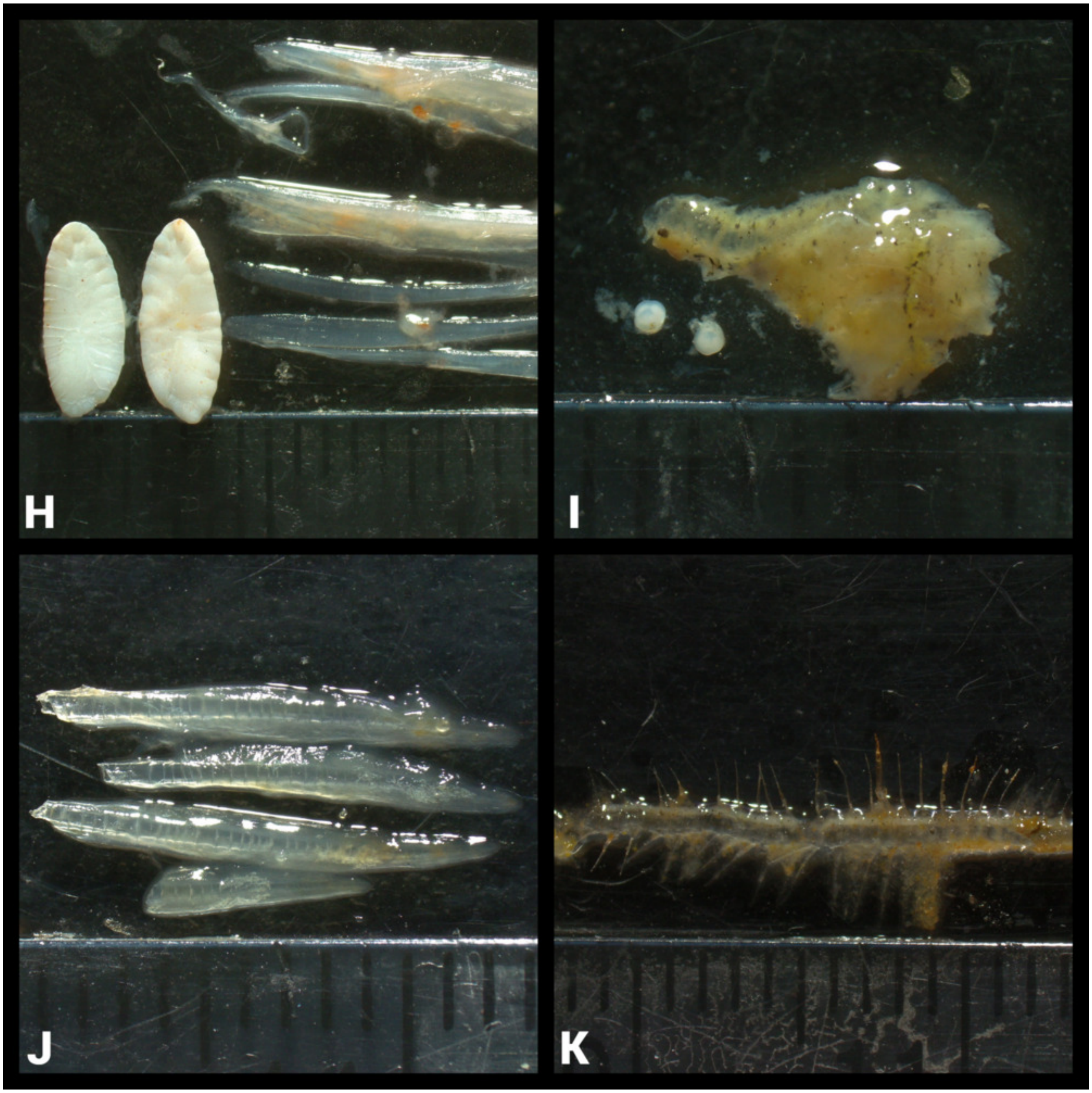


Figure 91. H) A pair of otoliths and fin rays from *Gadus* species. I) A pair of otoliths and a piece of tissue from unknown species. J) Fin rays from unknown species. K) Vertebrate of unknown species.

3.47 Foraminifera (Subphylum) - AphiaID: 1410

Description:

A group of single-celled organisms that are classified as amoeboid protists. They are characterized by their use of a granular ectoplasm that is used for catching food and other functions, often with a hard exterior shell (called a "test") that can take on a wide variety of forms (Figure 92). Can't be sure these are actual prey items eaten by the predator. We could suspect 1) they are ingested along with sediment (seeking worms, etc.), or 2) prey of prey (a prey item that was eating, or incidentally ingesting, forams).

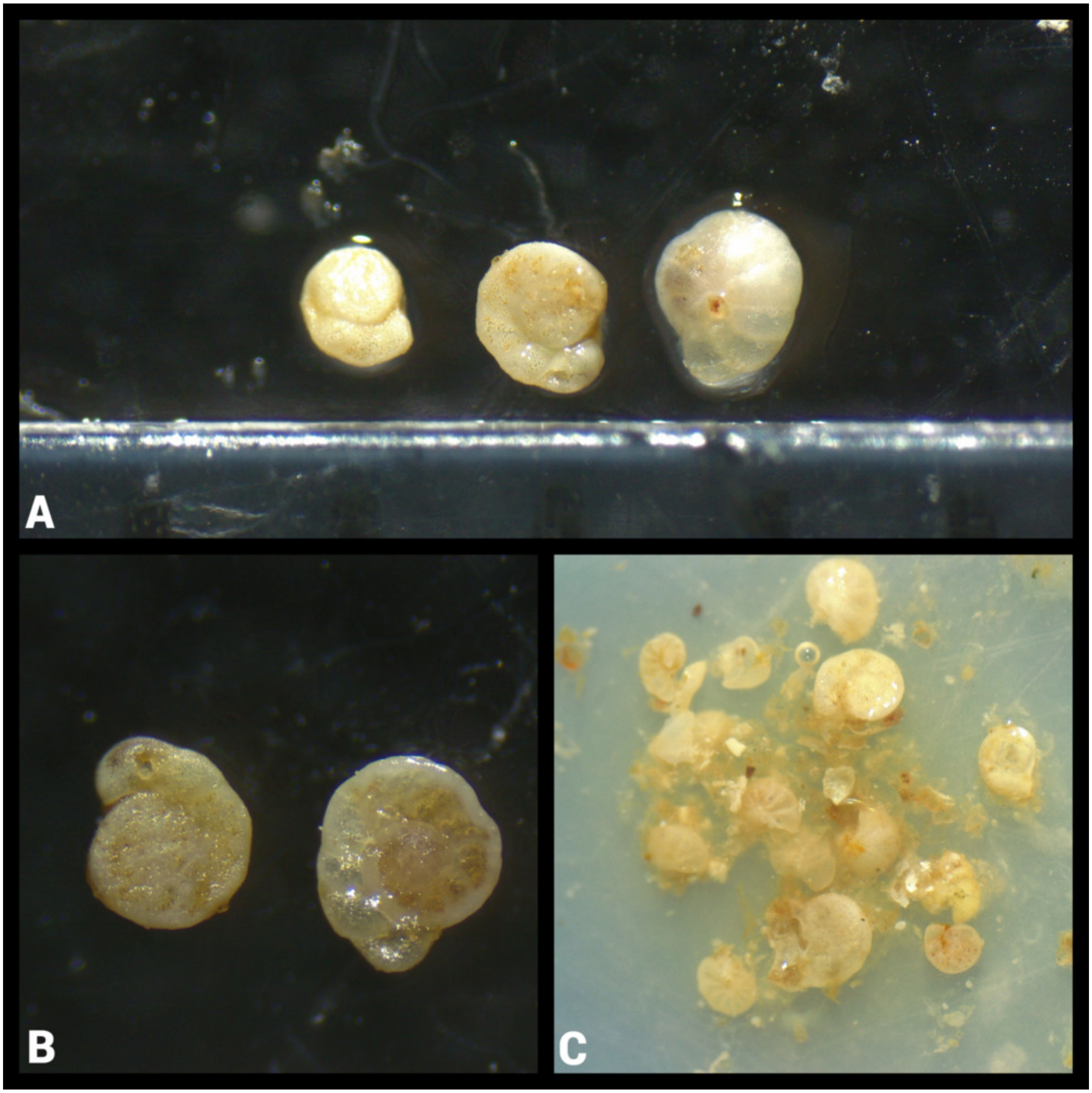


Figure 92. **Foraminifera**. A) Foraminifera. Note chambered gastropod-like shell and small size (<1mm). B) Closeup of Foraminifera. C) Partially digested Foraminifera.

3.48 Thallophyta (Division)

Description:

Several different types of algae or seaweed can be found in fish stomachs. They are typically ingested accidentally while consuming prey items, although some fish species do consume plants as a food source. Traditionally described as “thalloid plants”, “relatively simple plants”, or “lower plants”. This group includes plants with no leaves or roots and algae. Seaweeds are divided into three main groups based on colour: brown, green and red algae (Figure 93).

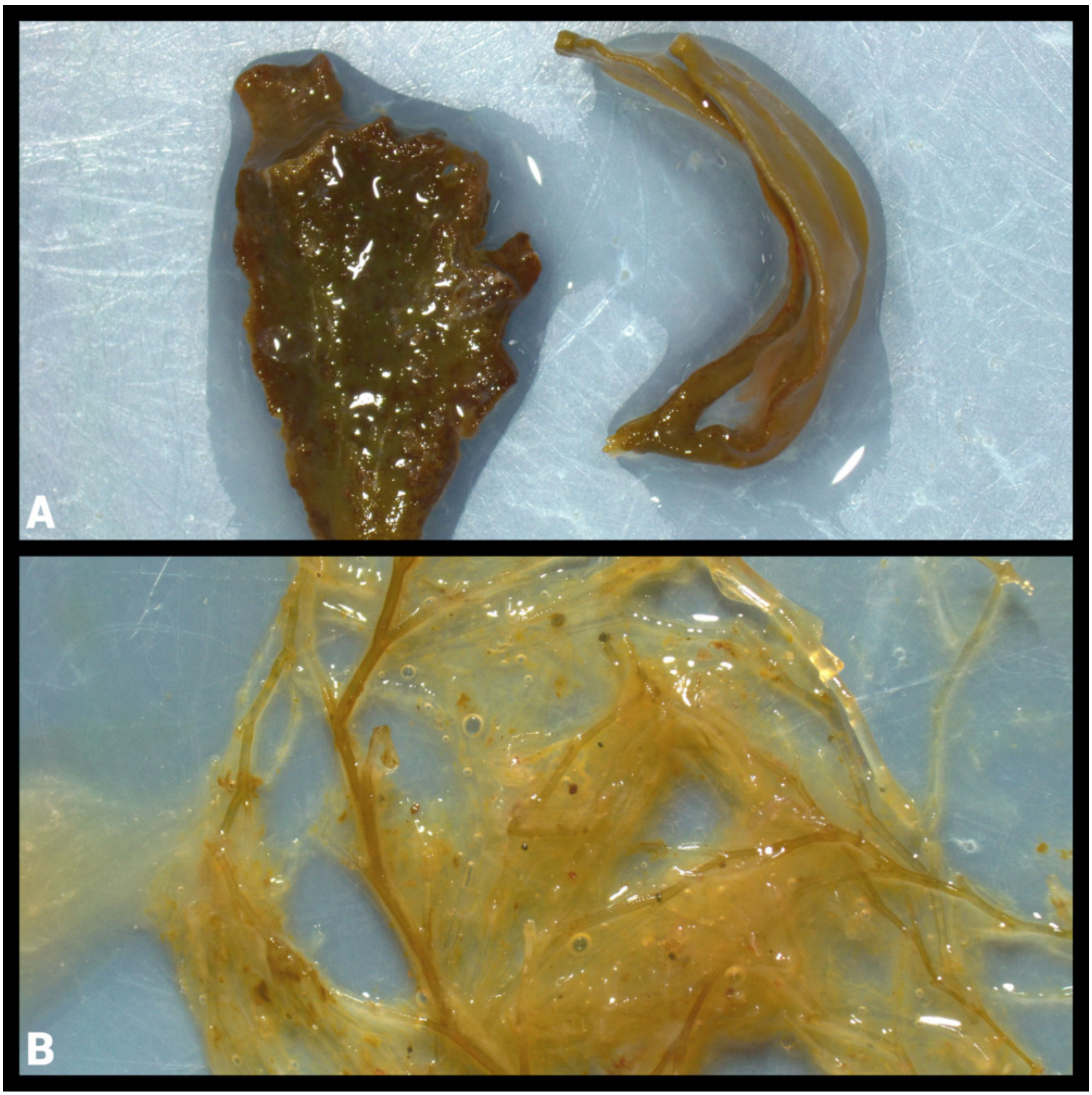


Figure 93. **Thallophyta.** A) Fucus (green algae). B) Thallophyta.

3.49 Casings

Description:

Come in a variety of shapes and sizes, can be constructed from mud, sand, shells, or stones. Typically cylindrical in shape and strongly associated with polychaetes, but they can be created by other marine life as well (Figures 94, 95).

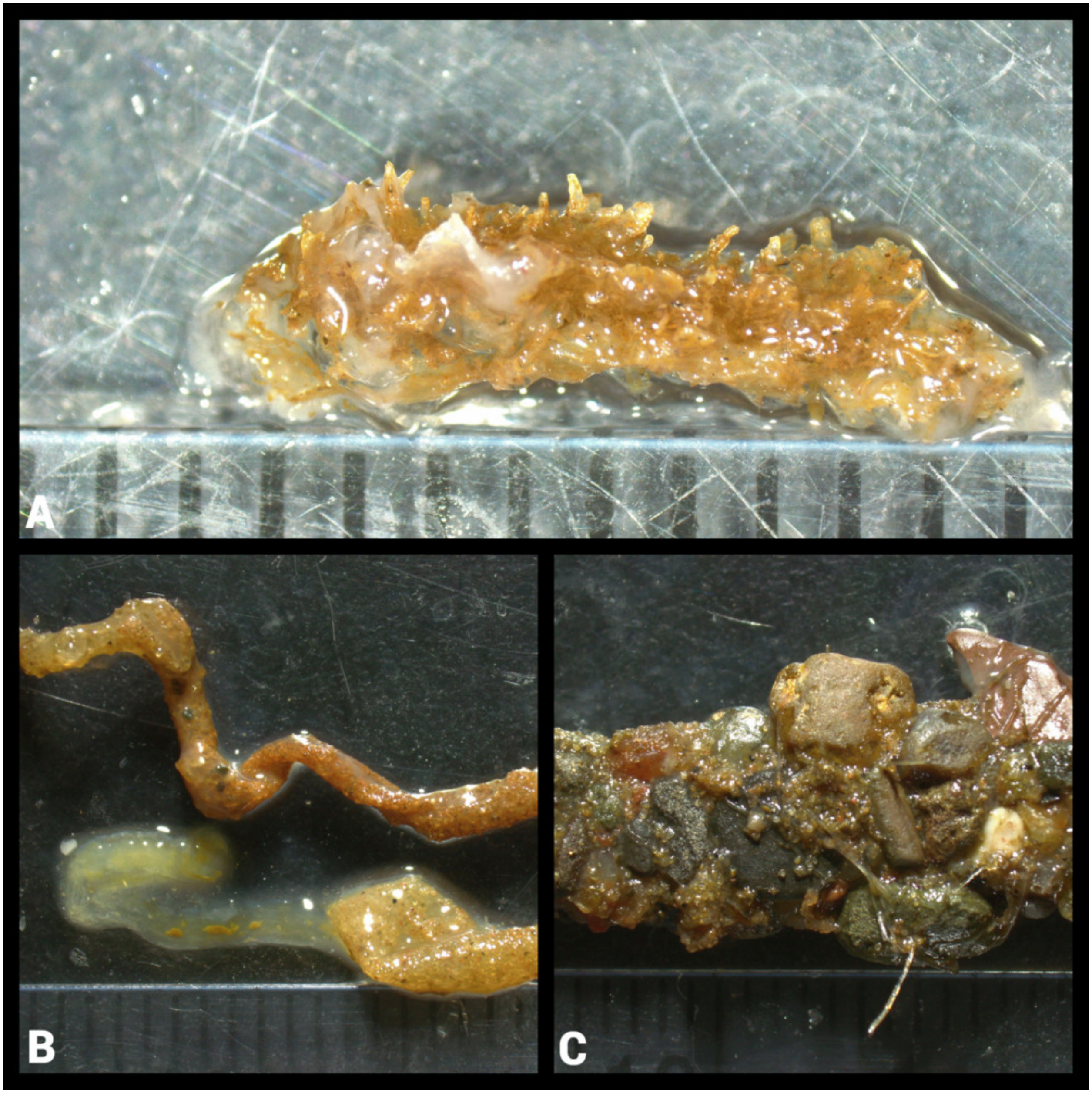


Figure 94. **Casings**. A) Polychaete casing with small protrusions. B) Polychaete casing and worm. Tube-like casing made of sand grains. C) *Nothria conchylega* casing made of larger stones and gravel.

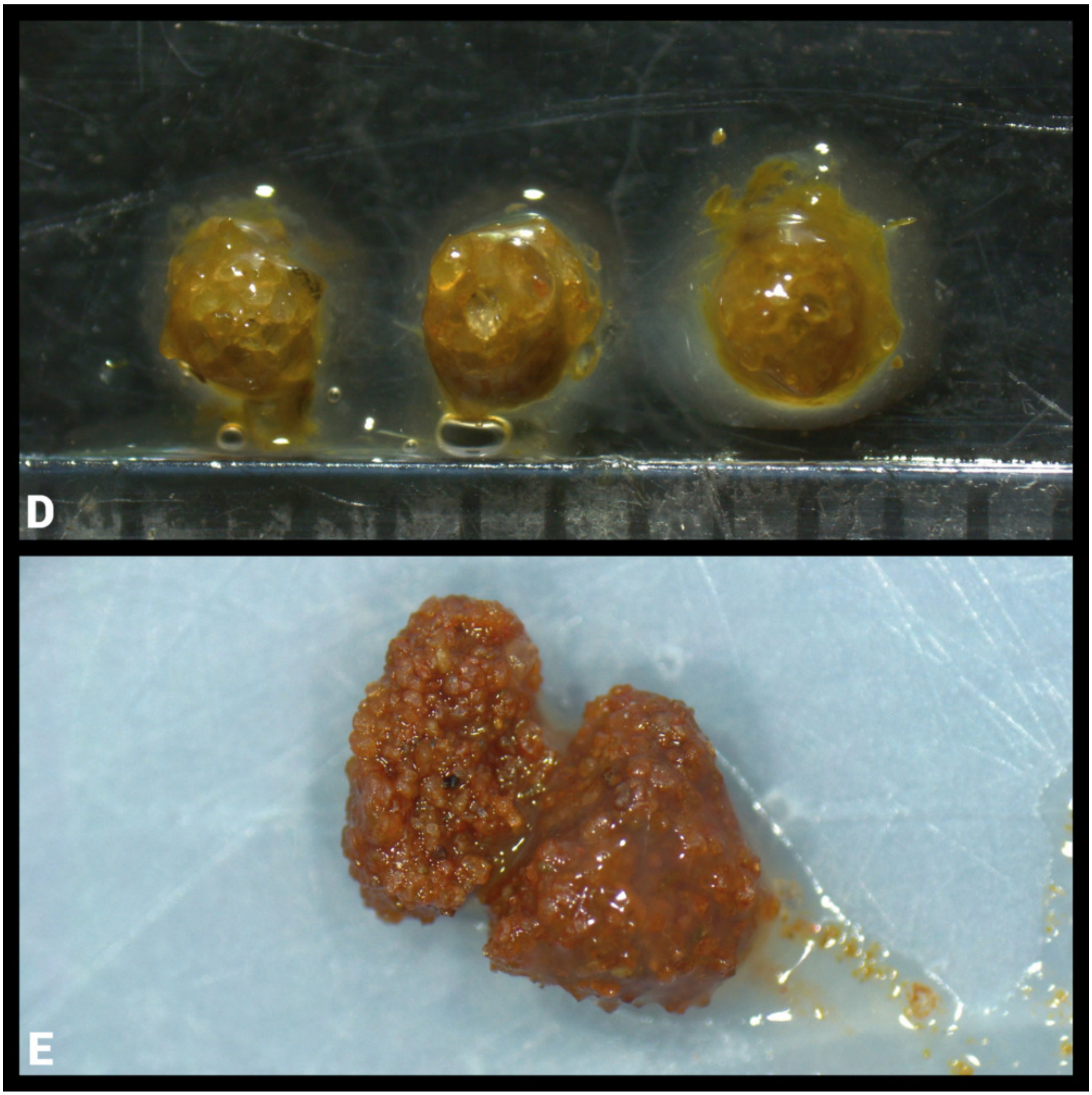


Figure 95. D) Unknown round casing E) Unknown casing made from sand.

3.50 Eggs and Egg Masses

Description:

A variety of eggs from different families and species can be found in fish stomachs. Most fish eggs are sphere-shaped and typically contain an embryo within the outer sphere (Figure 96). Other groups like gastropods and crustaceans can have a variety of egg shapes and sizes. Characteristics to look at include; overall shape of egg mass, texture of surface, and attachment to one another, or substrate.

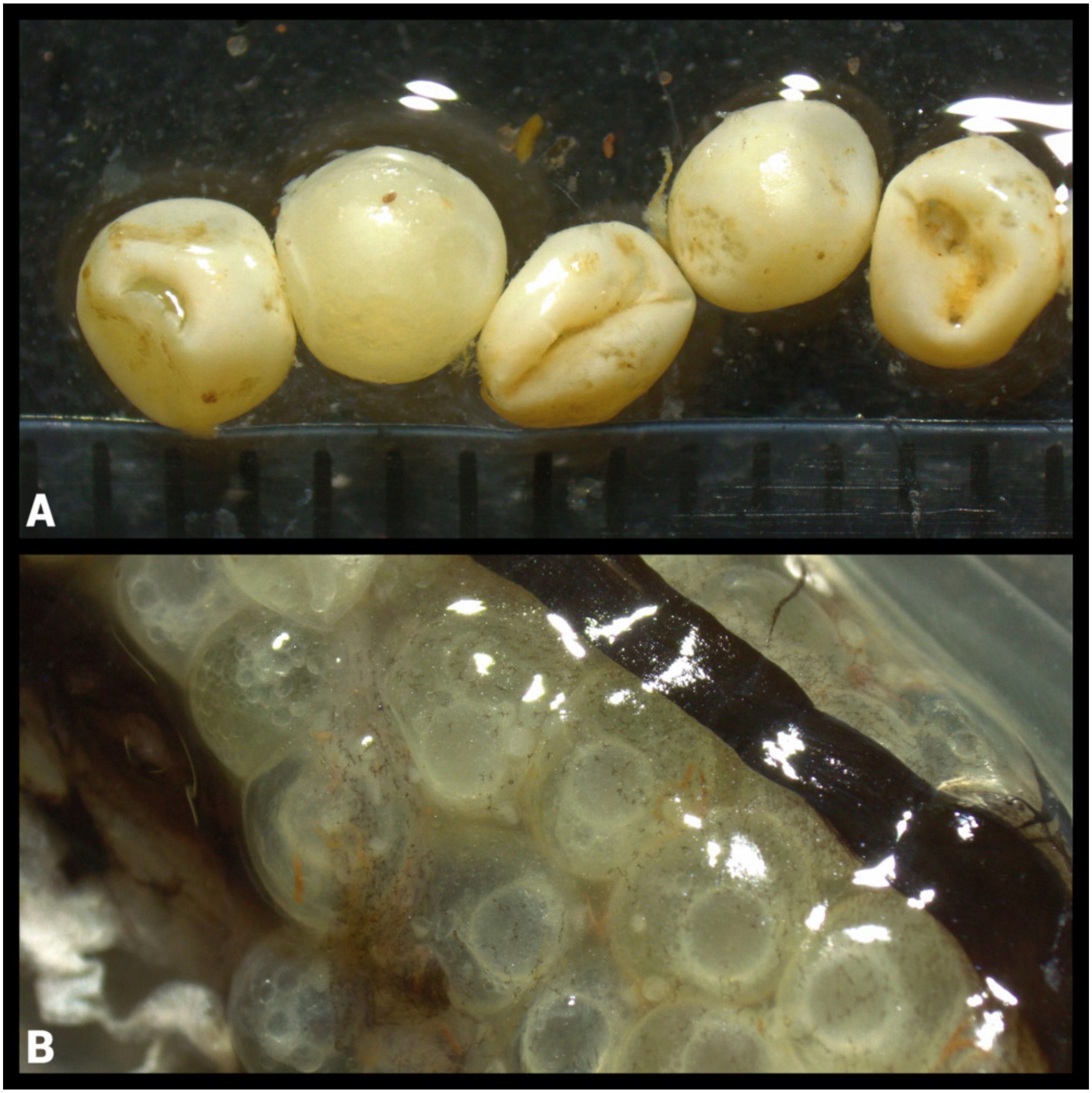


Figure 96. **Eggs and Egg Masses.** A) Round eggs from unknown species. B) Eggs from Sculpin species.

3.51 Zooplankton

Description:

A general term for a group of relatively small organisms that are living freely suspended in the water column. Crustaceans account for a significant portion of zooplankton, and includes both holoplanktonic forms such as copepods and ostracods, and meroplanktonic, larval stages. The larval stages can include Nauplius larvae (first larval stage), Zoea larvae, or larger crustacean larvae such as the megalops larva of crabs. There a variety of other zooplankton such as fish larvae and larval polychaetes, but a group you may encounter is the shelled pteropods (Thecosomata) which are also known as sea butterflies. They are very small and have a spiral shell that looks just like a gastropod, but they swim about by flapping foot lobes that resemble butterfly wings.

4 Discussion

This report demonstrates the results possible with the visual identification of prey items in fish stomachs. While visual examination is the traditional approach to document diets, there are now several advanced techniques commonly used to analyze fish diets such as the sequencing of marker genes (18S and COX1) or the analysis of isotopes (Albaina et al. 2016; Waraniak and Scribner 2019; Lazic et al. 2021), and fatty acid profiles (Brown-Vuillemin et al. 2023). These contemporary methods enable the identification of species in heavily digested prey items for organisms that are unrecognizable or invisible via microscopy, however, these methods also offer challenges such as (1) the impossibility to compare results from studies with different molecular protocols (Clare 2014); (2) the identification of contaminant sequences, which are easily confused with real observations (Cuff et al. 2022); and (3) the dependence on incomplete online sequence databases (Lazic et al. 2021; He et al. 2022). Thus, visual analysis of stomach contents is still very relevant today and provides complementary information to molecular-based approaches, in particular to provide direct evidence of species occurrence and abundance (Albaina et al. 2016).

When conducted at multiple time points or locations, fish stomach contents analyses can be useful to indicate the prey that were selected of those available in an environment. As such, a long time series or comparison across different areas is needed to compare and contrast similarities and differences. In a recent review of redfish from the Gulf of St. Lawrence, a long time series indicated patterns in the contributions of zooplankton and shrimp to fish diets (Brown-Vuillemin et al. 2022). Environmental changes may be interpreted from the diet contributions, for example, *Themisto* amphipods in the review were more dominant in the 1990s, which coincided with a coldwater period that had increased abundance of *Themisto libellula*, a large species that was once absent in the region (Marion et al. 2008), though now well-established but in colder areas not shared by redfish. However, interpretations can also be difficult with long time series as the data has to be consistently analyzed, for example, in the identification of digested prey remains. Depending on staff expertise and experience, identifications may vary, more specific detail is typically provided when ID is conducted by someone with more experience.

In the above example with redfish, data has to be interpreted with care as prey recorded generally as digested shrimp are now identified to the species level, using partial remains and perhaps ecology (e.g., known prey presences by area and depth). Thus, changes in species may reflect changes in effort, not diet, which is sometimes referred to as the ‘Javier effect’ - increased taxonomic diversity on fisheries surveys resulting from the presence of a specialist compared to other years. The creation and publication of visual references for identification, such as this report, will help to improve standardization of the datasets and lead to improved ecological analyses.

When data is available and standardized, interpretations can be made about subjects of interest to other groups, such as for marine conservation, invasive species, or climate change—as in the example of amphipods cited above. Some generalist predators, especially cod, are valuable indicators to confirm changes, when their diet reflects general availability. Others may have preferences, and thus changes in diet may reflect drastic shifts, or no changes may hide shifts underway. For example, Greenland Halibut has a preference for coldwater prey such as northern shrimp and capelin, and despite their decline, seem unable to find alternatives, and thus are declining in body condition (DFO 2021). Redfish also eat northern shrimp, but more of the mesopelagic shrimp, *Pasiphaea multidentata*, and thus the decline in northern shrimp may not affect them as strongly. However, this raises another challenge with species data and the value of stomach contents analysis. While the abundance and distribution of prey items is generally reflected in fisheries surveys and stomach contents, e.g., Atlantic cod and their prey, in some cases data from stomachs indicated prey abundance unavailable by current surveys, notably for zooplankton and pelagic species not well-sampled by bottom trawls. Thus, stomach contents may provide further evidence of the state of an ecosystem, complementing data for conservation and climate change.

Apart from ecosystem indicators, the significance of prey items is usually evaluated by two main approaches. The first approach involves attempting to identify the trophic position of each prey species within a specific community or ecosystem. The second approach relates to calculating the amount of food a fish population consumes (Hyslop 1980).The identified species is not always necessarily the goal for diet analysis, but rather the functional group to which it belongs. Often, species and other levels may be regrouped at a higher classification, such as genus or family, and attributed to a functional level that reflects their trophic position. Thus, copepods and amphipods are zooplankton, while shrimp, then fish are usually higher trophic level groupings (see Brown-Vuillemin et al. (2022), Brown-Vuillemin et al. (2023) and Ouellette-Plante et al. (2020)). Labeling the prey contributions from their trophic position in the marine food web will help with understanding their roles in supporting a predator species, such as the possibility of switching to smaller prey if larger ones are unavailable. With the second approach, the calculation of prey contributions to diet can be important to understand impacts of predation on an ecosystem. For example, currently in the Gulf of St. Lawrence, there is a large population of redfish that impacts on shrimp, and grey seals that impact on fishes. It is important for modeling fisheries trends to get estimates of how much a prey item is in an individual meal, say, northern shrimp ingested by redfish, or Atlantic Cod by a grey seal, to help with management decisions on these commercial species that are also prey.

5 Acknowledgments

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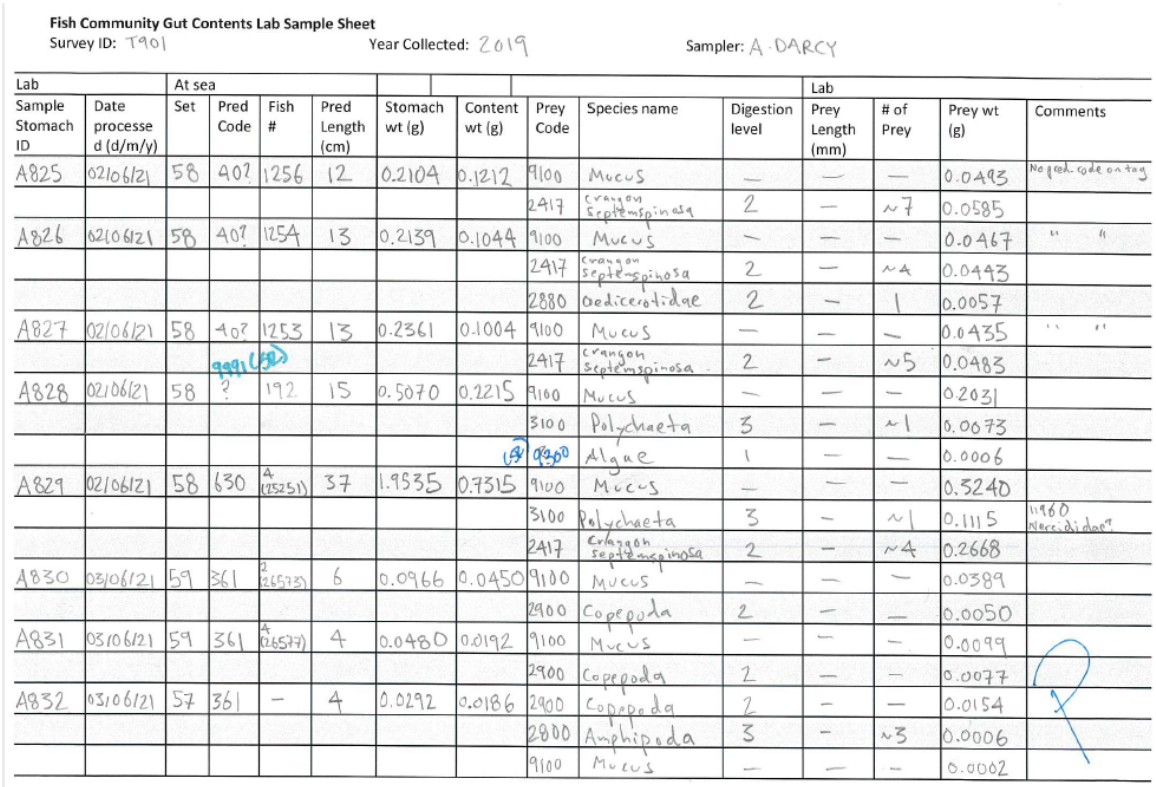
7 Figures



Fish Community Gut Contents Lab Sample Sheet

Survey ID: T901 Year Collected: 2019 Sampler: A. DARCY

Lab		At sea									Lab			
Sample Stomach ID	Date processed (d/m/y)	Set	Pred Code	Fish #	Pred Length (cm)	Stomach wt (g)	Content wt (g)	Prey Code	Species name	Digestion level	Prey Length (mm)	# of Prey	Prey wt (g)	Comments
A825	02/06/21	58	40?	1256	12	0.2104	0.1212	9100	Mucus	–	–	–	0.0493	No pred. code on tag
								2417	Crangon septemspinosa	2	–	~7	0.0585	
A826	02/06/21	58	40?	1254	13	0.2139	0.1044	9100	Mucus	–	–	–	0.0467	" "
								2417	Crangon septemspinosa	2	–	~4	0.0443	
								2880	Oedicerotidae	2	–	1	0.0057	
A827	02/06/21	58	40?	1253	13	0.2361	0.1004	9100	Mucus	–	–	–	0.0435	" "
			9991 (58)					2417	Crangon septemspinosa	2	–	~5	0.0483	
A828	02/06/21	58	?	192	15	0.5070	0.2215	9100	Mucus	–	–	–	0.2031	
								3100	Polychaeta	3	–	~1	0.0073	
								9300	Algae	1	–	–	0.0006	
A829	02/06/21	58	630	4 (25251)	37	1.9535	0.7315	9100	Mucus	–	–	–	0.3240	
								3100	Polychaeta	3	–	~1	0.1115	1960 Nereididae?
								2417	Crangon septemspinosa	2	–	~4	0.2668	
A830	03/06/21	59	361	2 (26573)	6	0.0966	0.0450	9100	Mucus	–	–	–	0.0389	
								2900	Copepoda	2	–	–	0.0050	
A831	03/06/21	59	361	4 (26577)	4	0.0480	0.0192	9100	Mucus	–	–	–	0.0099	
								2900	Copepoda	2	–	–	0.0077	
A832	03/06/21	57	361	–	4	0.0292	0.0186	2900	Copepoda	2	–	–	0.0154	
								2800	Amphipoda	3	–	~3	0.0006	
								9100	Mucus	–	–	–	0.0002	

Figure 97. Screen capture of the Excel spreadhseet used to record stomach content details in the laboratory.

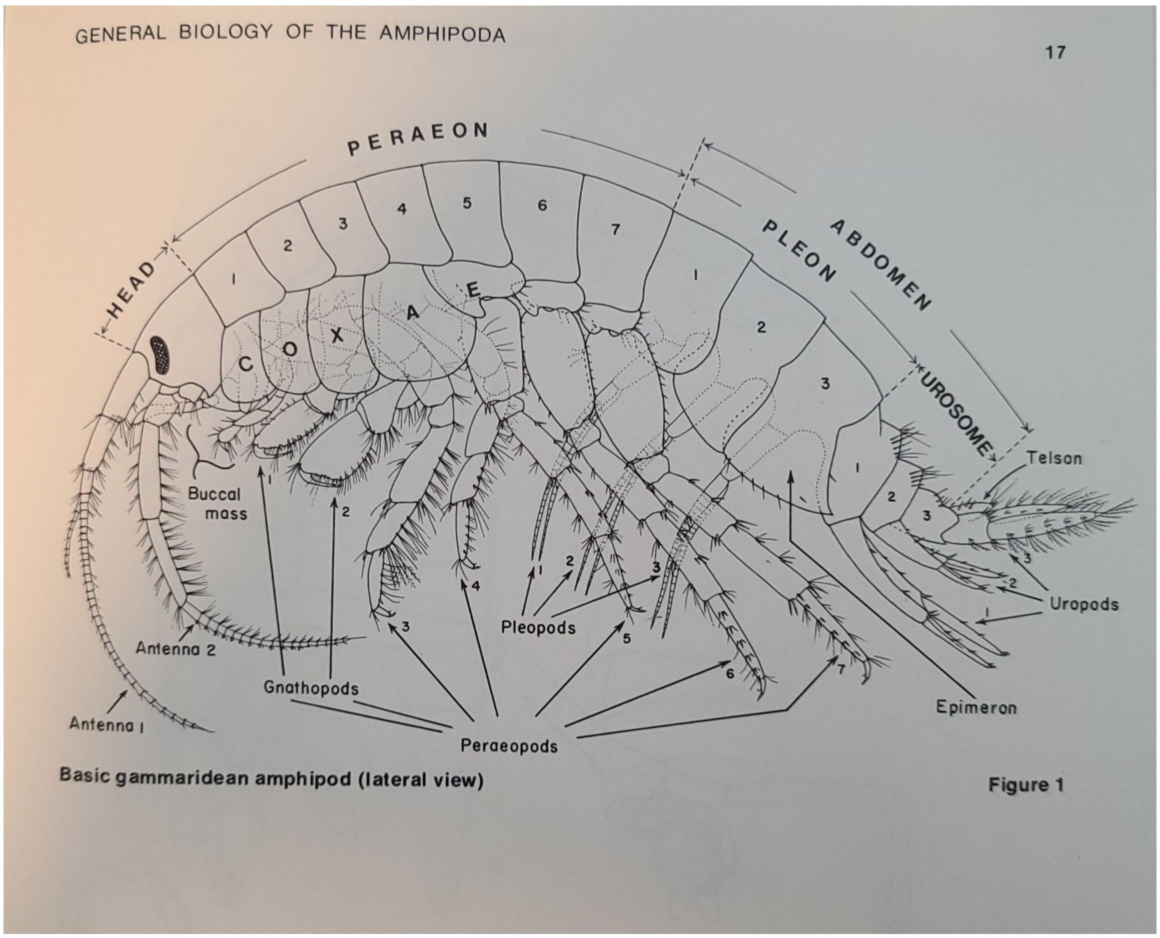


Figure 98. Anatomical features of a basic gammaridean amphipod (from Bousfield 1973).

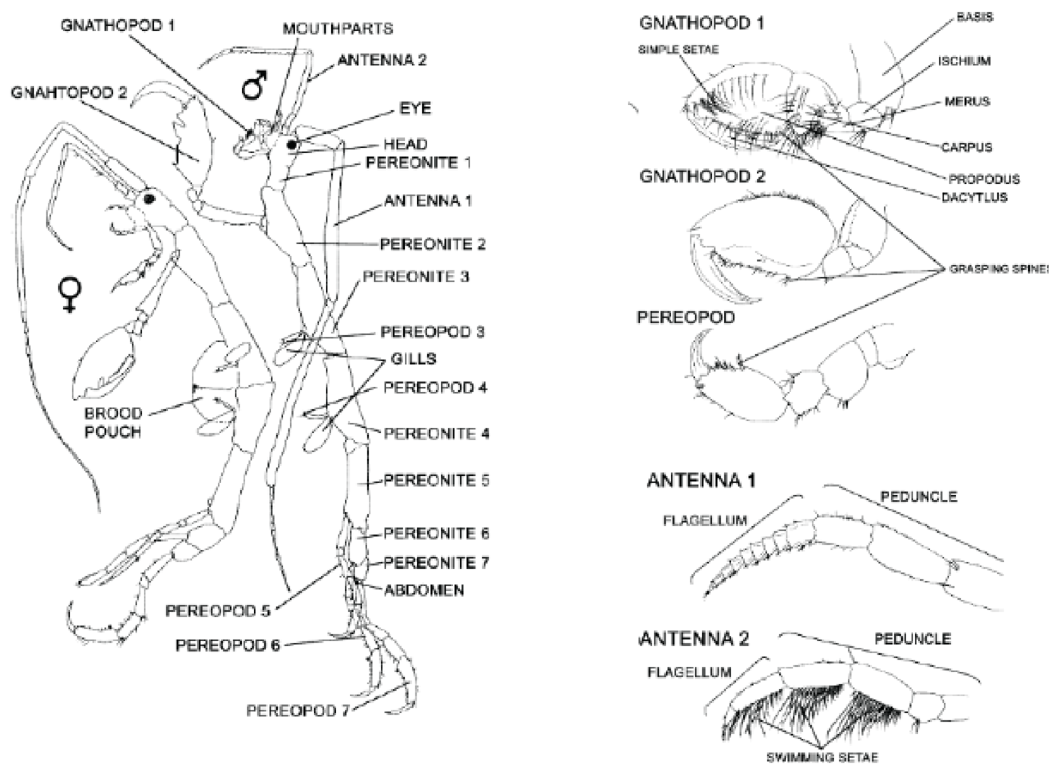


Figure 99. Main characteristics used for the identification of Caprellidae (from Guerra-García 2014).

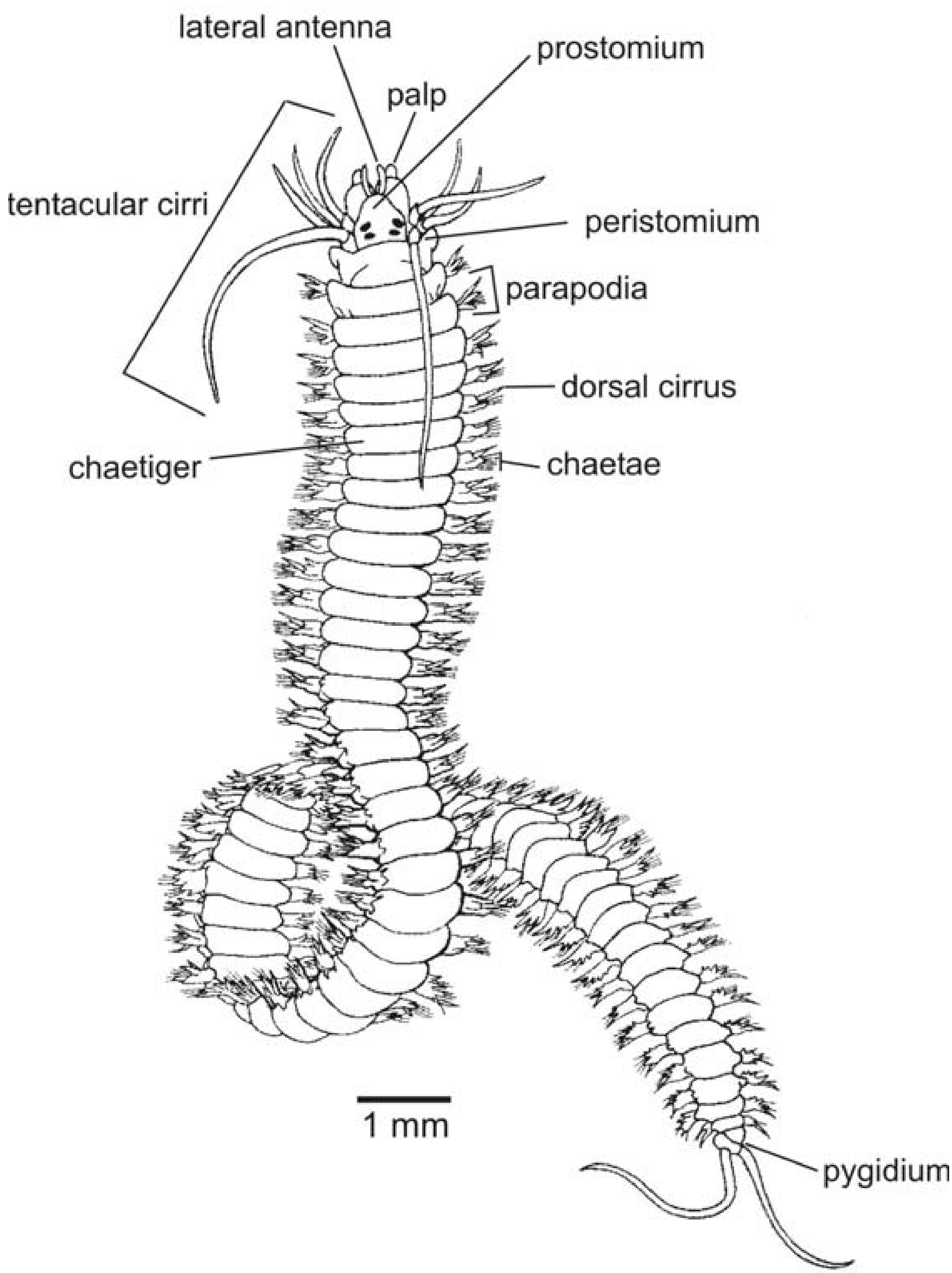


Figure 100. A polychaete belonging to the family Nereididae, showing the arrangement of external features in polychaetes (from Beesley et al. 2000).

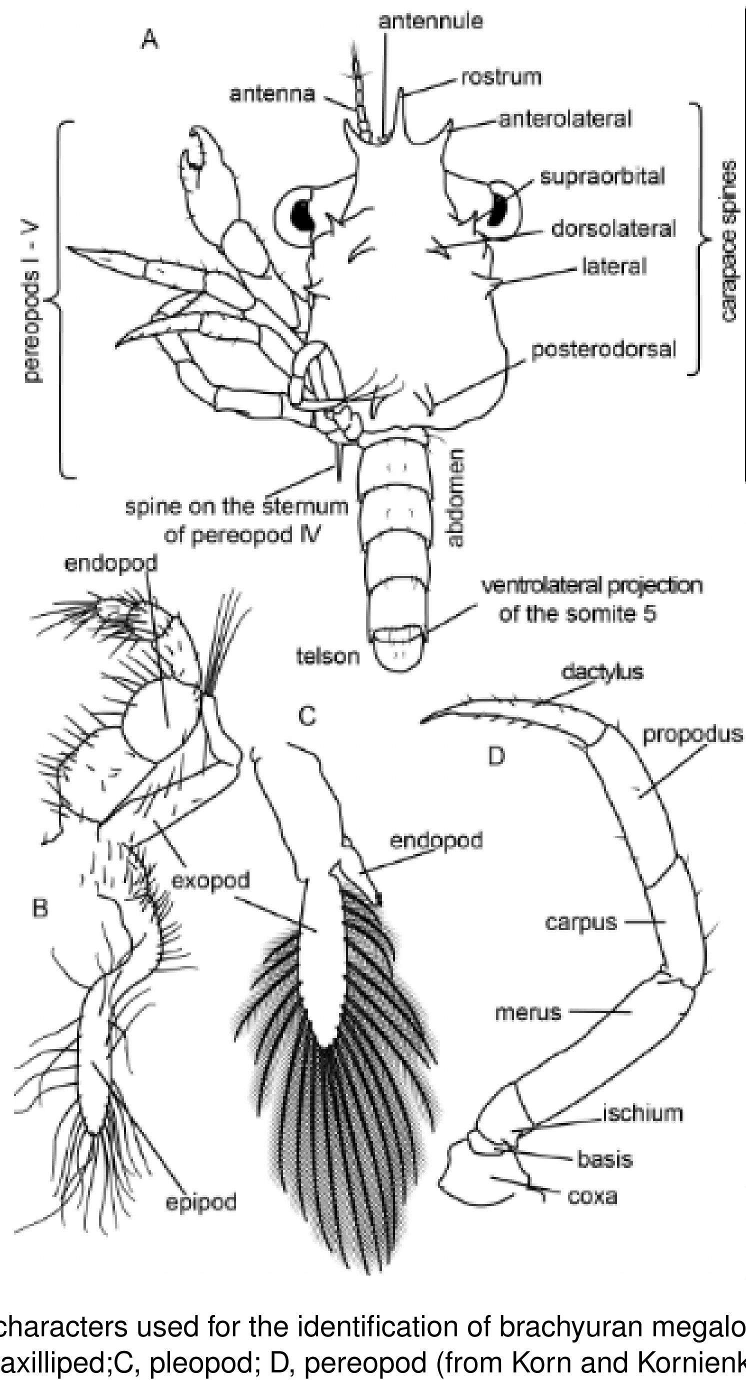


Figure 101. Main characters used for the identification of brachyuran megalopae. A, dorsal view of megalopa; B, maxilliped;C, pleopod; D, pereopod (from Korn and Kornienko 2010).

8 Glossary

abdomen the posterior six body segments, consisting of anterior three segments (pleon) bearing pleopods, and posterior three segments (urosome) bearing uropods and telson.

accessory flagellum the secondary ramus of antenna 1, sometimes vestigial or lacking (rarely equal to or longer than the main flagellum).

antenna one of two paired segmented appendages arising from the anterior part of the head.

anterior front, toward head end.

biramous two-branched; normal, basic, or "primitive" condition of limbs of Crustacea.

carinate with middorsal ridge that is compressed and elevated above the dorsum.

chela a terminal pincer formed by a moveable and immovable finger, parallel to the axis of the appendage.

chelate having a form of chela.

compressed flattened from side to side.

coxal plate the outer ventrolateral expansion of the coxa (segment 2) of the peraeonal (thoracic) appendages, forming a shield for the gills and brood plates.

dactyl talon-like terminal segment of claw or peraepods.

flagellum the main distal portion of antenna 1 or 2; the portion beyond the peduncle.

fusiform spindle-shaped; widest in middle, , tapering towards the ends.

gnathopod one of the first two appendages of the peraeon, usually subchelate, and usually differing in form and function from peraeopods 3-7.

head lobe anterior head lobe or interantennal head lobe- lateral head processes between antennal sinuses.

maxilliped the hindmost mouthpart and hindmost paired appendage of the head region or cephalon.

mucronate sharply toothed; bearing acute processes that are an integral part of the integument, not movably hinged, nor medially ridged as in carina.

ocelli are simple photo-receptors (light detecting organs). They consist of a single lens and several sensory cells. Unlike compound eyes, ocelli do not form a complex image of the environment but are used to detect movement.

ossicle small bone or bony structure.

palp the segmented appendage attached laterally to the basal segments of certain mouth parts; in amphipods, found only on the mandible, the first maxilla, and maxilliped.

parapodium each of a number of paired muscular bristle-bearing appendages used in locomotion, sensation, or respiration.

pedicellariae a defensive organ like a minute pincer present in large numbers on an echinoderm.

peraeopod one of the seven paired uniramous limbs of the peraeon, the first two of which are usually subchelate and termed gnathopods.

pleon the first three segments of the abdomen, bearing paired pleopods.

pleopod one of three anterior paired biramous appendages of the abdomen, consisting of basal peduncle and marginally setose, multisegmented rami.

posterior toward tail or rear.

proboscis an elongated appendage from the head of an animal, either a vertebrate or an invertebrate.

prostomium the portion of the head of an annelid worm (such as an earthworm) that is situated in front of the mouth.

rostrum the dorsal median anterior projection of the head.

setose bearing bristles or setae.

subchelate a prehensile condition of the peraeopod or palp in which the palm of the subterminal segment is not produced to form an immovable finger, but is at right angles to (or posteriorly oblique to) the axis of that segment (usually the propod).

telson a terminal flap of the urosome attached to segment 6 dorsal to the anus, normally consisting of two nearly separated lobes, but often fused into a single plate, and always present in Amphipoda.

uniramous one-branched; opposite to biramous or two-branched.

uropod one member of three most posterior paired biramous appendages of the abdomen; a paired appendage of the urosome, consisting of a peduncle and paired rami.

urosome the posterior three segments of the abdomen, some or all of which may be fused together.

APPENDIX A Digestion levels

The following appendix provides a general description of the various levels of digestion and a series of figures that illustrate typical examples of prey item digestion levels for polychaeta worms, hyperiid amphipods, hyas crab, and fish. The interpretation of the degree of digestion can be subjective in nature, however, these guidelines will provide clarity.

Table A.1. Codes used to identify the digestion level of prey items.

Code	Digestion level	Description
1	Undigested / Freshly consumed	No skin discoloration or fin deterioration of fish prey. Crustacean carapaces and echinoderm flesh are hard.
2	Slight	Prey easily recognizable. Fish skin is discolored. Crustacean carapaces are soft but intact.
3	Intermediate	Prey barely recognizable to the species level, however individual prey items are still reasonably distinct from each other.
4	Advanced	Prey only recognizable at a coarse taxonomic level; Mush or bones.

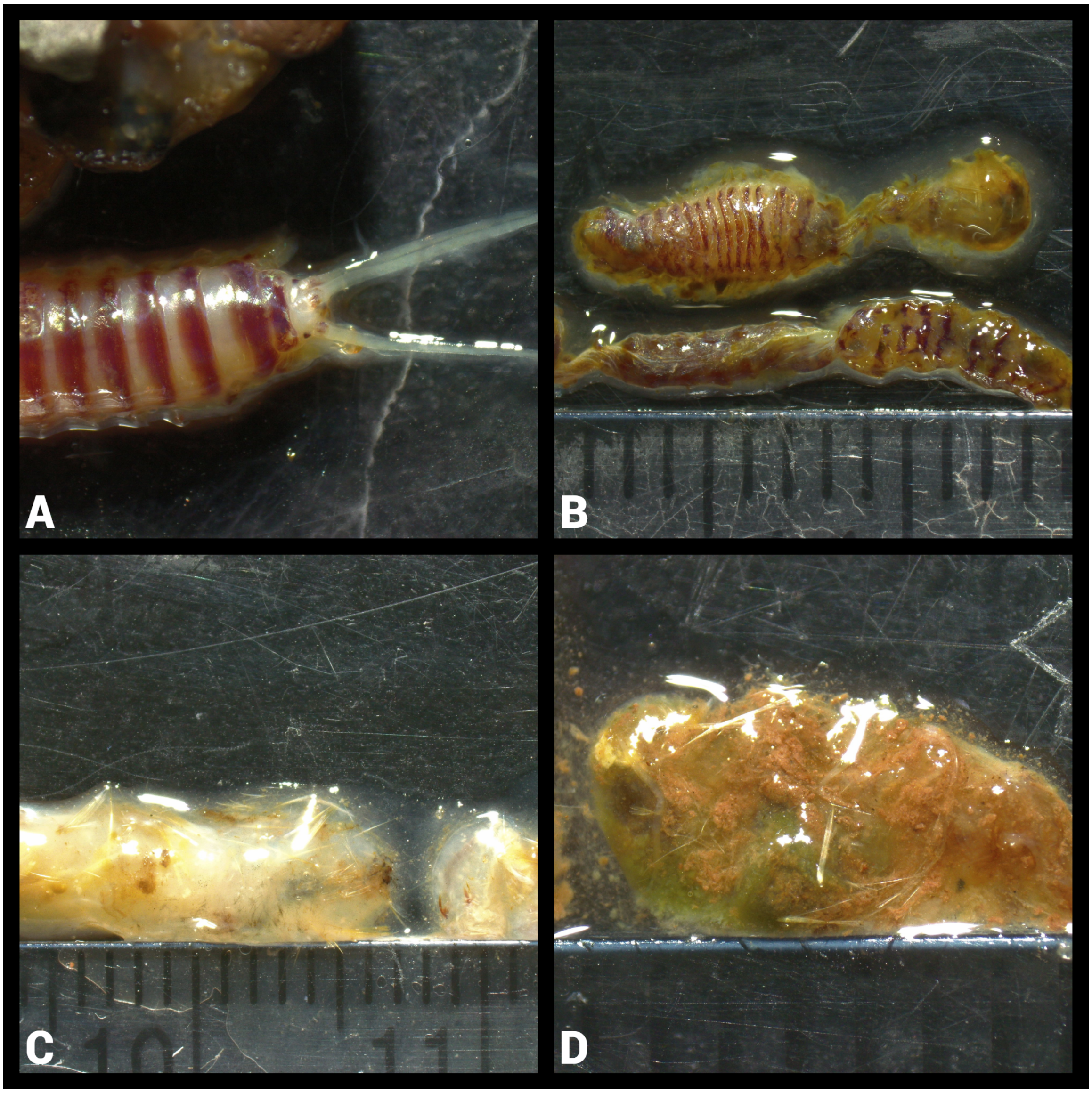


Figure A.1. Polychaeta worm in various states of digestion. A) Undigested), B) Slight, C) Intermediate, and D) Advanced.

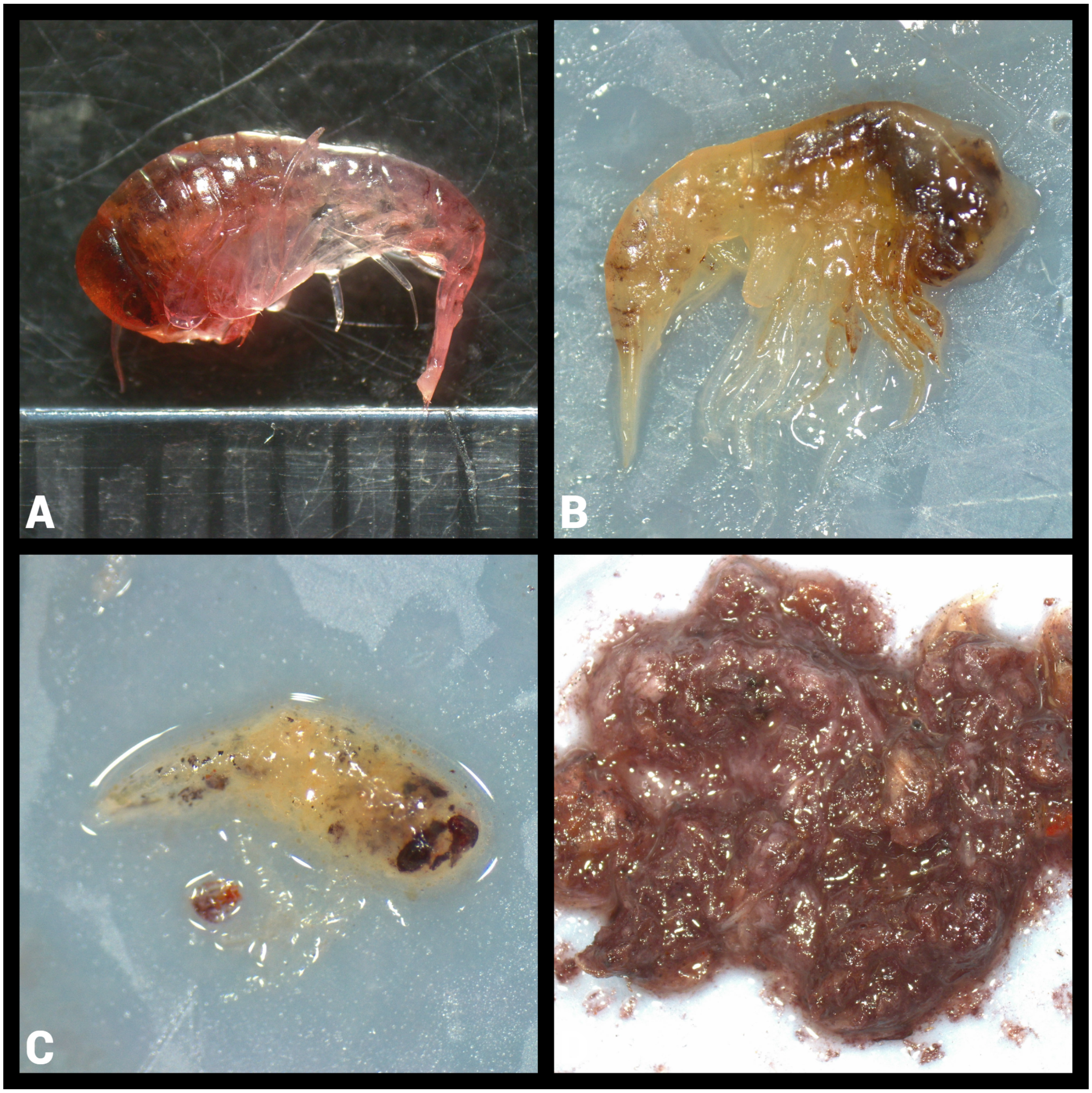


Figure A.2. Hyperiid amphipod in various states of digestion. A) Undigested), B) Slight, C) Intermediate, and D) Advanced.

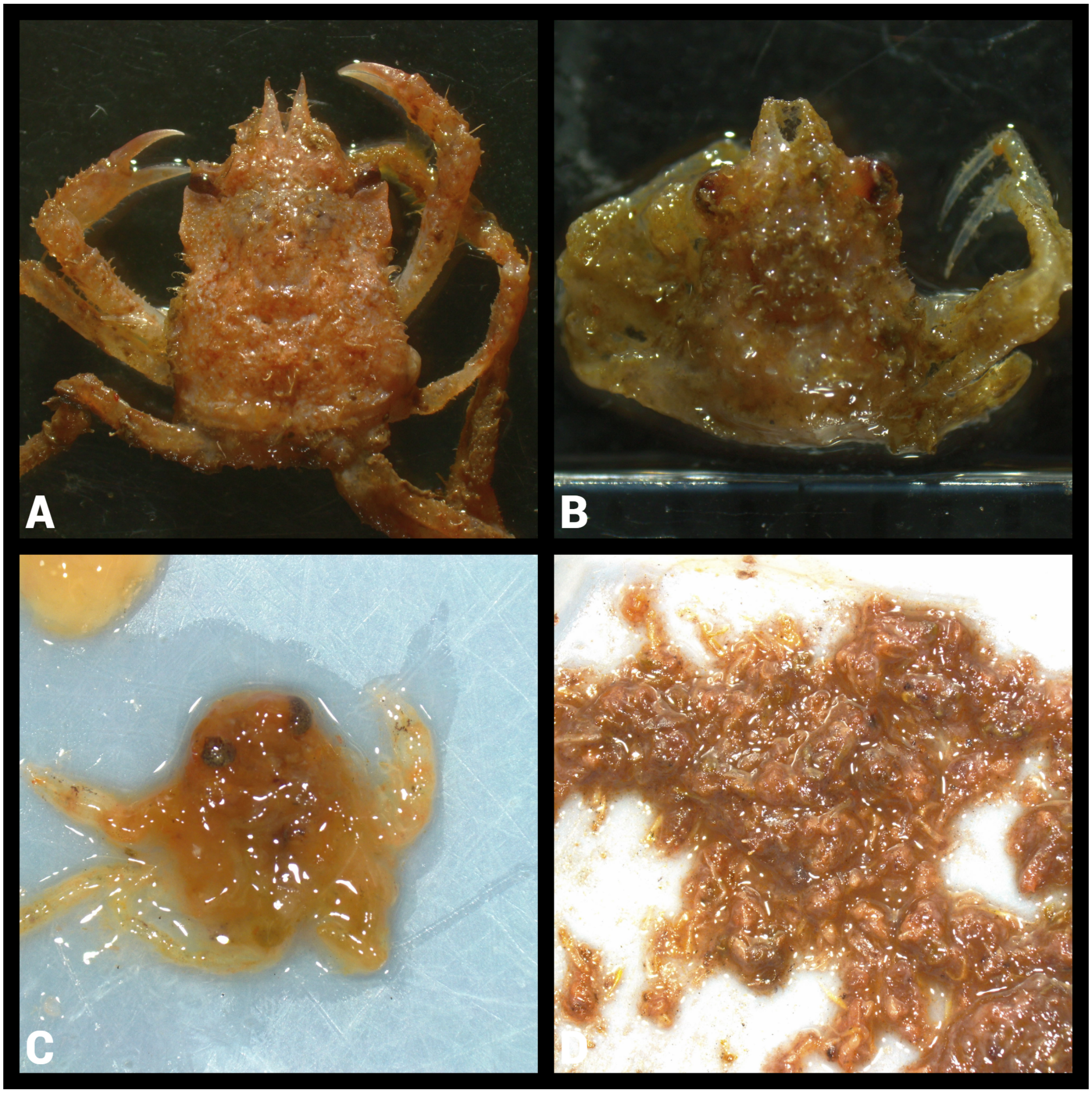


Figure A.3. Hyas crab in various states of digestion. A) Undigested), B) Slight, C) Intermediate, and D) Advanced.

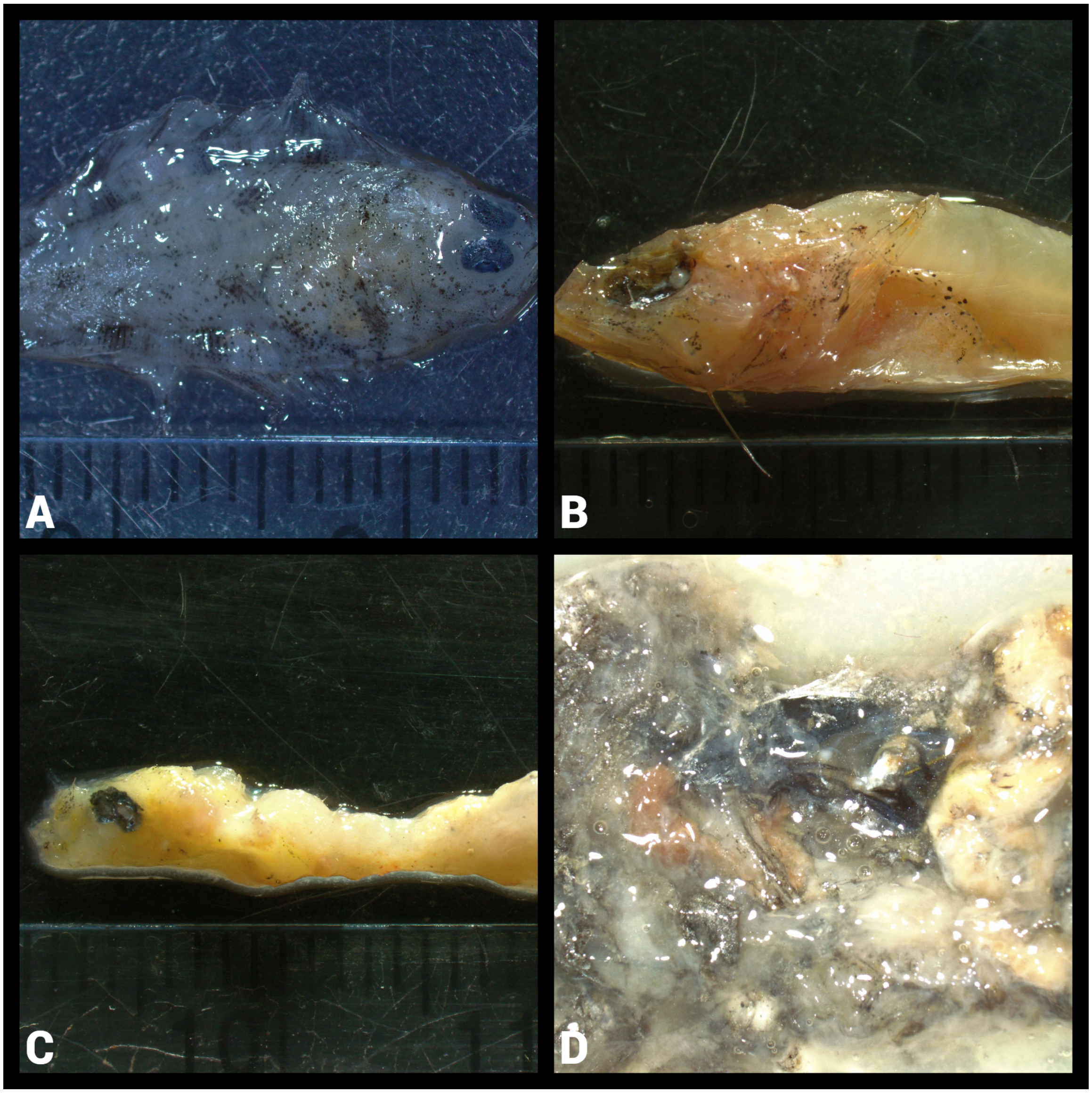


Figure A.4. Fish in various states of digestion. A) Undigested), B) Slight, C) Intermediate, and D) Advanced.