NOAA Technical Memorandum NMFS

NOVEMBER 2011

PHOTOGRAPHIC CATALOG OF CALIFORNIA MARINE FISH OTOLITHS: PREY OF CALIFORNIA SEA LIONS *(Zalophus californianus)*

Mark S. Lowry

NOAA-TM-NMFS-SWFSC-483

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

The National Oceanic and Atmospheric Administration (NOAA), organized in 1970, has evolved into an agency that establishes national policies and manages and conserves our oceanic, coastal, and atmospheric resources. An organizational element within NOAA, the Office of Fisheries is responsible for fisheries policy and the direction of the National Marine Fisheries Service (NMFS).

In addition to its formal publications, the NMFS uses the NOAA Technical Memorandum series to issue informal scientific and technical publications when complete formal review and editorial processing are not appropriate or feasible. Documents within this series, however, reflect sound professional work and may be referenced in the formal scientific and technical literature.

NOAA Technical Memorandum NMFS
This TM series is used for documentation and timely communication of preliminary results, interim reports, or special purpose information. The TMs have not received complete formal review, editorial control, or detailed editing.

NOVEMBER 2011

PHOTOGRAPHIC CATALOG OF CALIFORNIA MARINE FISH OTOLITHS: PREY OF CALIFORNIA SEA LIONS *(Zalophus californianus)*

Mark S. Lowry

Protected Resources Division, Southwest Fisheries Science Center, National Marine Fisheries Service,
National Oceanic & Atmospheric Administration, 3333 N. Torrey Pines Ct., La Jolla, CA 92037

NOAA-TM-NMFS-SWFSC-483

U.S. DEPARTMENT OF COMMERCE
Rebecca M. Blank, Secretary
National Oceanic and Atmospheric Administration
Jane Lubchenco, Undersecretary for Oceans and Atmosphere
National Marine Fisheries Service
Eric C. Schwaab, Assistant Administrator for Fisheries

Photographic catalog of California marine fish otoliths:

Prey of California sea lions (*Zalophus californianus*)

Mark S. Lowry

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

Southwest Fisheries Science Center

3333 N. Torrey Pines Court

La Jolla, CA 92037

INTRODUCTION

Fish otoliths have been used to identify prey in the diet of marine mammals, fish, and seabirds, and in remains from archaeological sites. Researchers have used otolith reference collections and/or drawings and photographs in publications to aid in these identifications. The standard (or most complete) otolith reference collection for the Northeast Pacific, the John Fitch Otolith Collection, resides at the Natural History Museum of Los Angeles County (LACM). Specimens from this collection were photographed and organized into a catalog. Otolith selection was based on fish species identified in California sea lion (*Zalophus californianus*) diet studies and includes other closely related species. This catalog can be used as an aide in the identification of marine fish otoliths recovered in scat samples, spewings, and stomach contents of piscivorous predators or of otoliths found in Native American middens. Species in the catalog each have multiple otoliths illustrated (with multiple views) to document within-species variability in otolith shape and form. As fish grow, otolith shape can change, so whenever possible, otoliths from different sizes or ages of fish were included in the catalog.

METHODS

High-resolution digital photographs of sagittal otoliths were taken with a Media Cybernetics Evolution MP color video camera mounted on a Zeiss Stemi 2000-C microscope. Media Cybernetics Image-Pro Plus 5.0 software was used to capture photographic images and save them into a Tagged Image File (.tif) format. The medial and distal surfaces and the dorsal rim edge of an otolith were photographed for almost all species. Whenever possible, these three views were photographed for different-sized otoliths within a species. The medial view is

always provided, however distal and edge views may not be included for some species. In the catalog, the left otolith usually appears on the lower left and the right otolith appears on the upper right side of paired otoliths; left or right otoliths may also appear side by side or above one another. Dorsal rim edge photographs show the left otolith below the right otolith, with the distal surface facing the ruler. A plastic millimeter ruler was placed next to the otoliths to provide scale (distance between two lines equals one millimeter). Adobe Photoshop Elements 5.0 or 8.0 were used to clean .tif-formatted photographic files, which were subsequently saved as a Portable Network Graphics (.png) formatted file. The high resolution .png files were imported into MS Word for creating the photographic catalog. The MS Word files were then imported into an Adobe PDF file.

Most otoliths in the catalog were from the John Fitch Otolith Collection at the Natural History Museum of Los Angeles County. Additional otoliths came from the author's otolith collection at the Southwest Fisheries Science Center (SWFSC) or from other sources. Each page of otolith photographs in the catalog gives the family name, scientific name, common name, and the museum specimen catalog number (e.g., LACM #####-#). Although the photographs are of paired otoliths, these do not necessarily come from the same fish because the otoliths in the Fitch Otolith Collection are stored in a single vial by species and contain otoliths from more than one individual fish. For many species, more than one page of photographs is provided for each species to show within-species individual variability. Some otoliths have had pencil lead rubbed on them to highlight features. Fish families are arranged in the order found in Nelson (2006). Genera and species within a family are in alphabetical order. Family, genera, species, and common names follow Nelson et al. (2004) and Eschmeyer (2010).

RESULTS AND DISCUSSION

The original intent of this catalog was to document otoliths of marine fish found in the diet of California sea lions in southern California. While the catalog was being created, it became apparent that including closely related species would also be helpful, as would be including species found in the diet of sea lions at other localities.

Otolith identification is a difficult process. Over time, I have learned many "tricks" to identifying an otolith to species level. Begin by matching otoliths of similar size and shape. Is the otolith thick (robust), thin (fragile), or in between? Next, examine the sulcus in the medial surface. Is it straight or curved? If curved, where does the curve begin and what is the angle? What is the shape of the sulcus? Is the sulcus long or short, deep or shallow, wide or narrow, centered on the otolith, or curved? Is the dorsal portion above the sulcus concave, convex, or flat? The distal surface is useful in distinguishing between species whose otoliths are very similar; examine patterns of the ridges, grooves, and lobes. The edge view helps to distinguish species; some otoliths are flat, others are curved, others are curved and twisted, while others form a bowl or a twisted bowl. Is the rostrum long, short, rounded, or pointed? In many instances, a dichotomous key would be expected in an identification guide, but the differences between species are often subtle and are not easily described in a dichotomous format.

As one would expect, otoliths of species within a genus are very similar, as are otoliths of genera within a family and closely related families. The classification and grouping of families in Nelson (2006) will provide clues to otolith identification. As an example, the species within the family Hexagrammidae can be mistaken for species within Cottidae, and vice versa. These families are closely related and otoliths from these fish have similar characteristics. Often, a

student of otolith identification will need to examine related families to derive the correct species identification.

ACKNOWLEDGMENTS

This catalog was made possible by using the collection amassed by the late John Fitch. I would like to thank Christine Thacker, Rick Feeney, Jeff Seigel, and Neftali Camacho from the Natural History Museum of Los Angeles County, which archives the Fitch Otolith Collection, for allowing me to borrow otoliths for creating the otolith photographic catalog. The equipment used to photograph otoliths was provided by Wayne Perryman and Morgan Lynn of the Southwest Fisheries Science Center. Rachel Struch assisted with creating the catalog. The manuscript was reviewed by Jay Barlow, Christine Thacker, Rick Feeney, Jeff Seigel, Margaret Neighbors, Bill Walker, and Susan Riemer.

LITERATURE CITED

Eschmeyer, W. N. (ed.) Catalog of Fishes electronic version (25 October 2010). http://research.calacademy.org/ichthyology/catalog/fishcatmain.asp

Nelson, J.S. 2006. Fishes of the world. 4th ed. John Wiley and Sons, Inc., Hoboken, New Jersey, USA. 601p.

Nelson, J.S., E. J. Crossman, H. Espinosa-Pérez, L. T. Tindley, C. R. Gilbert, R. N. Lea, and J. D. Williams. 2004. Common and scientific names of fishes from the United States, Canada, and Mexico. 6th ed. American Fisheries Society Special Publication 29. Bethesda, Maryland. 386p.

Photographic catalog of fish otoliths

Species listed under each family name are in the catalog. Prey of California sea lions have asterisk (*)

Engraulidae Page

Engraulis mordax, northern anchovy*……..…12

Clupeidae

Clupea pallisii, Pacific herring*……14

Sardinops sagax, Pacific sardine*……..…17

Argentinidae

Argentina sialis, Pacific argentine*…….……..……19

Microstomatidae

Leuroglossus stilbius, California smoothtongue*……20

Osmeridae

Hypomesus pretiosus, surf smelt……..……..…21

Thaleichthys pacificus, eulachon*…….……22

Salmonidae

Oncorhynchus gorbuscha, pink salmon…….……23

Oncorhynchus kisutch, coho salmon…….……..……29

Oncorhynchus mykiss, rainbow trout*……..……..……30

Synodontidae

Synodus lucioceps, California lizardfish*…….……32

Scopelarchidae

Benthalbella dentata, northern pearleye……35

Paralepididae

Lestidiops ringens, slender barracudina*……..… ……36

Magnisudis atlantica, Atlantic barracudina*……...……..……37

Neoscopelidae

Scopelengys tristis,Pacific blackchin…….……38

Myctophidae

Ceratoscopelus townsendi, dogtooth lampfish*……39

Diaphus theta, California headlightfish*……...……41

Nannobrachium ritteri, broadfin lampfish*……...……43

Protomyctophum crockeri, California flashlightfish*……...……44

Stenobrachius leucopsarus, northern lampfish*……46

Symbolophorus californiensis, California lanternfish*…….…...47
Tarletonbenia crenularis, blue lanternfish*…….…..…48
Triphoturus mexicanus, Mexican lampfish*…….…….……51

Moridae
Physiculus rastrelliger, hundred-fathom codling*……52

Merlucciidae
Merluccius productus, Pacific hake*……53

Gadidae
Microgadus proximus, Pacific tomcod*……...……56

Ophidiidae
Chilara taylori, spotted cusk-eel*…….……57
Ophidion scrippsae, basketweave cusk-eel*…….……60

Bythitidae
Brosmophycis marginata, red brotula*…….…….……62

Batrachoididae
Porichthys myriaster, specklefin midshipman*……65
Porichthys notatus, plainfin midshipman*……68

Atherinopsidae
Atherinops affinis, topsmelt*……70
Atherinopsis californiensis, jacksmelt*…….……73
Leuresthes tenuis, California grunion……75

Exocoetidae
Cheilopogon pinnatibarbatus californicus, California flyingfish*……..…….77

Belonidae
Strongylura exilis, California needlefish……..…….……78

Scomberesocidae
Cololabis saira, Pacific saury*……..……80

Melamphaidae
Melamphaes lugubris, highsnout bigscale*……..…….……81

Scorpaenidae
Sebastes aurora, aurora rockfish……..…….……83
Sebastes caurinus, copper rockfish*…….…….……85
Sebastes diploproa, splitnose rockfish*…….……87

Sebastes elongatus, greenstriped rockfish*……90
Sebastes ensifer, swordspine rockfish*……93
Sebastes entomelas, widow rockfish*……95
Sebastes goodei, chilipeper*……96
Sebastes hopkinsi, squarespot rockfish*……100
Sebastes jordani, shortbelly rockfish*……104
Sebastes lentiginosus, freckled rockfish*……107
Sebastes miniatus, vermilion rockfish*……108
Sebastes mystinus, Blue rockfish*……110
Sebastes paucispinis, bocaccio*……112
Sebastes proriger, redstripe rockfish*……115
Sebastes rufus, bank rockfish*……116
Sebastes saxicola, stripetail rockfish*……117
Sebastes semicinctus, halfbanded rockfish*……119
Sebastes serranoides, olive rockfish*……120
Sebastes umbrosus, honeycomb rockfish*……123
Sebastes wilsoni, pygmy rockfish*……124
Sebastolobus alascanus, shortspine thornyhead*……126

Triglidae
Prionotus stephanophrys, lumptail searobin……130

Anoplopomatidae
Anoplopoma fimbria, sablefish*……132

Hexagrammidae
Ophiodon elongatus, lingcod*……134
Oxylebius pictus, painted greenling……137
Zaniolepis frenata, shortspine combfish*……139
Zaniolepis latipinnis, longspine combfish*……141

Cottidae
Artedius corallinus, coralline sculpin*……144
Artedius notospilotus, bonyhead sculpin*……146
Icelinus filamentosus, threadfin sculpin*……149
Icelinus fimbriatus, fringed sculpin*……151
Icelinus tenuis, spotfin sculpin*……153
Leptocottus armatus, staghorn sculpin*……155
Orthonopias triacis, snubnose sculpin*……158
Radulinus asprellus, slim sculpin*……161
Ruscarius creaseri, roughcheek sculpin*……163

Agonidae
Xeneretmus ritteri, stripfin poacher*……165
Xeneretmus triacanthus, bluespotted poacher*……167

Liparidae
Careproctus melanurus, blacktail snailfish*……...……170

Serranidae
Paralabrax clathratus, kelp bass*……..…...……171
Paralabrax nebulifer, barred sand bass*…….……172

Carangidae
Trachurus symmetricus, jack mackerel*…….……173

Sciaenidae
Genyonemus lineatus, white croaker*…….……175
Seriphus politus, queenfish*……176

Kyphosidae
Girella nigricans, opaleye……...……177
Medialuna californiensis, halfmoon*…….…..……179

Embiotocidae
Cymatogaster aggregata, shiner surfperch*……182
Cymatogaster aggregata gracilis, island surfperch*……...……184
Embiotoca jacksoni, black surfperch*…….……186
Hyperprosopon anale, spotfin surfperch*……...……188
Phanerodon furcatus, white surfperch*……..…..……190
Zalembius rosaceus, pink surfperch*……..……193

Pomacentridae
Chromis punctipinnis, blacksmith*…….……195

Labridae
Oxyjulis californica, señorita*…….……199
Semicossyphus pulcher, California sheephead*……..……201

Bathymasteridae
Rathbunella hypoplecta, bluebanded ronquil*……..…..……203

Zoarcidae
Lycodes cortezianus, bigfin eelpout*…….……..……206
Lycodes pacificus, blackbelly eelpout*……208
Lyconema barbatum, bearded eelpout*……...……210

Ammodytidae
Ammodytes hexapterus, Pacific sandlance*……212

Clinidae
Heterostichus rostratus, giant kelpfish*…….…..……213

Gobiidae
Rhinogobiops nicholsii, blackeye goby*……..……215

Sphyraenidae
Sphyraena argentea, California barracuda*…….……..……..……217

Scombridae
Sarda chiliensis, Pacific bonito*…….……..……219
Scomber japonicus, Pacific mackerel*……222

Centrolophidae
Icichthys lockingtoni, medusafish*……..……225

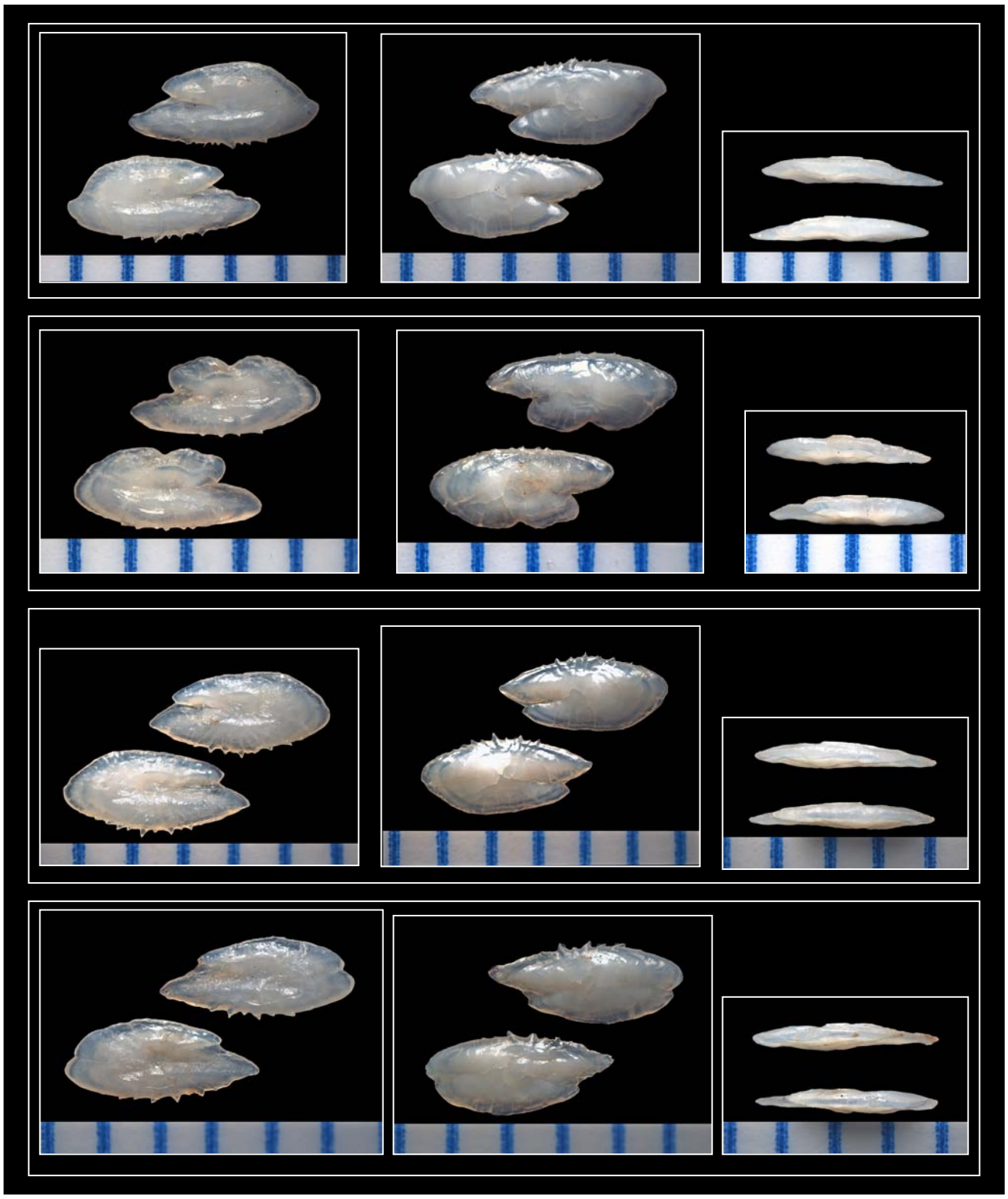
Tetragonuridae
Tetragonurus cuvieri, smalleye squaretail*……..……228

Stromateidae
Peprilus simillimus, Pacific pompano*……231

Paralichthyidae
Citharichthys sordidus, Pacific sanddab*……..…..……234
Citharichthys stigmaeus, speckled sanddab*……...……235
Citharichthys xanthostigma, longfin sanddab……..……237
Hippoglossina stomata, bigmouth sole*……..……239
.
Pleuronectidae
Glyptocephalus zachirus, rex sole*…….……241
Lepidopsetta bilineata, rock sole…….……243
Lyopsetta exilis, slender sole*…….……..……244
Microstomus pacificus, Dover sole*……...…….……245
Parophrys vetulus, English sole*……...…….……..……247

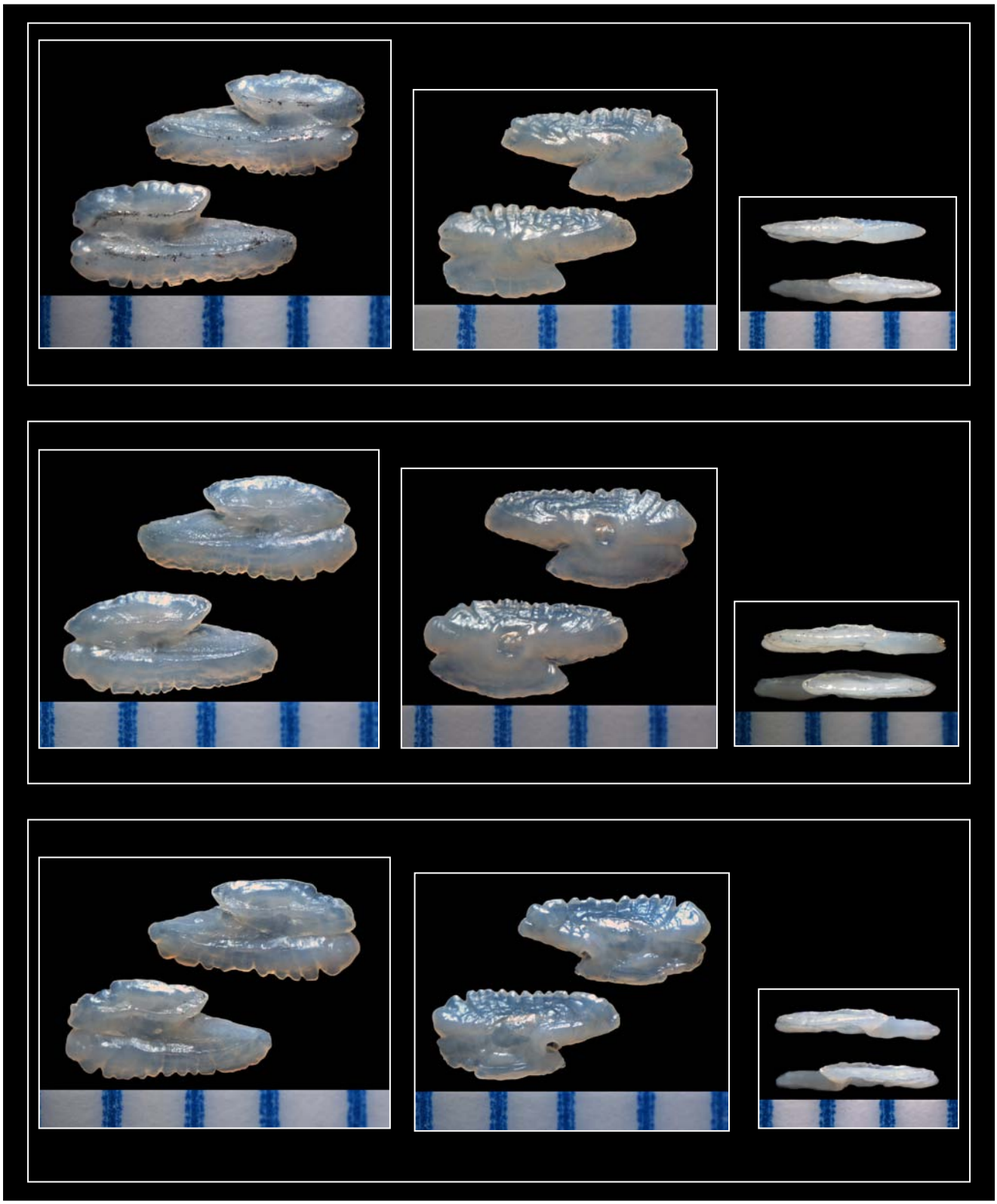
Cynoglossidae
Symphurus atricauda, California tonguefish*…….……249

Engraulidae
Engraulis mordax, northern anchovy, LACM 56590-1

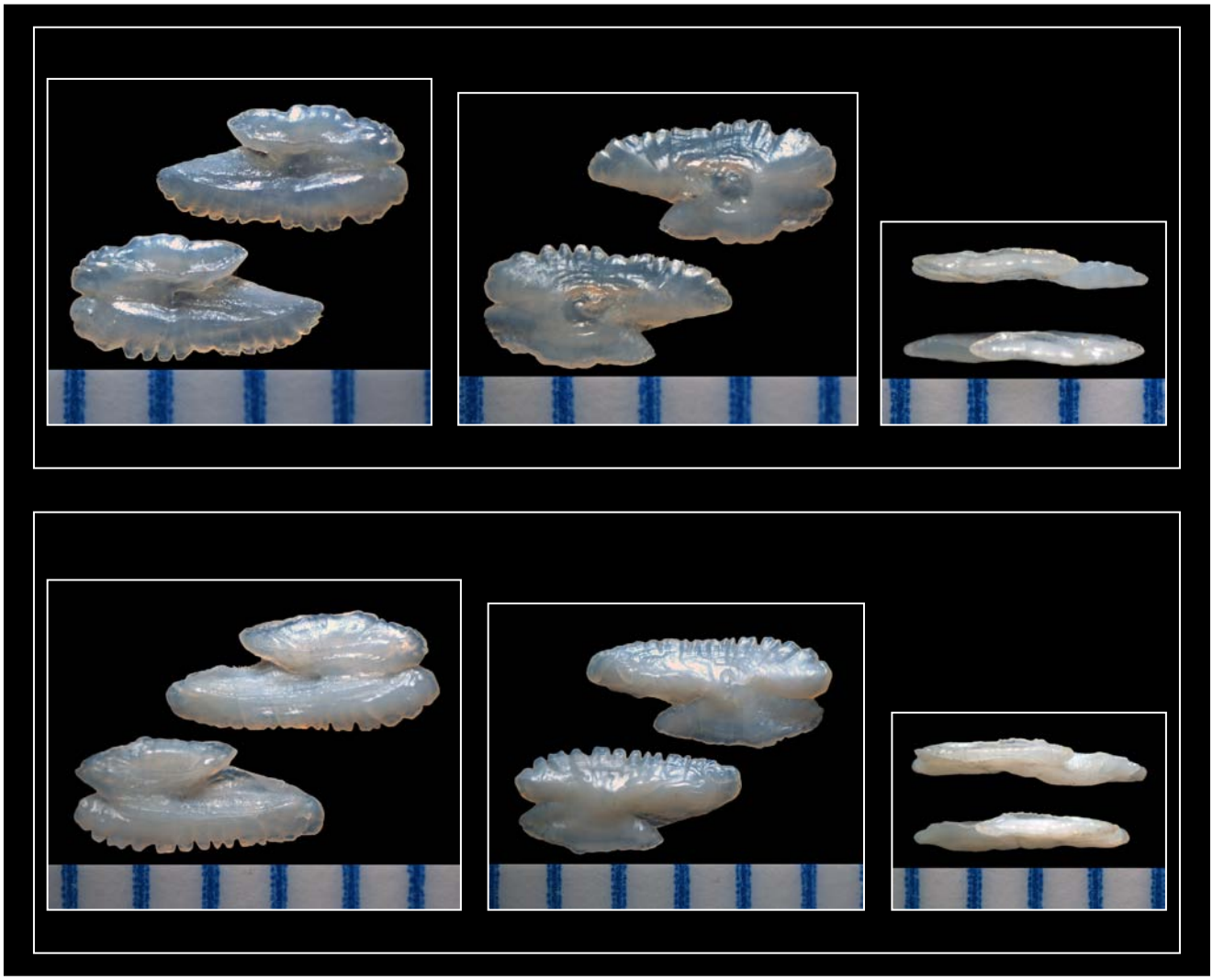


Engraulidae
Engraulis mordax, northern anchovy, LACM 56590-1

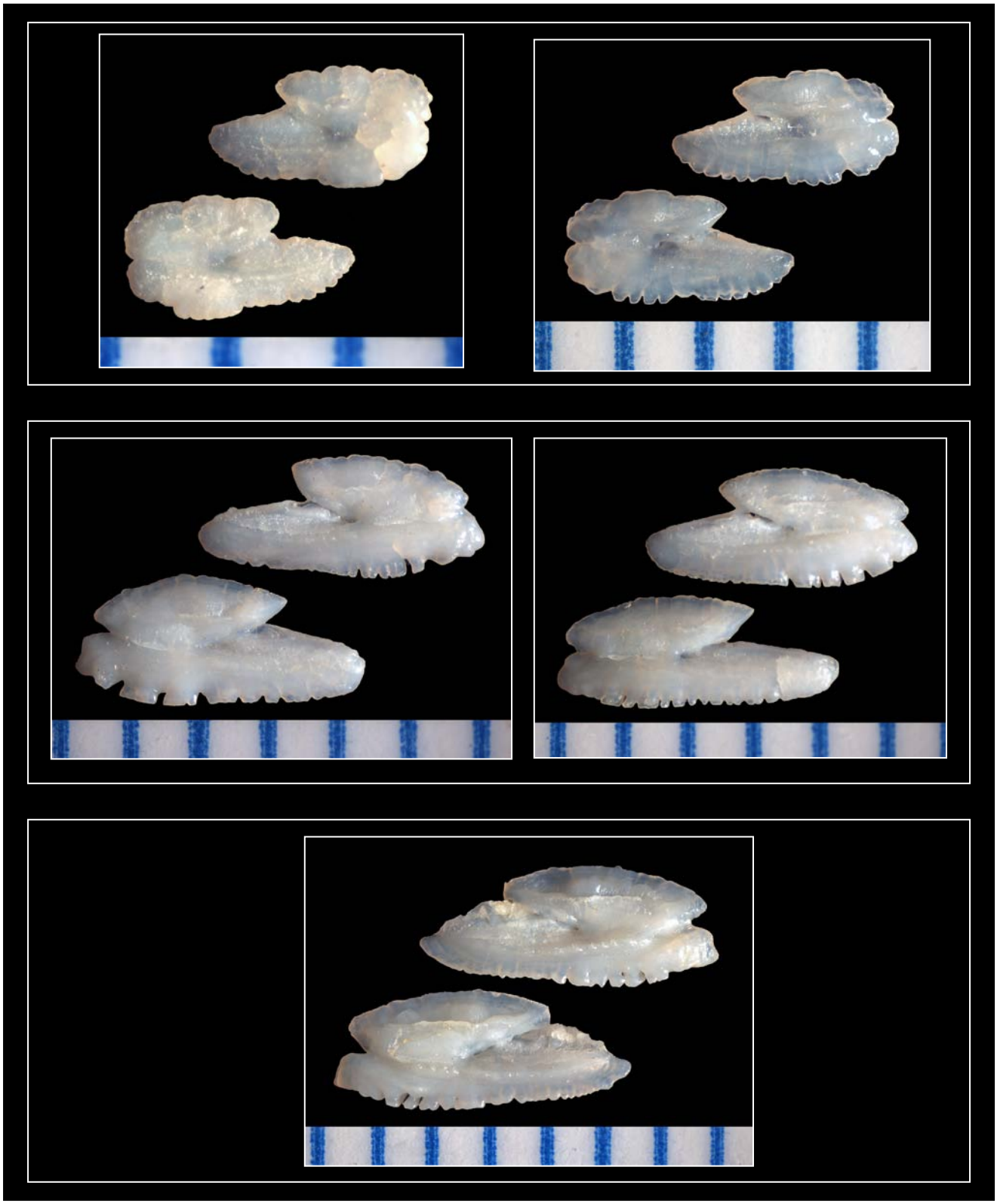
Clupeidae
Clupea pallisii, Pacific herring, LACM 56595-1



Clupeidae
Clupea pallisii, Pacific herring, LACM 56595-1

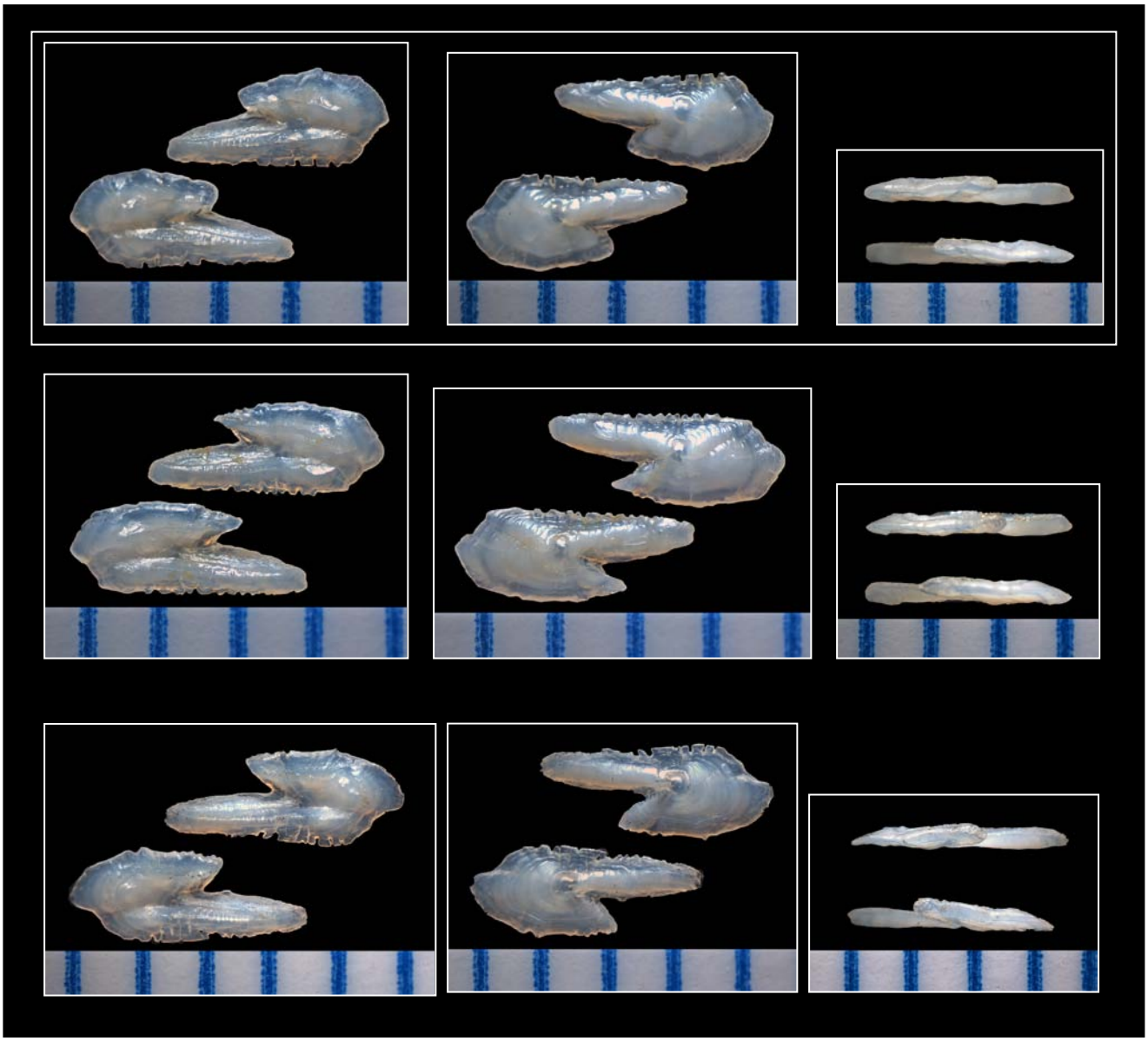


Clupeidae
Clupea pallisii, Pacific herring, LACM 56595-1



Clupeidae
Sardinops sagax, Pacific sardine, LACM 56608-1

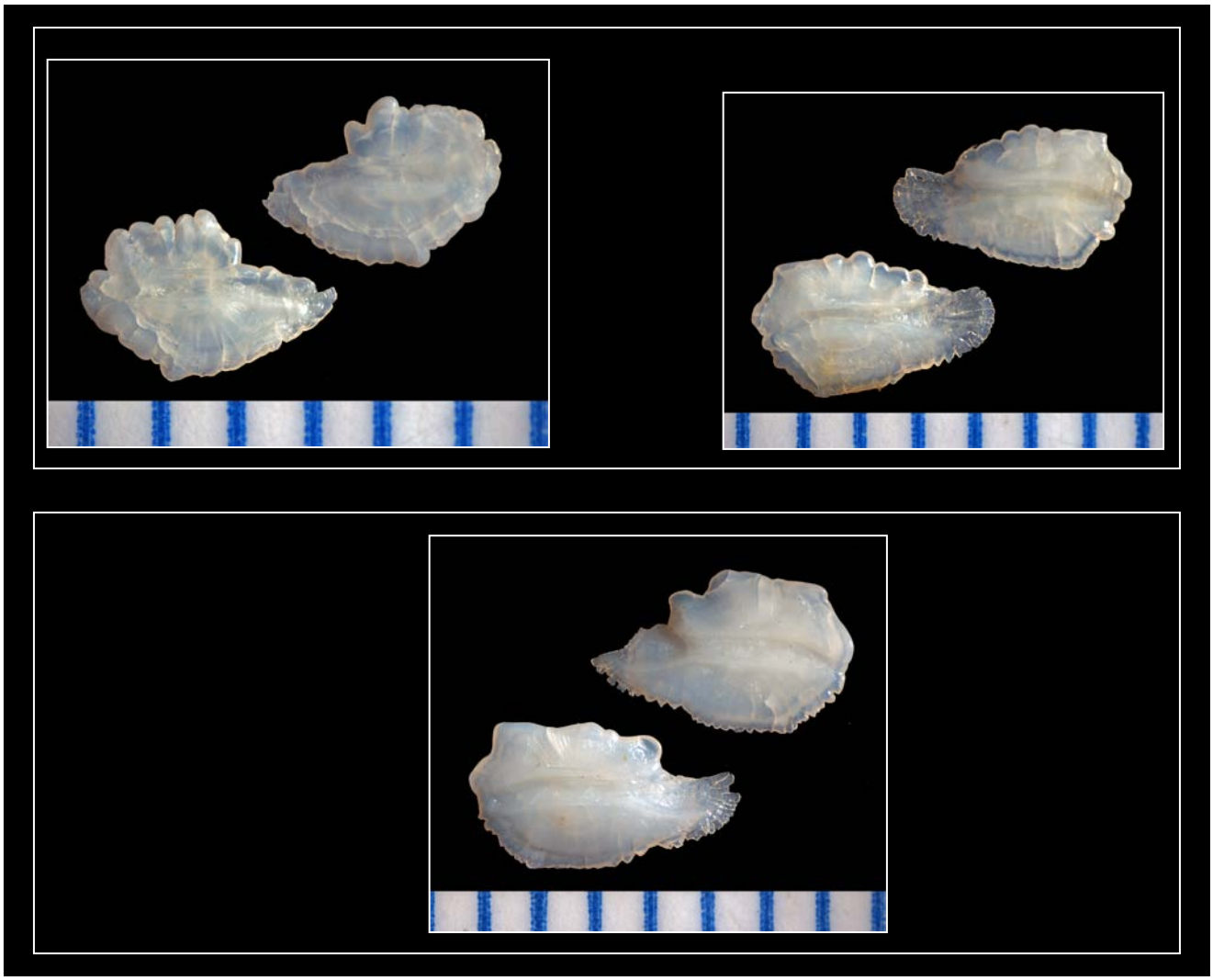
Clupeidae
Sardinops sagax, Pacific sardine, LACM 56608-1



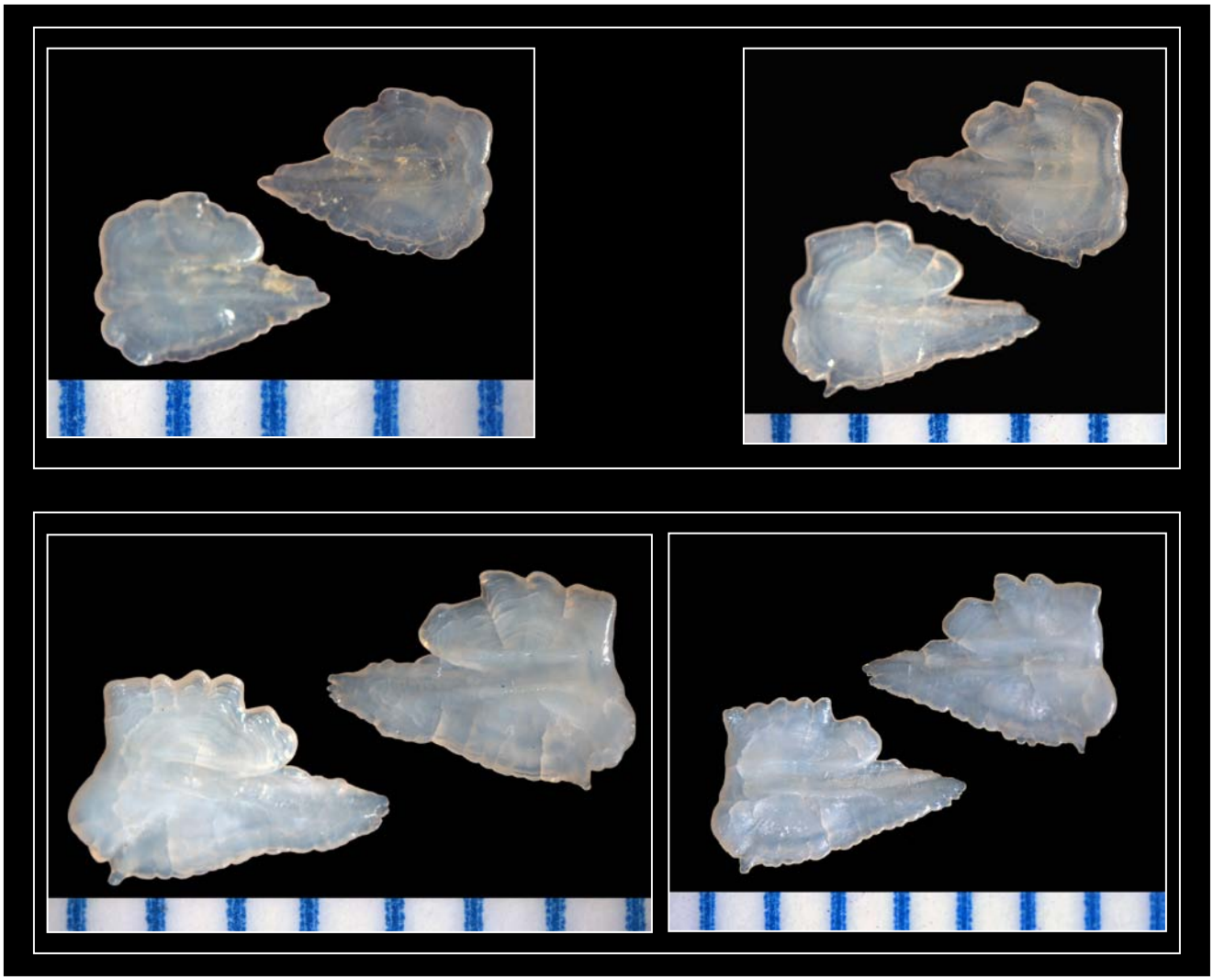
Argentinidae
Argentina sialis, Pacific argentine, LACM 56654-1

Microstomatidae
Leuroglossus stilbius, California smoothtongue, LACM 56609-1

Osmeridae
Hypomesus pretiosus, surf smelt, LACM 56597-1

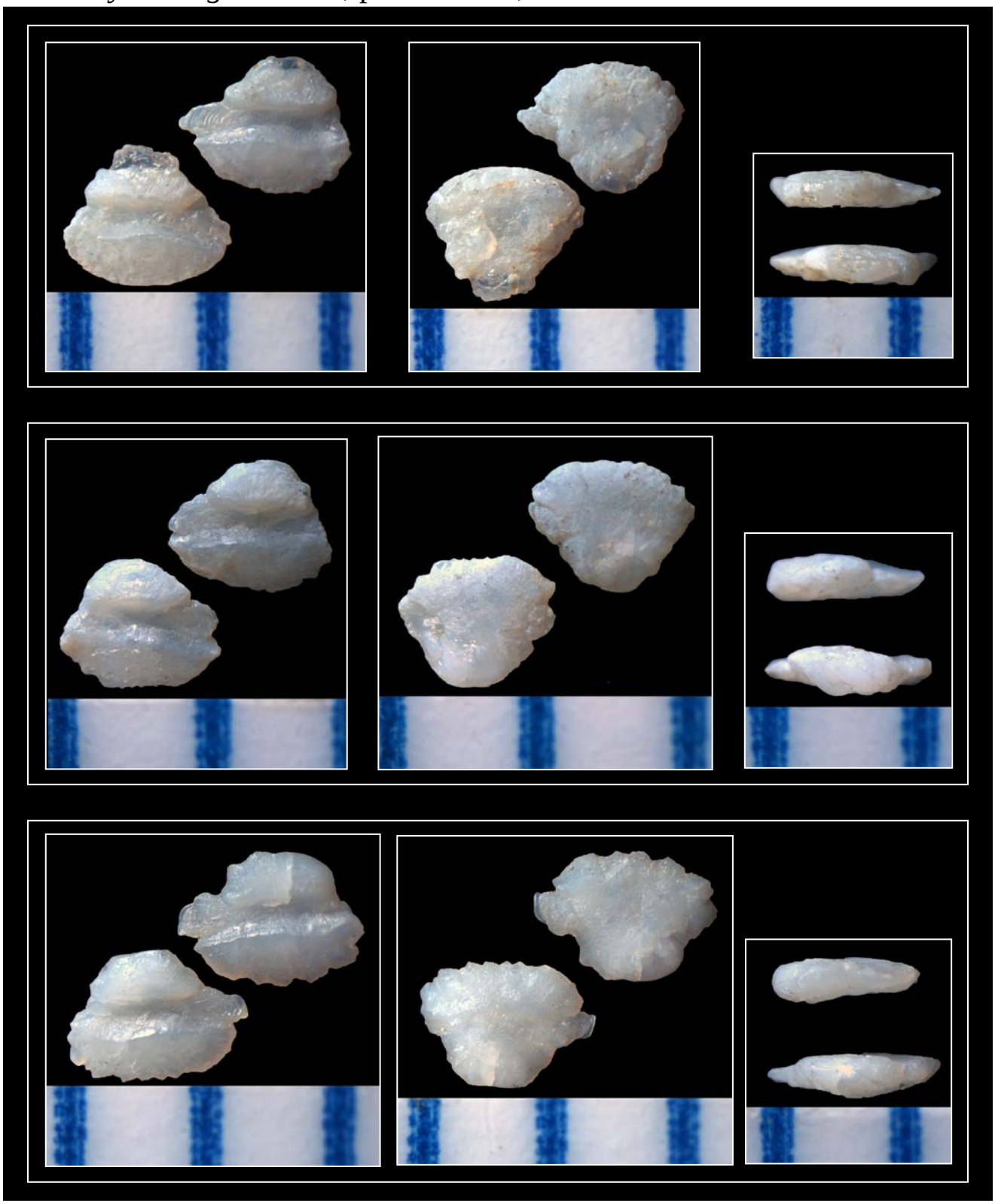


Osmeridae
Thaleichthys pacificus, eulachon, LACM 56594-1



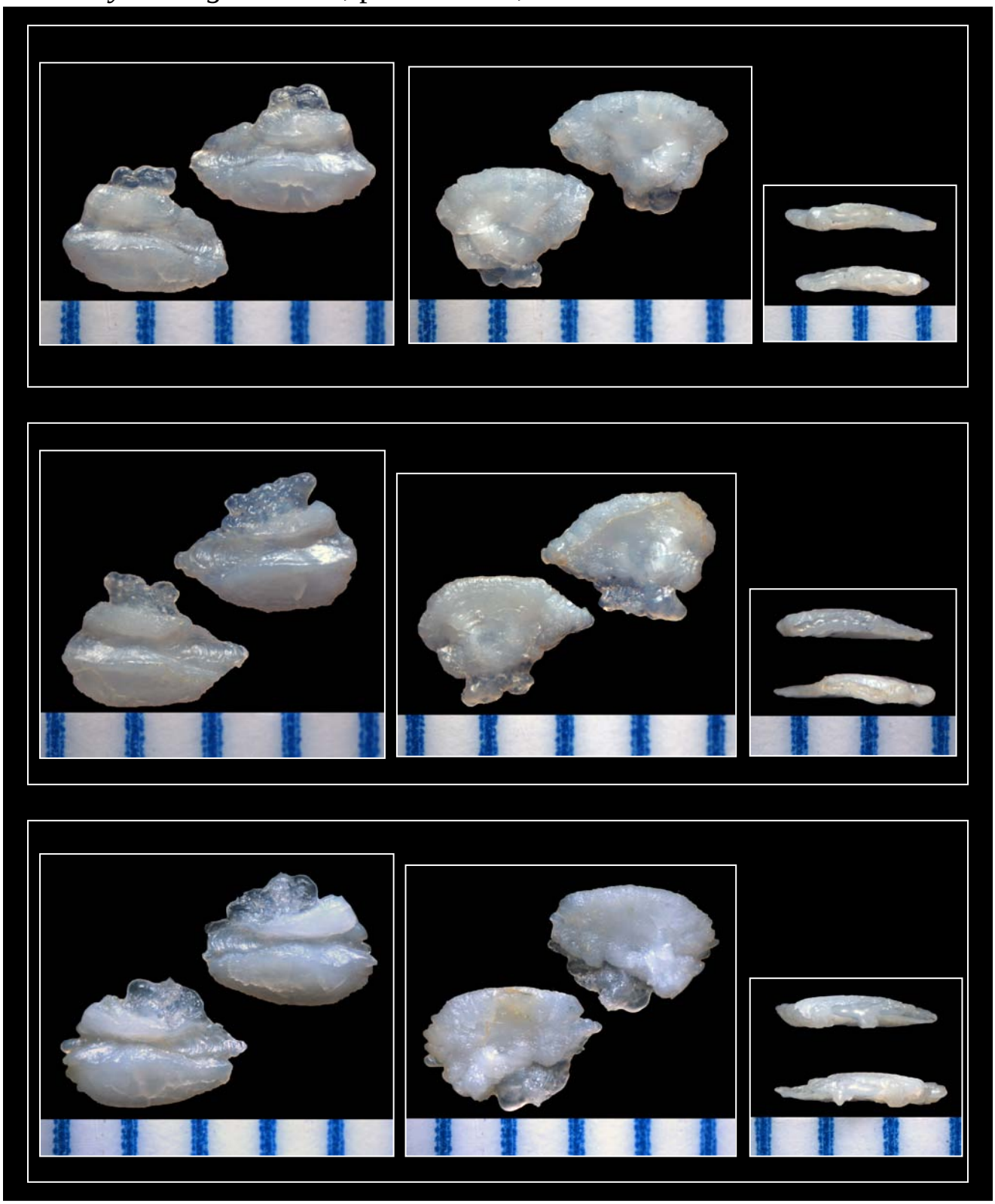
Salmonidae

Oncorhynchus gorbuscha, pink salmon, LACM 56167-1



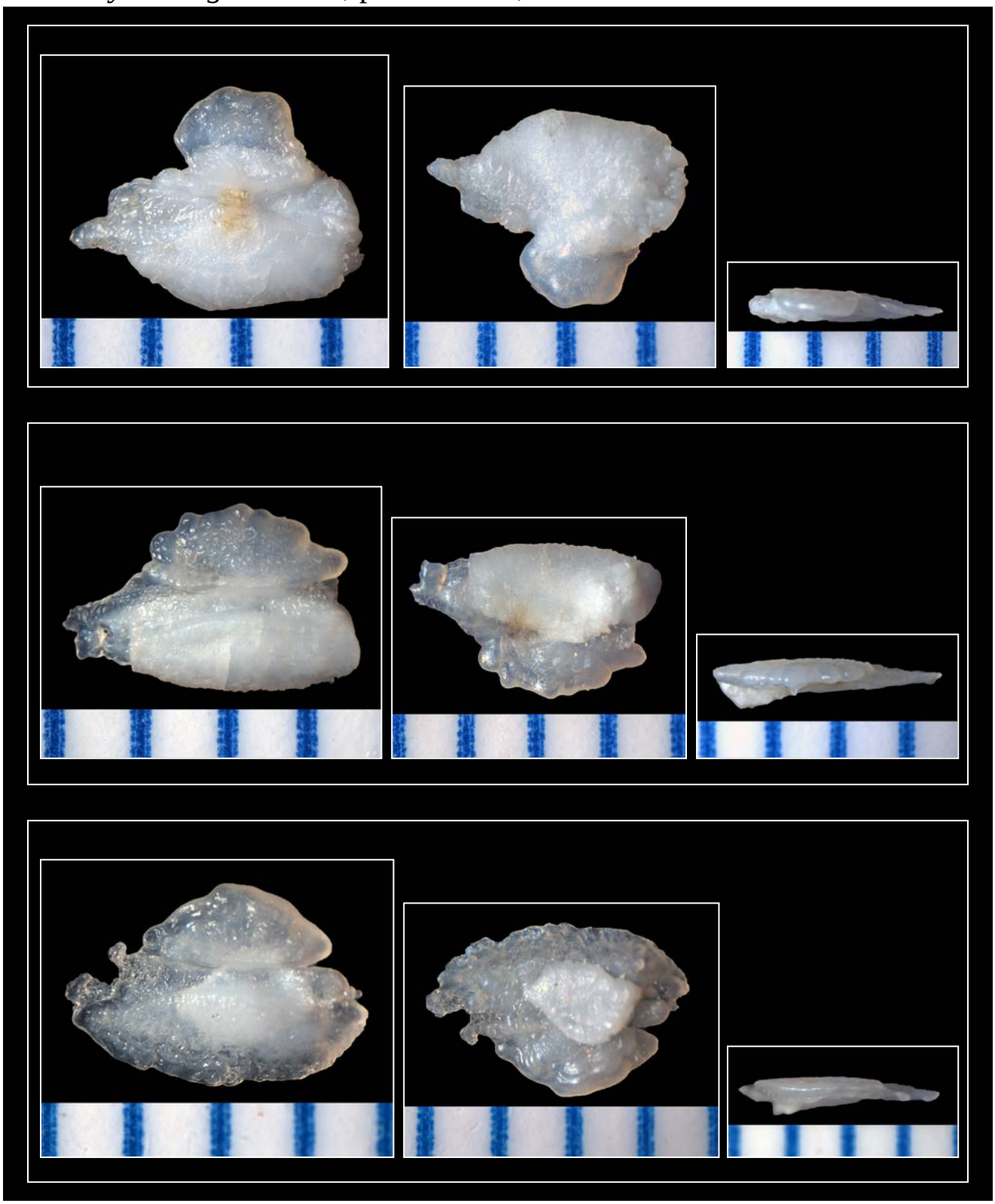
Salmonidae

Oncorhynchus gorbuscha, pink salmon, LACM 56167-1



Salmonidae

Oncorhynchus gorbuscha, pink salmon, LACM 56167-1



Salmonidae

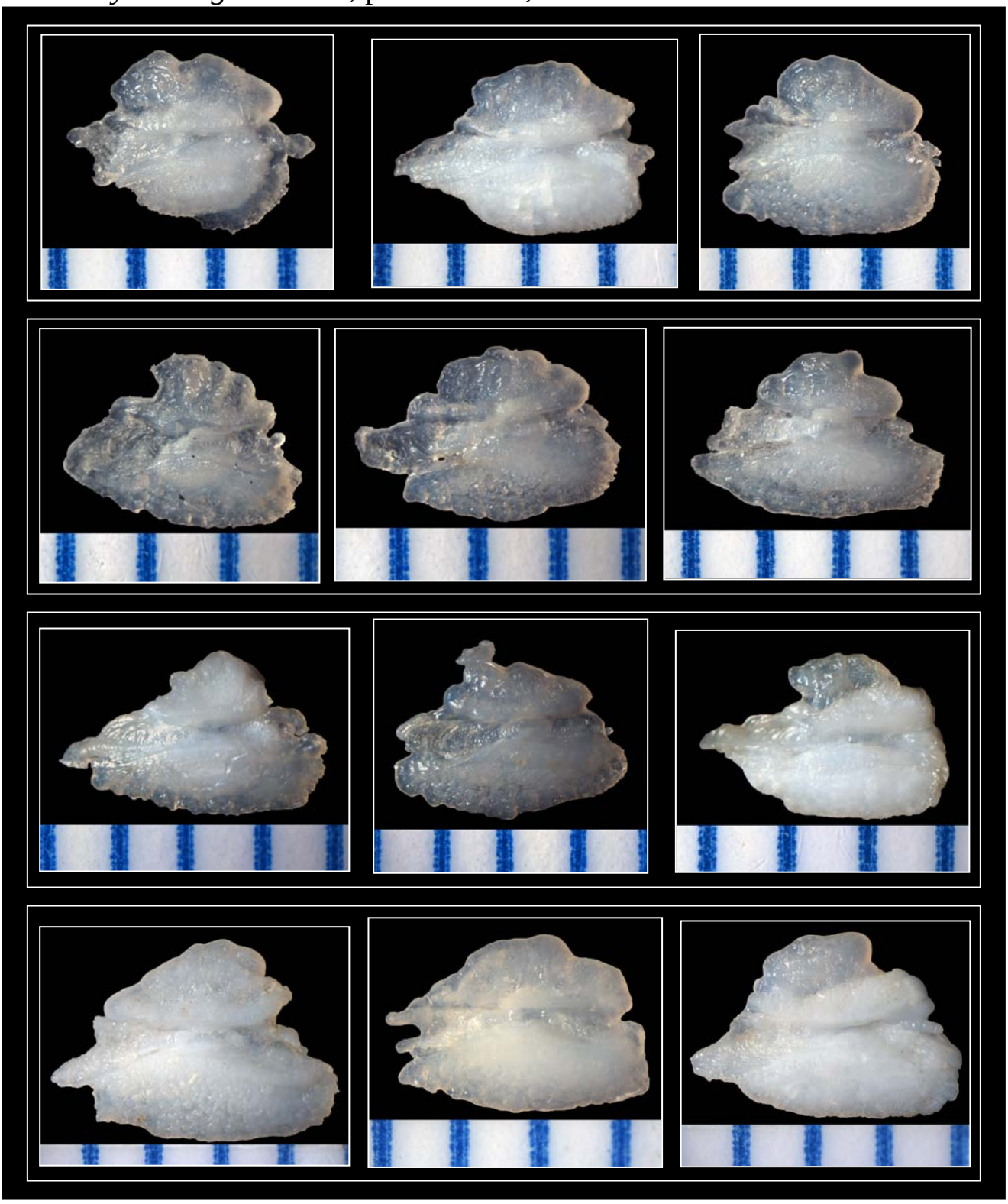
Oncorhynchus gorbuscha, pink salmon, LACM 56167-1

Salmonidae

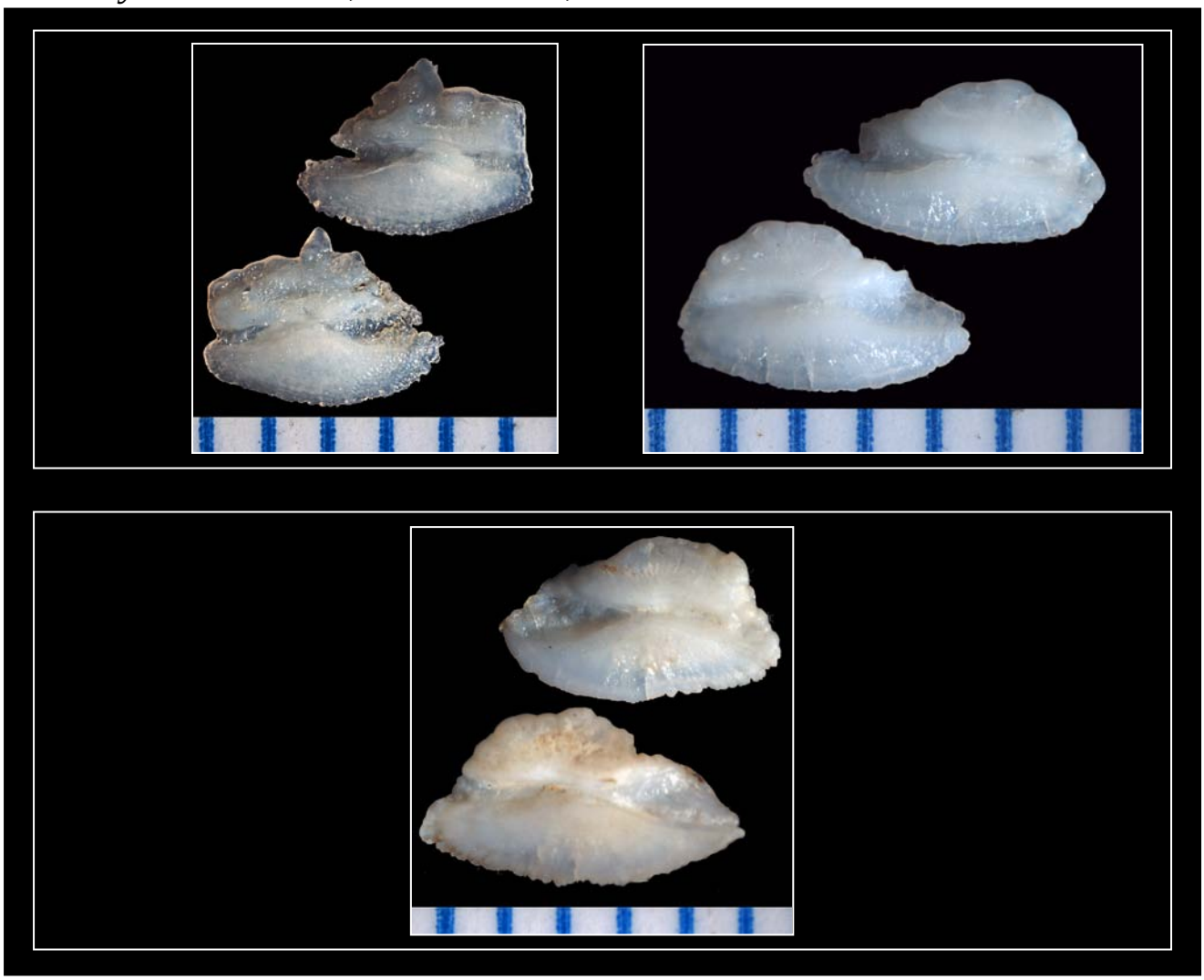
Oncorhynchus gorbuscha, pink salmon, LACM 56167-1

Salmonidae

Oncorhynchus gorbuscha, pink salmon, LACM 56167-1

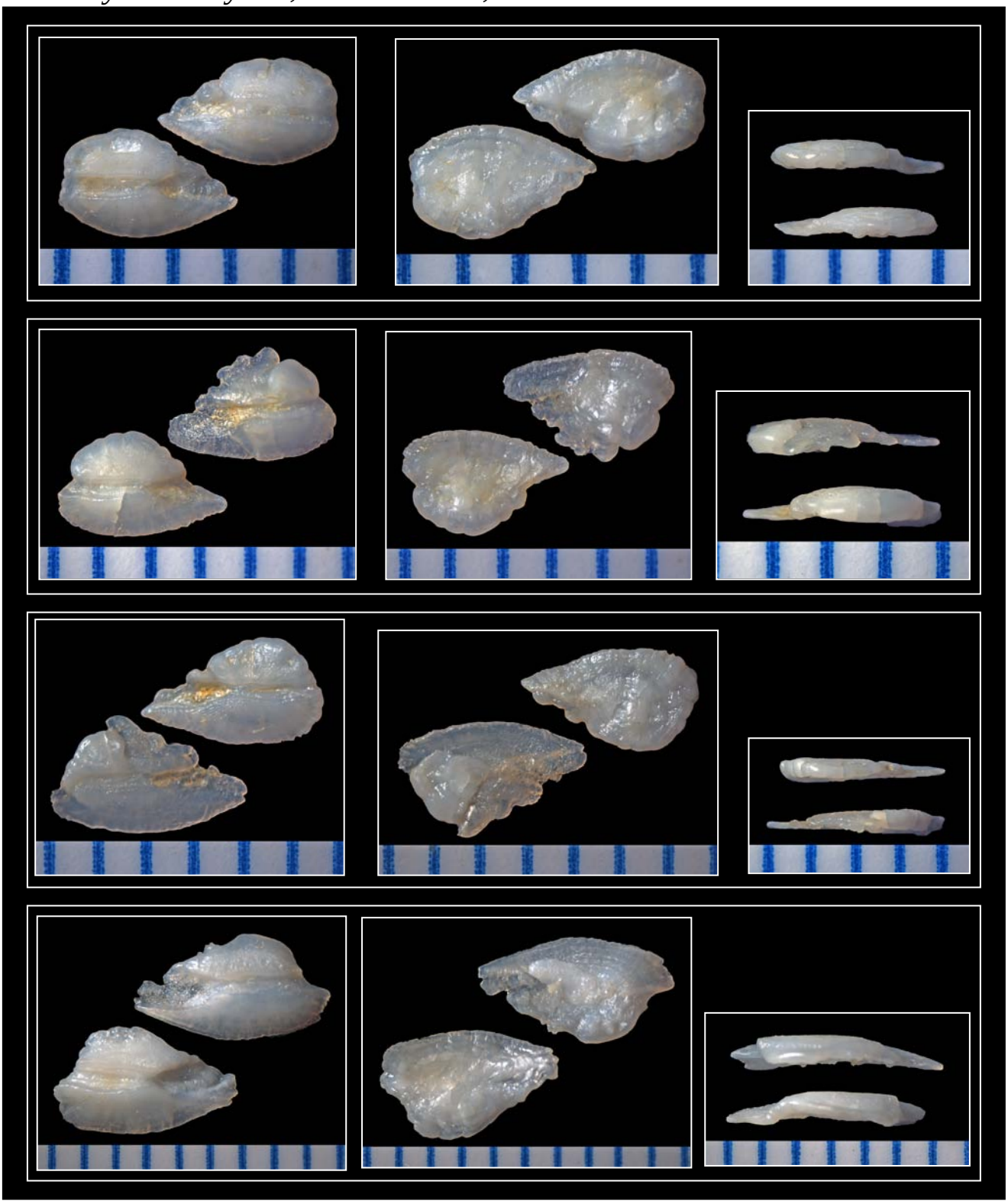


Salmonidae
Oncorhynchus kisutch, coho salmon, LACM 56596-1



Salmonidae

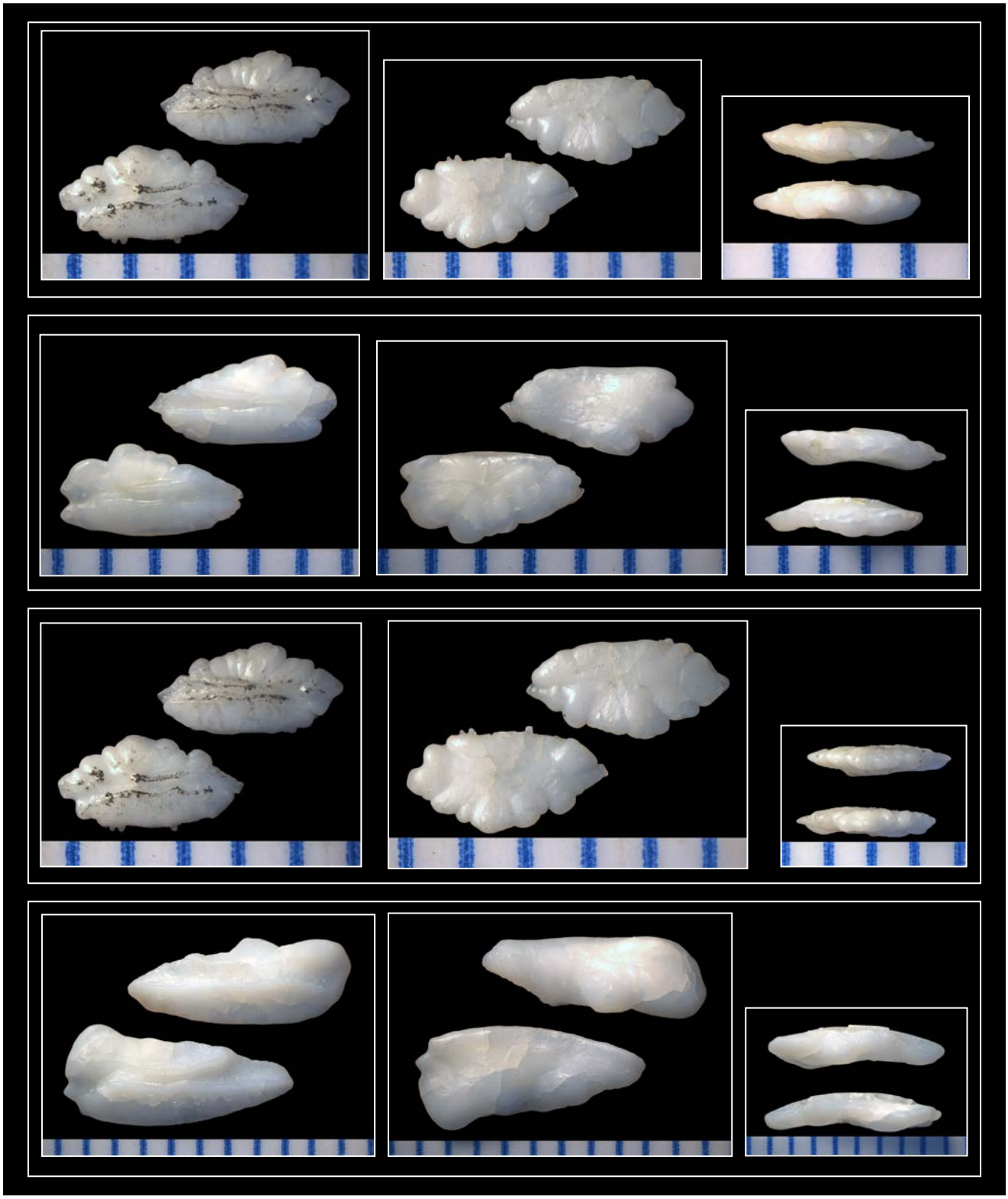
Oncorhynchus mykiss, rainbow trout, LACM 56656-1



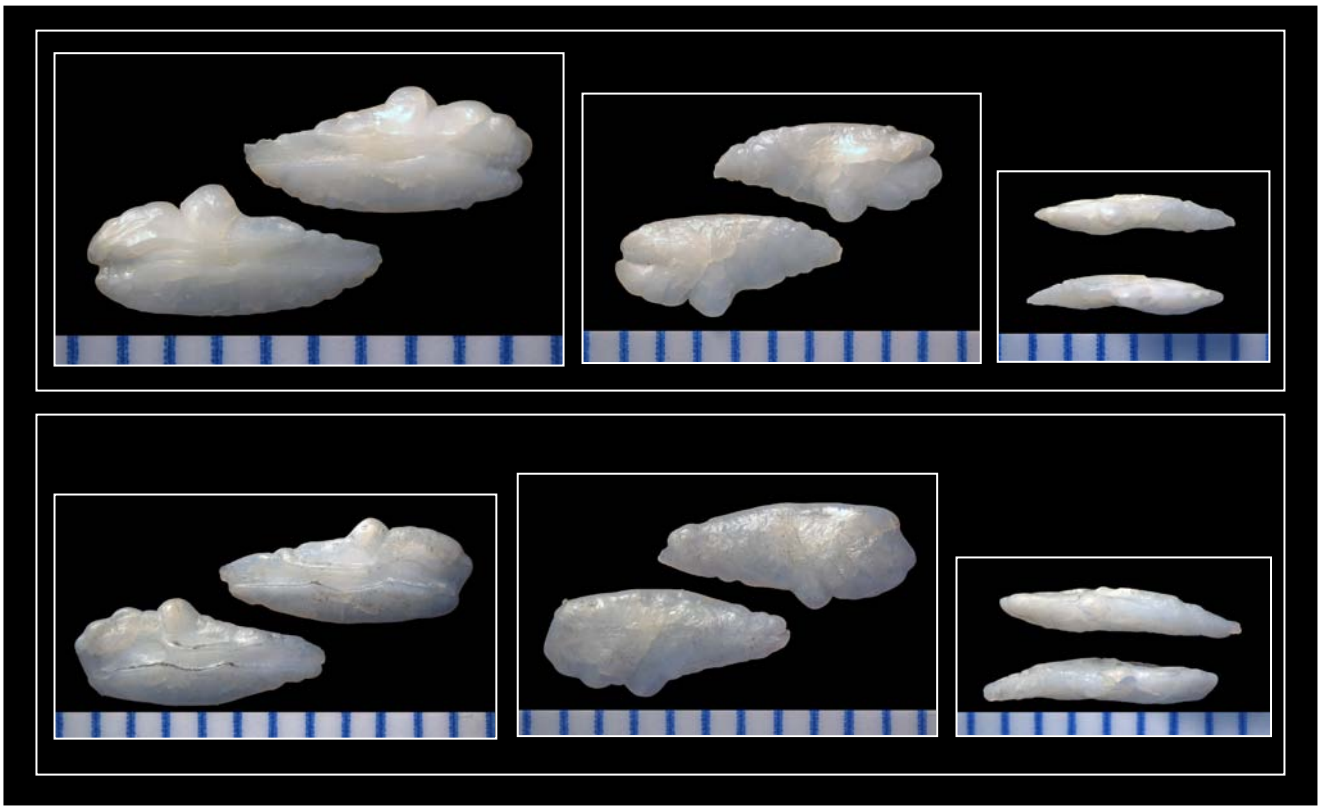
Salmonidae

Oncorhynchus mykiss, rainbow trout, LACM 56656-1

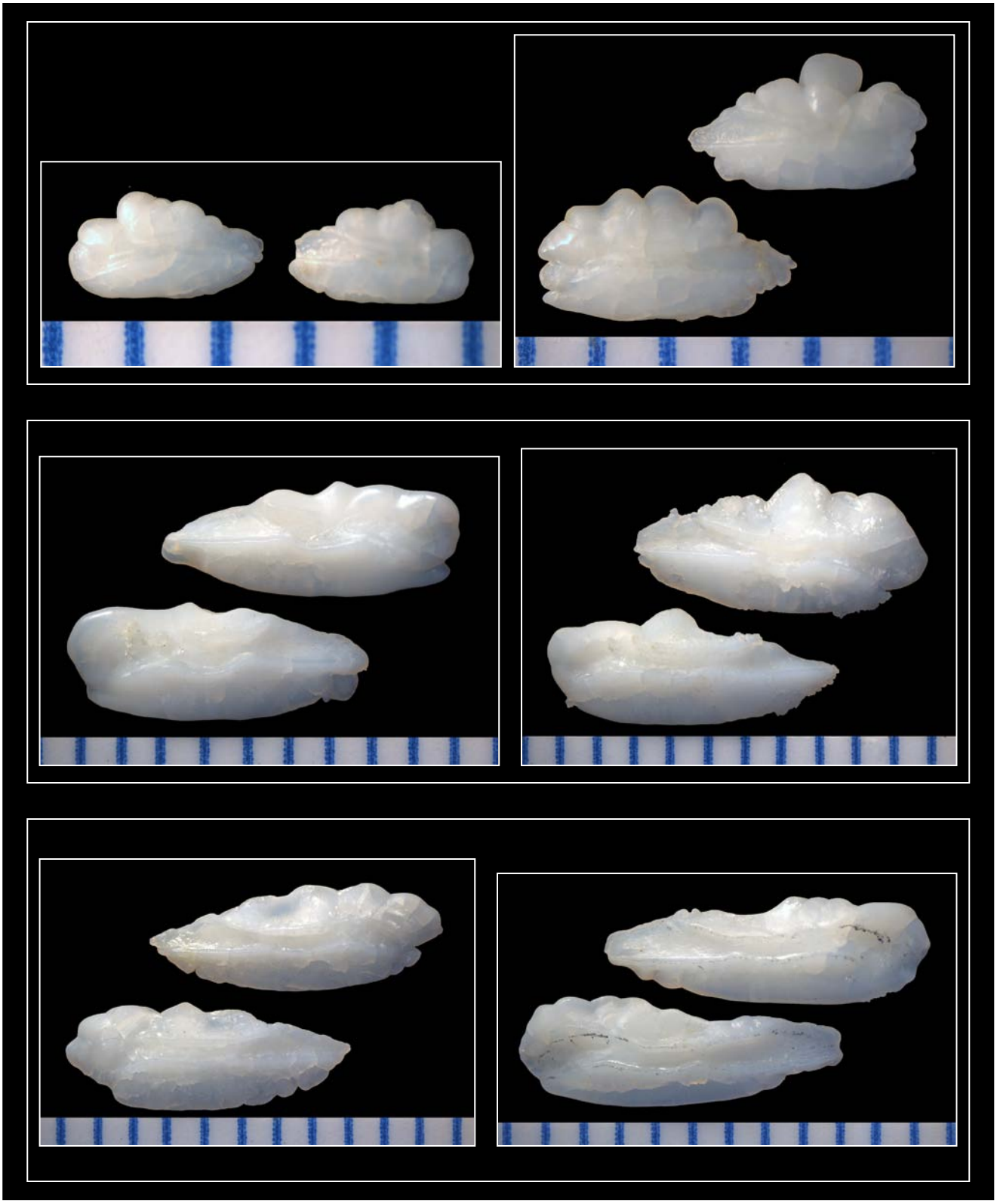
Synodontidae
Synodus lucioceps, California lizardfish, LACM 56697-1



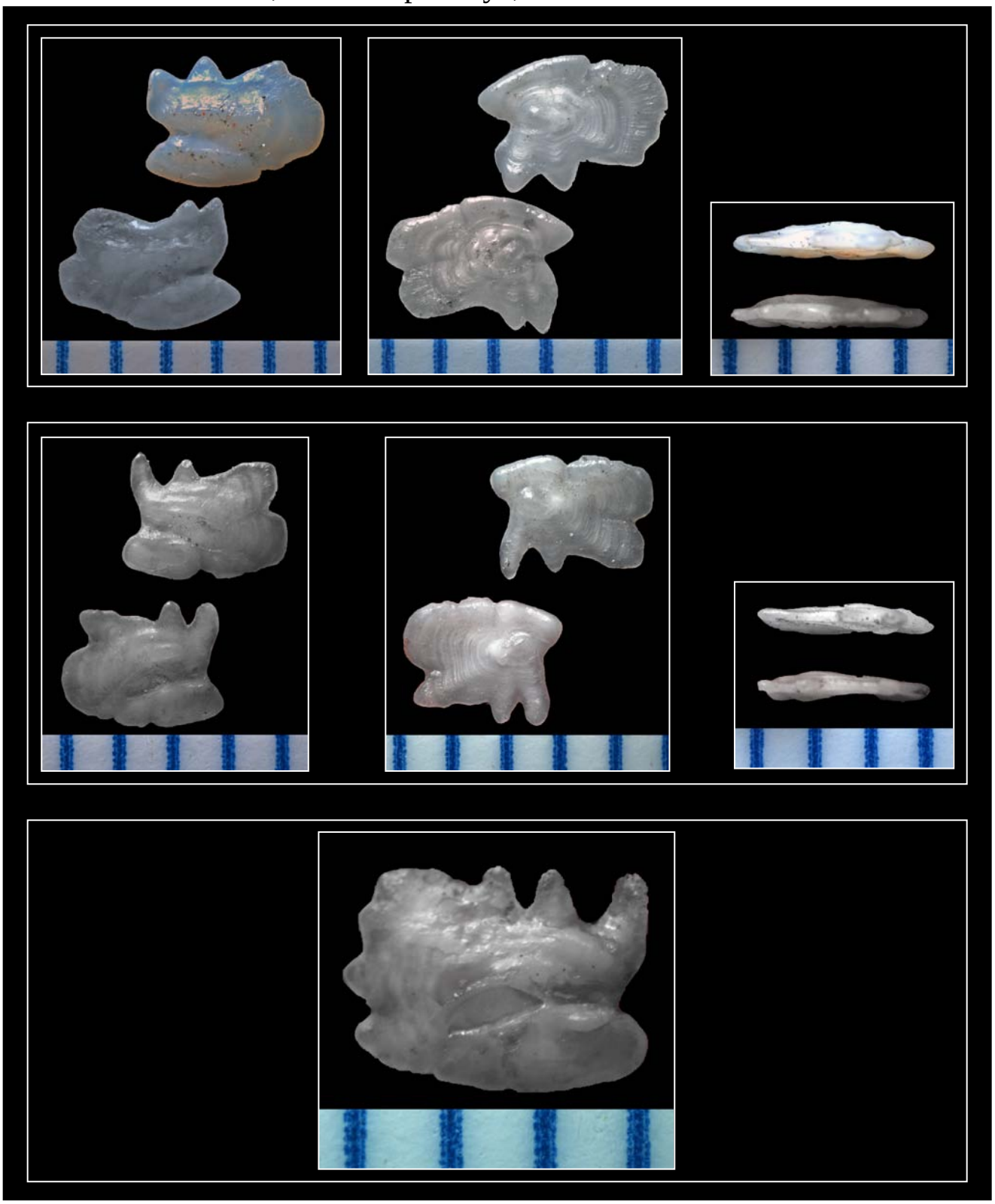
Synodontidae
Synodus lucioceps, California lizardfish, LACM 56697-1



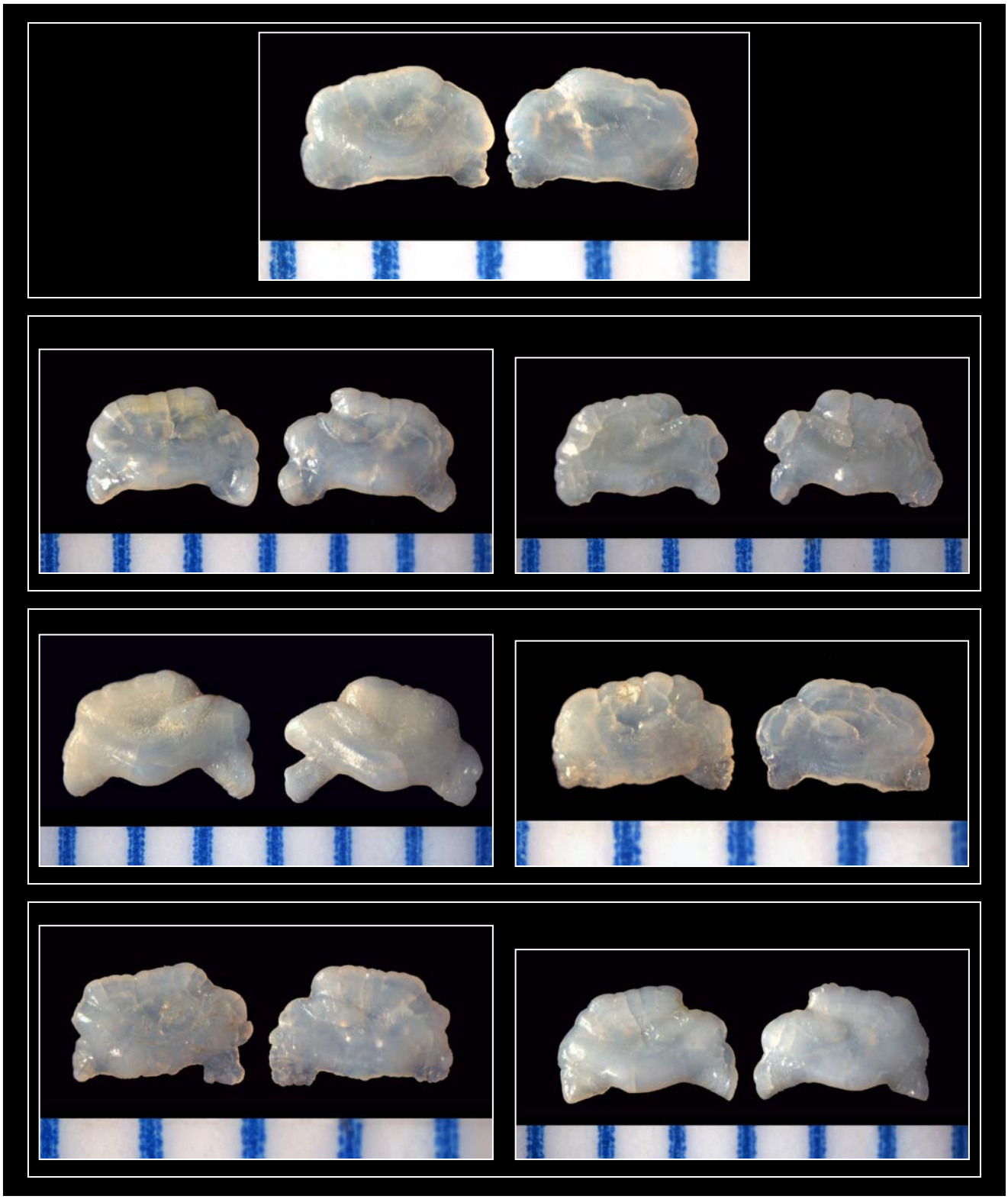
Synodontidae
Synodus lucioceps, California lizardfish, LACM 56697-1



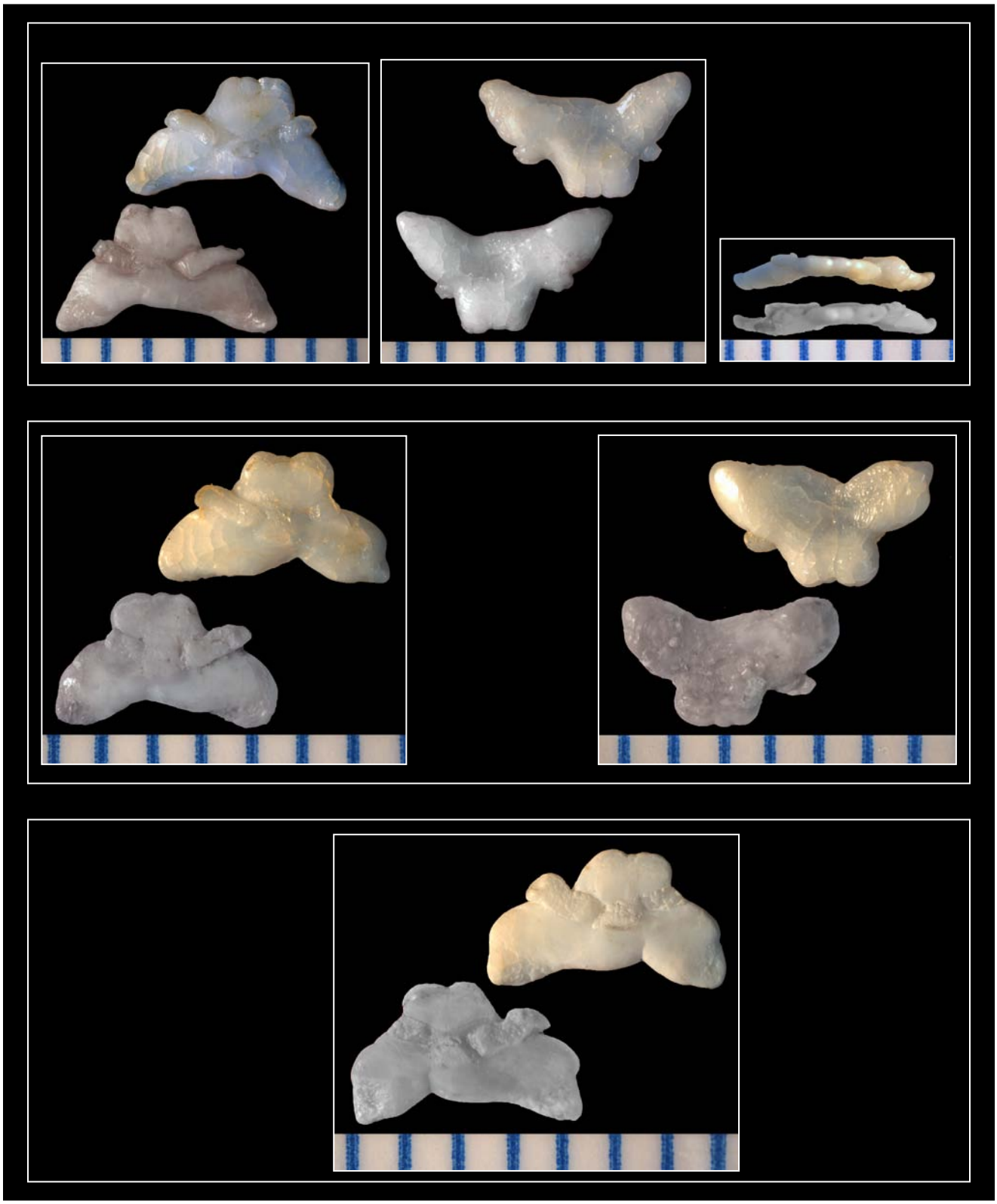
Scopelarchidae
Benthalbella dentata, northern pearleye, LACM 57262-1



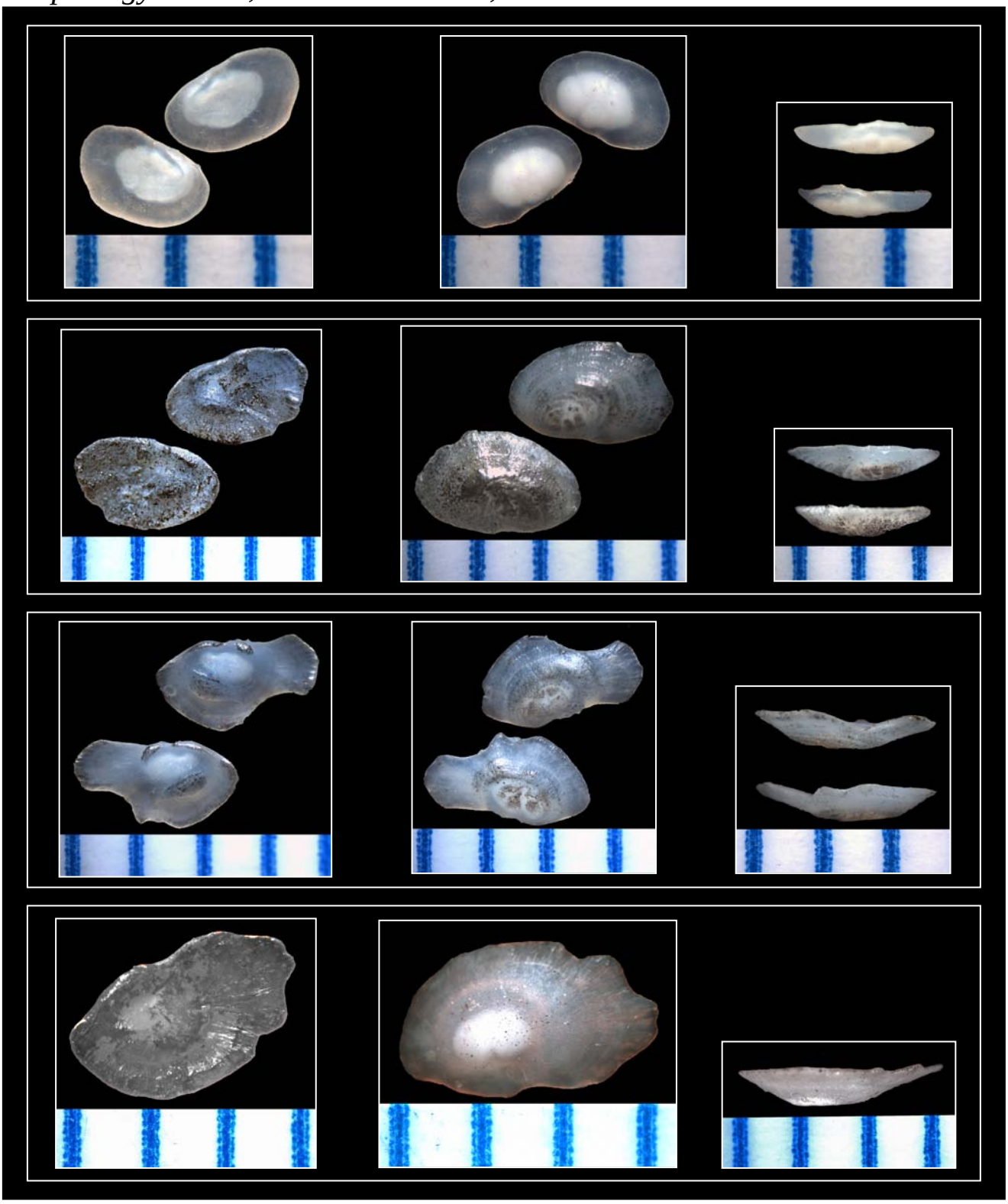
Paralepididae
Lestidiops ringens, slender barracudina, LACM 56641-1



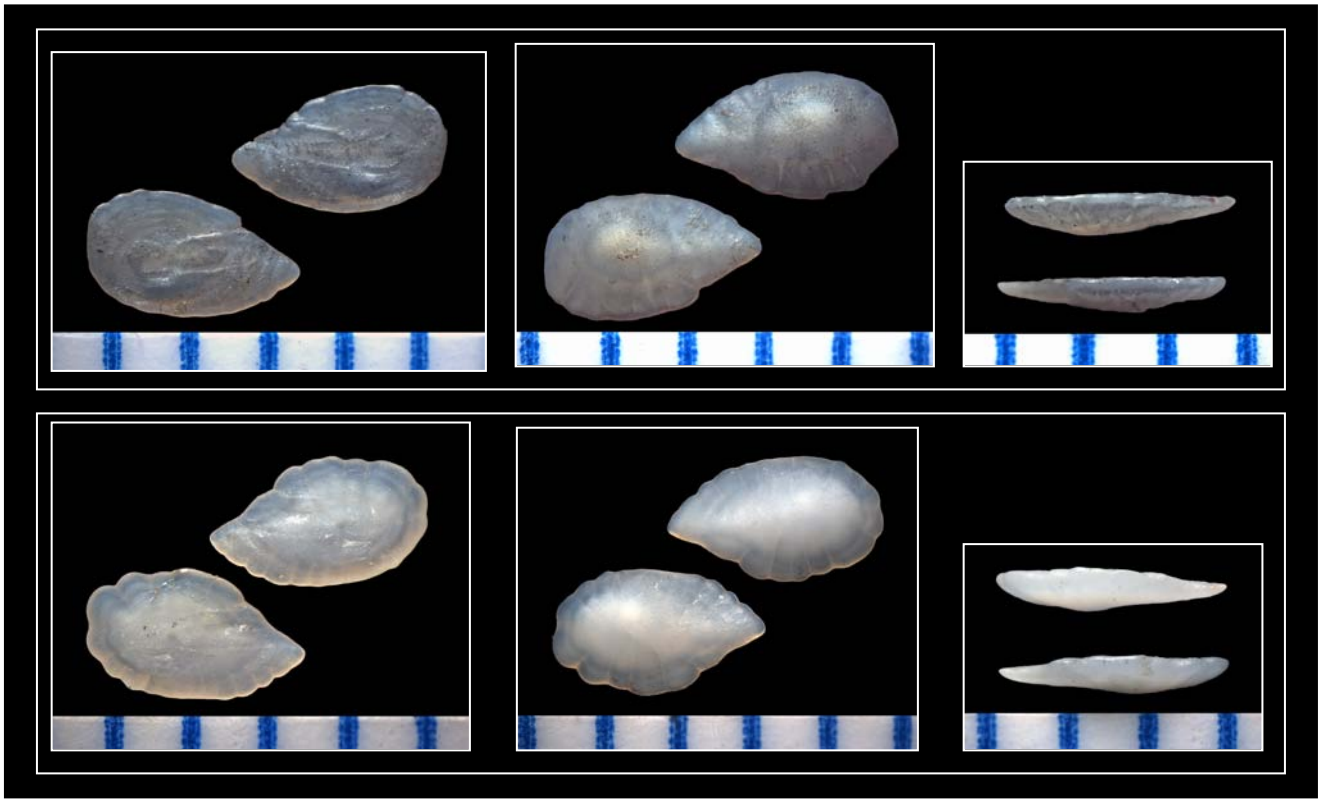
Paralepididae
Magnisudis atlantica, Atlantic barracudina, LACM 56659-1



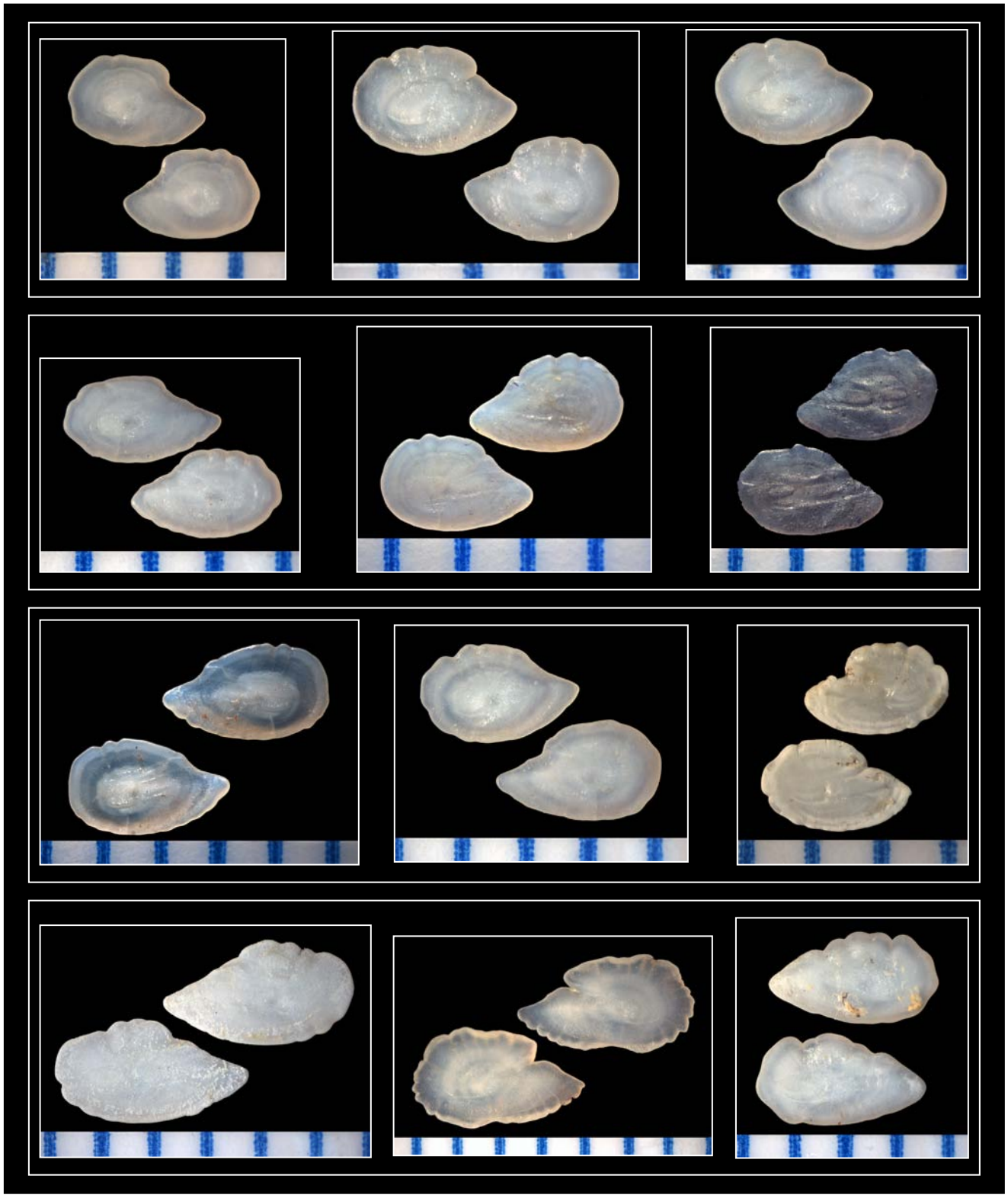
Neoscopelidae
Scopelengys tristis, Pacific blackchin, LACM 57261-1



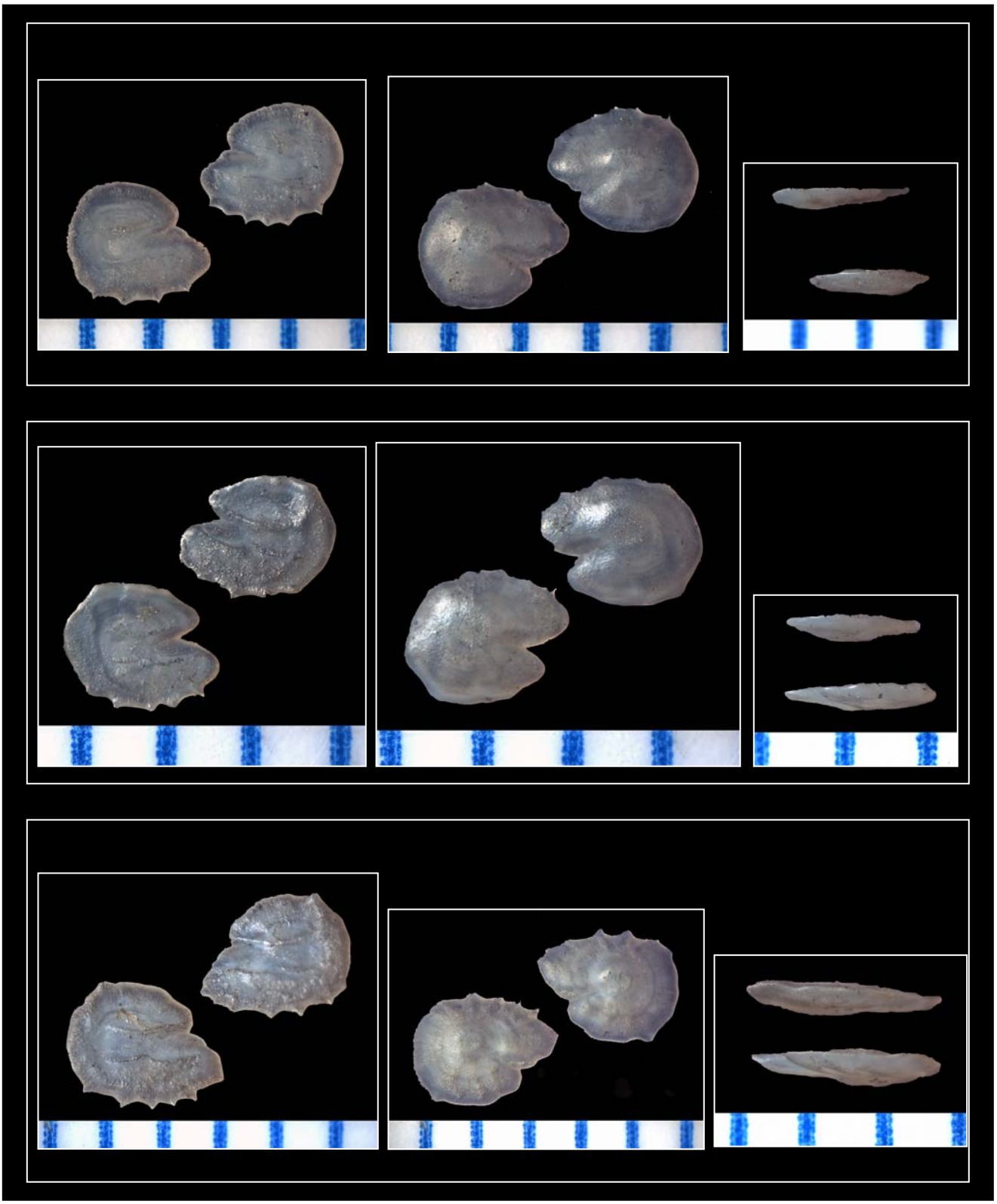
Myctophidae
Ceratoscopelus townsendi, dogtooth lampfish, LACM 56642-1



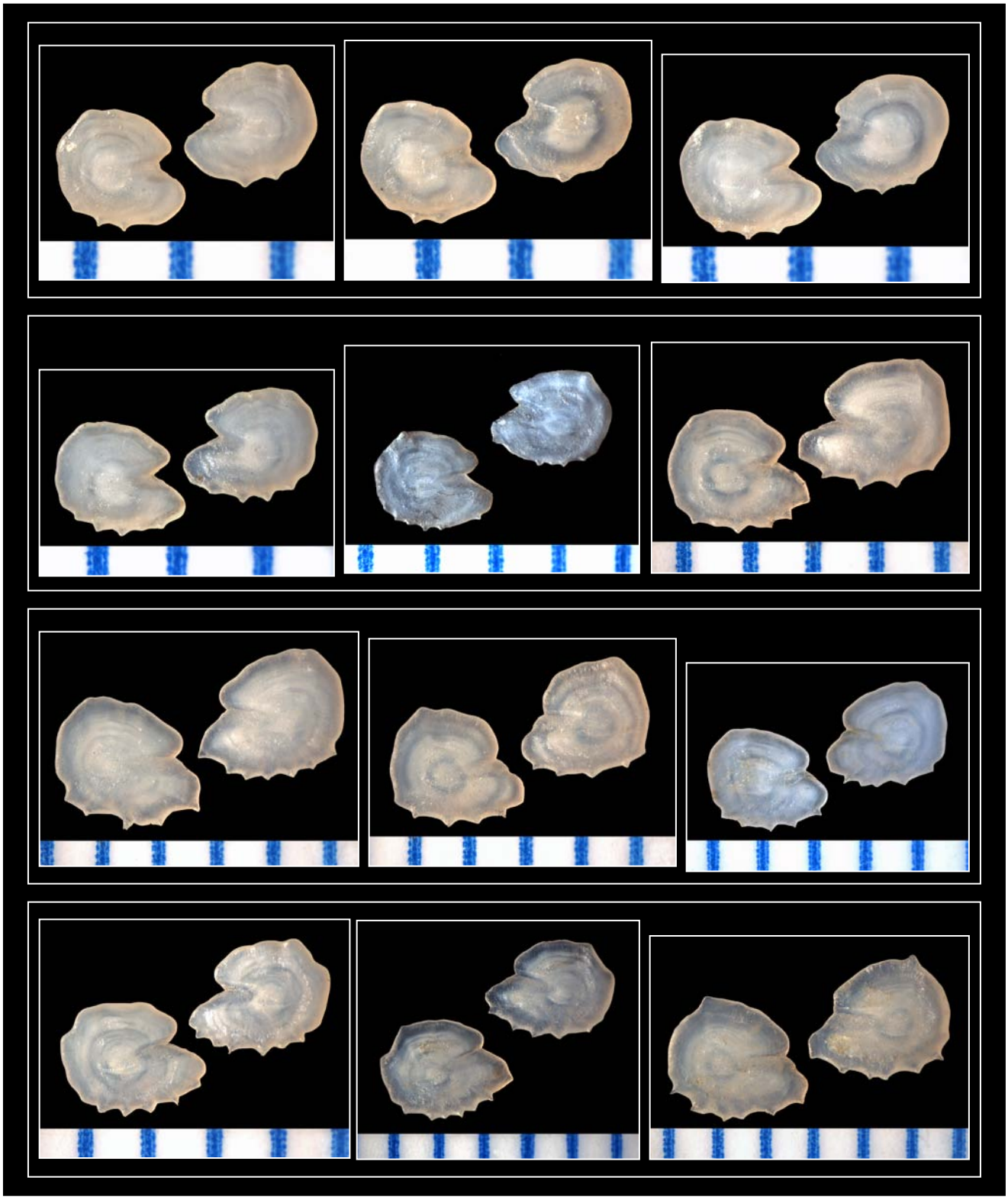
Myctophidae
Ceratoscopelus townsendi, dogtooth lampfish, LACM 56642-1



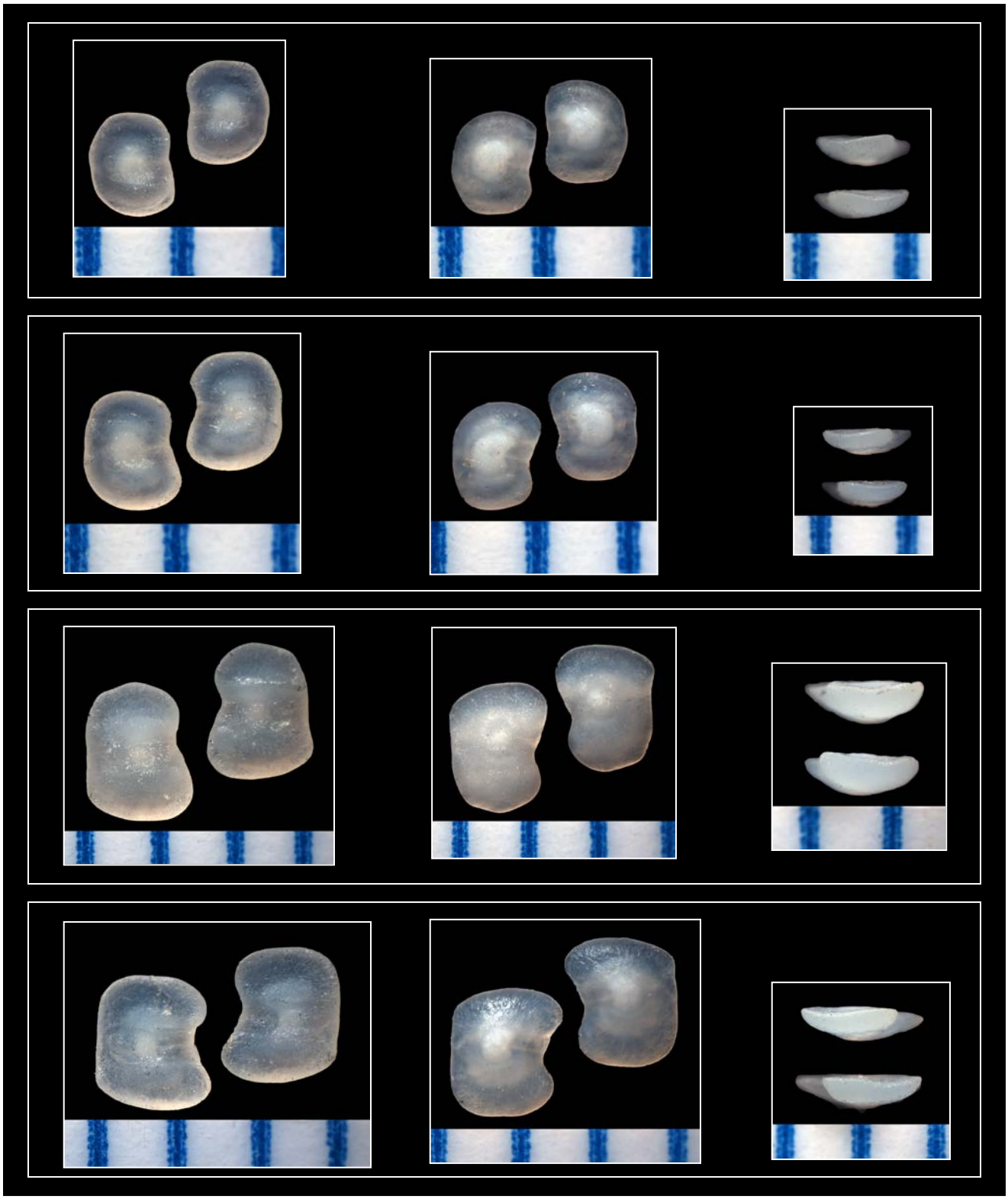
Myctophidae
Diaphus theta, California headlightfish, LACM 56636-1



Myctophidae
Diaphus theta, California headlightfish, LACM 56636-1

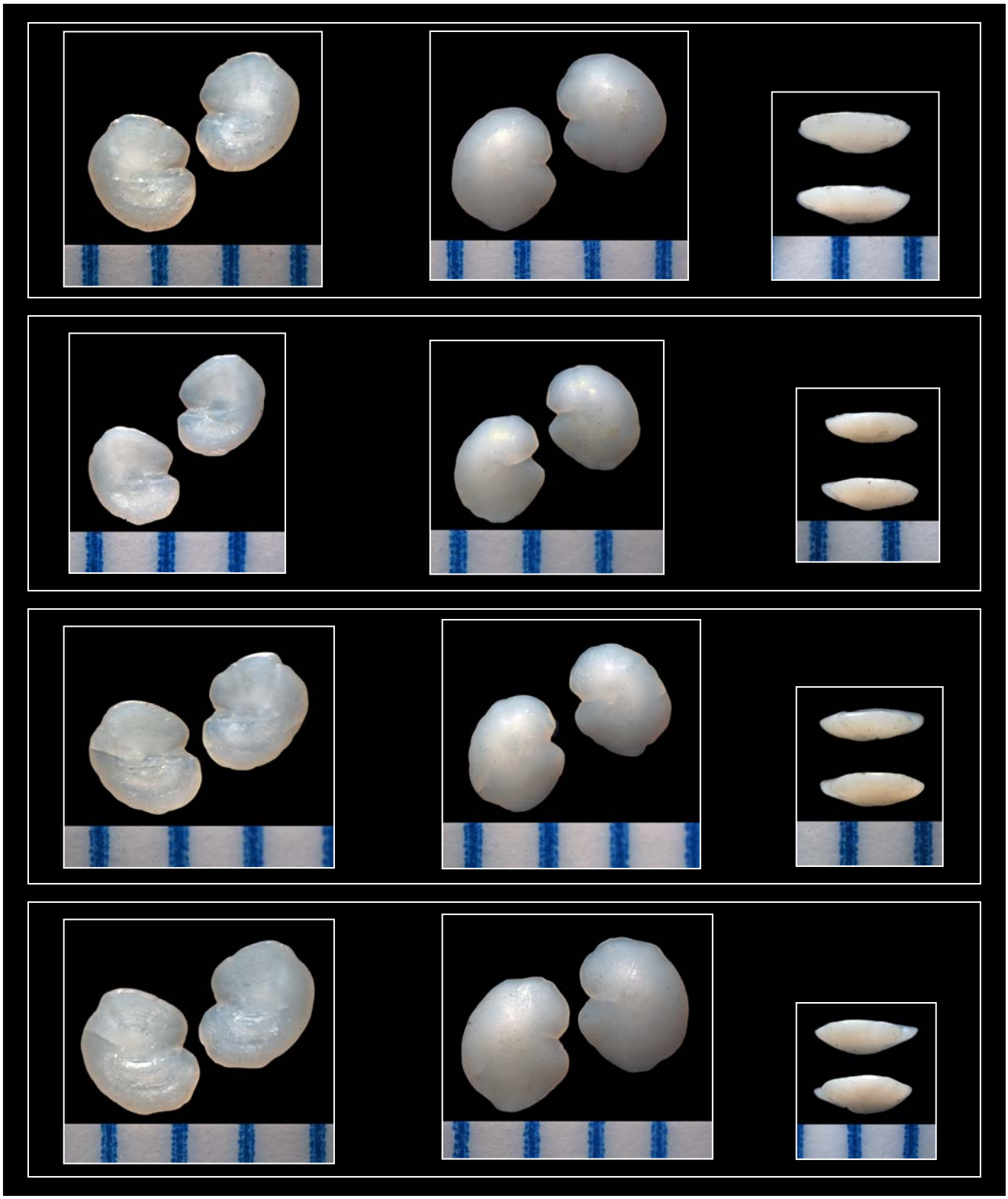


Myctophidae
Nannobrachium ritteri, broadfin lampfish, LACM 56929-1

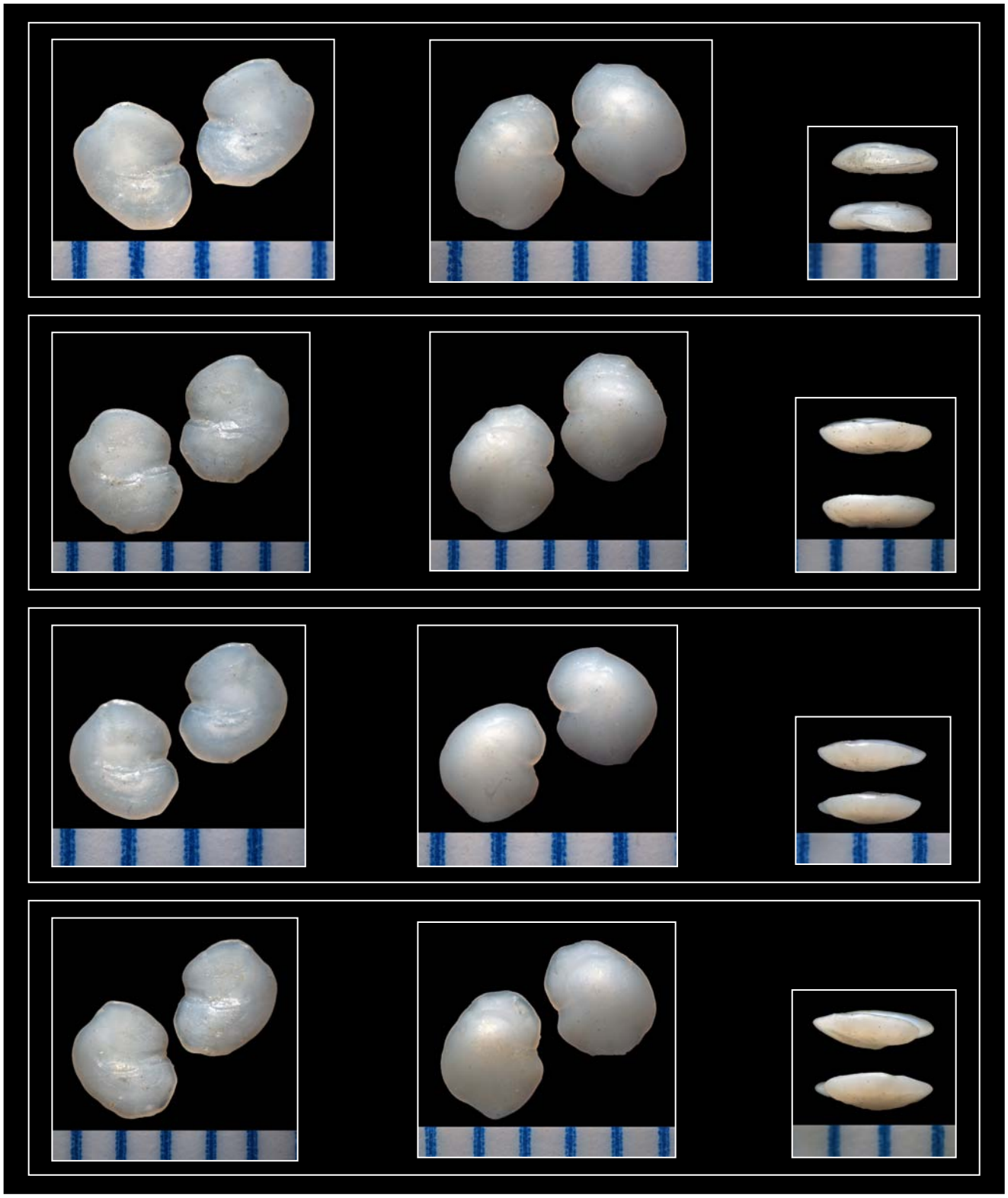


Myctophidae

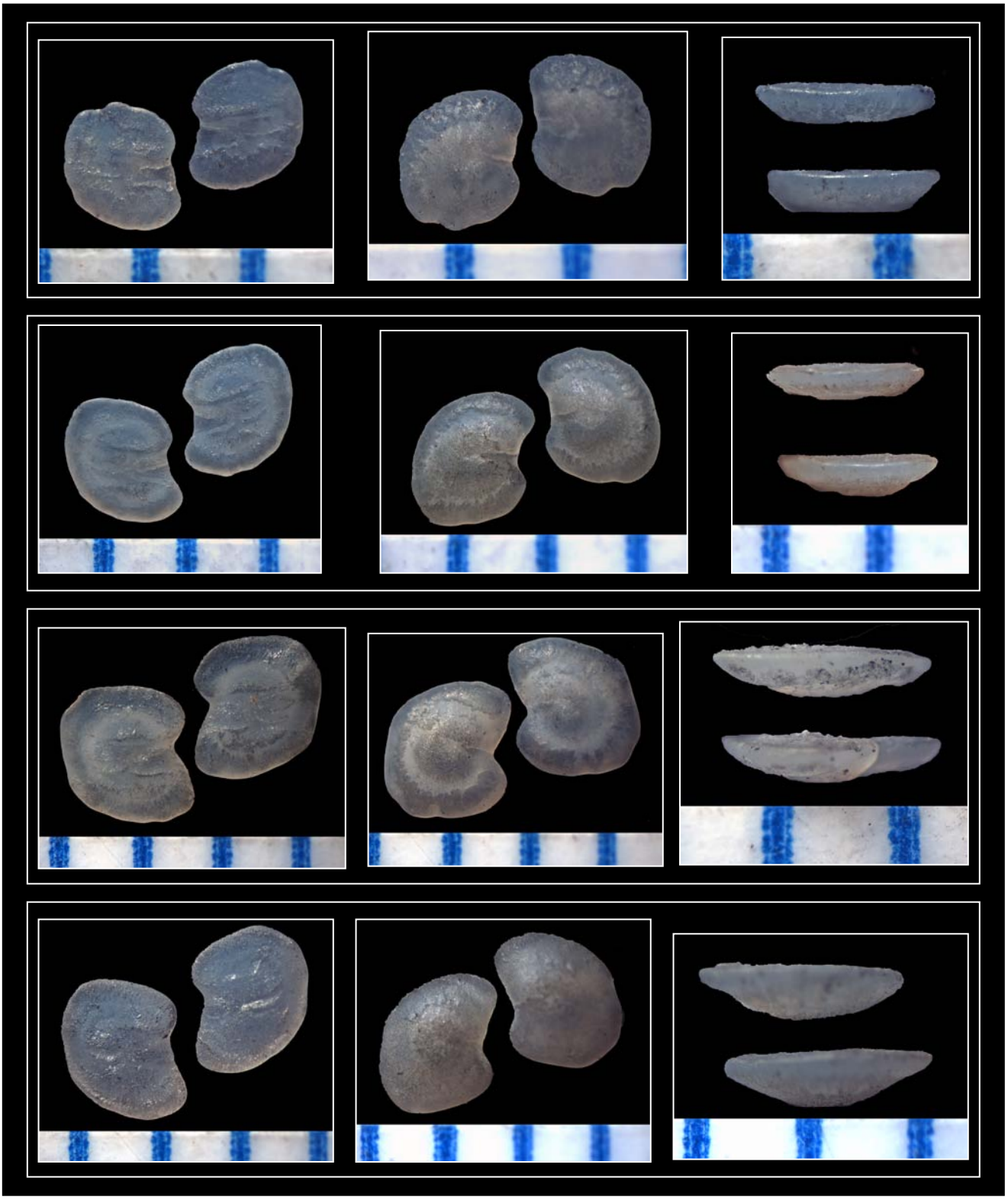
Protomyctophum crockeri, California flashlightfish, LACM 56927-1



Myctophidae
Protomyctophum crockeri, California flashlightfish, LACM 56927-1

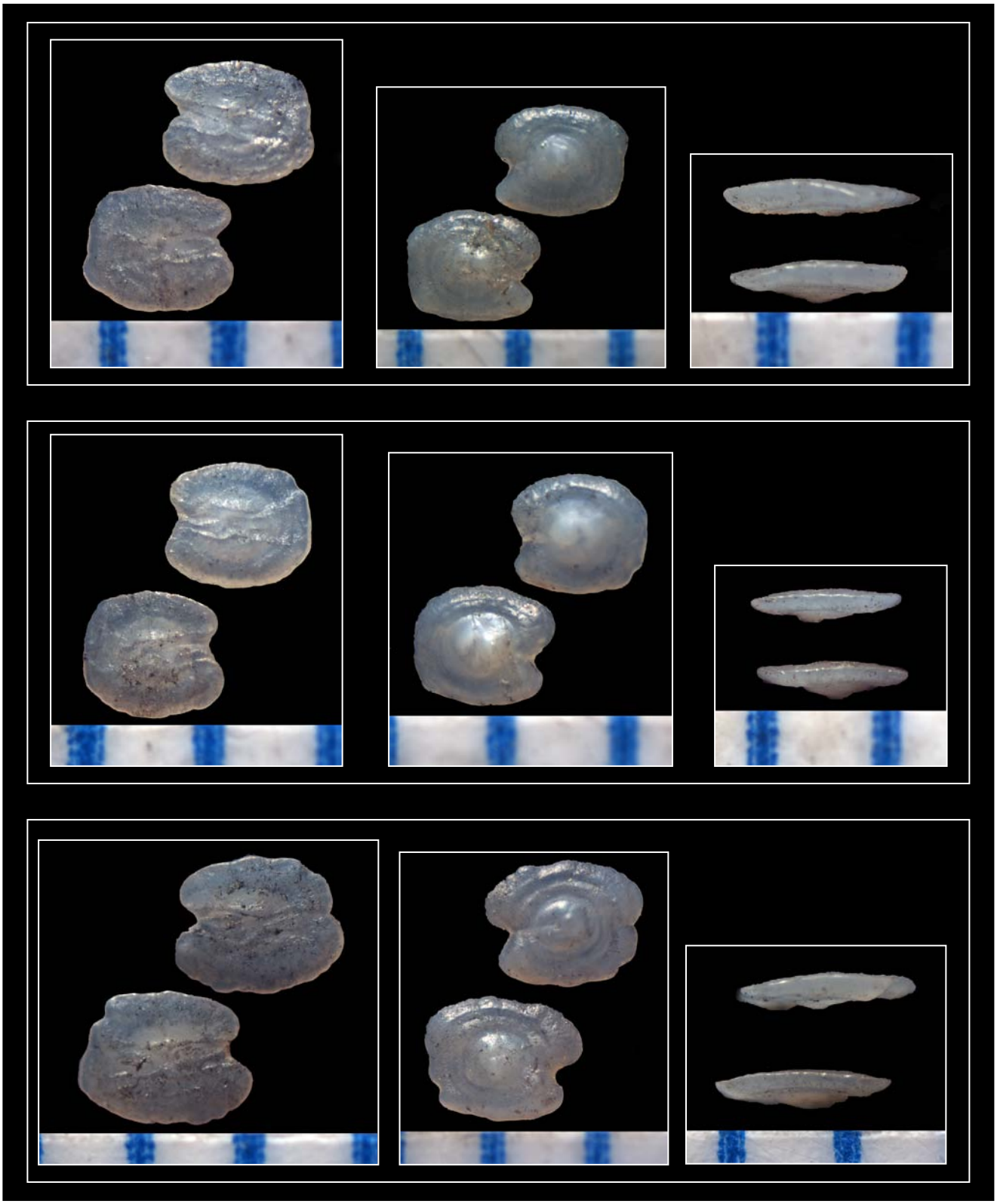


Myctophidae
Stenobrachius leucopsarus, northern lampfish, LACM 56642-1



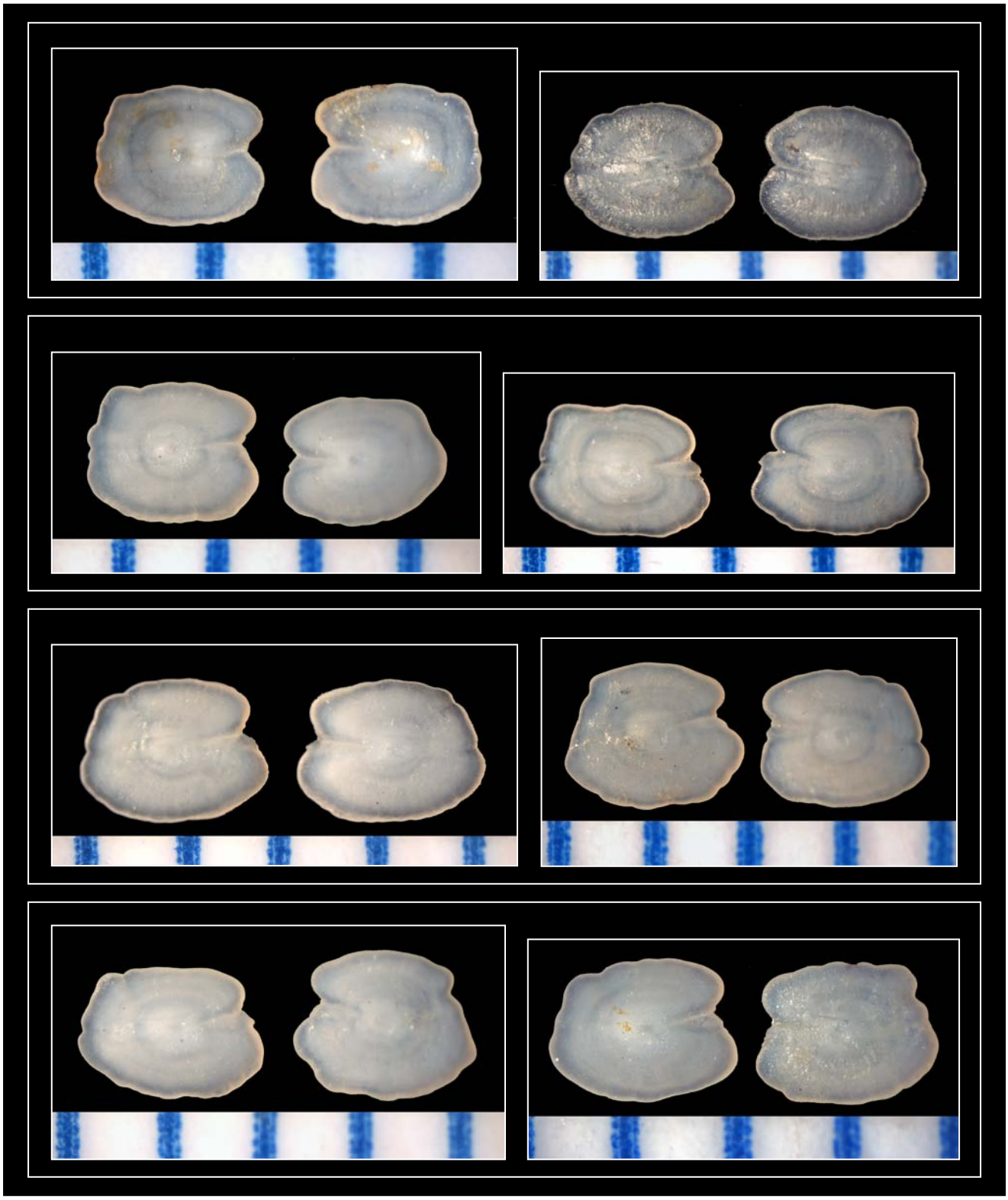
Myctophidae
Symbolophorus californiensis, California lanternfish, LACM 56643-1

Myctophidae
Tarletonbenia crenularis, blue lanternfish, LACM 56594-1

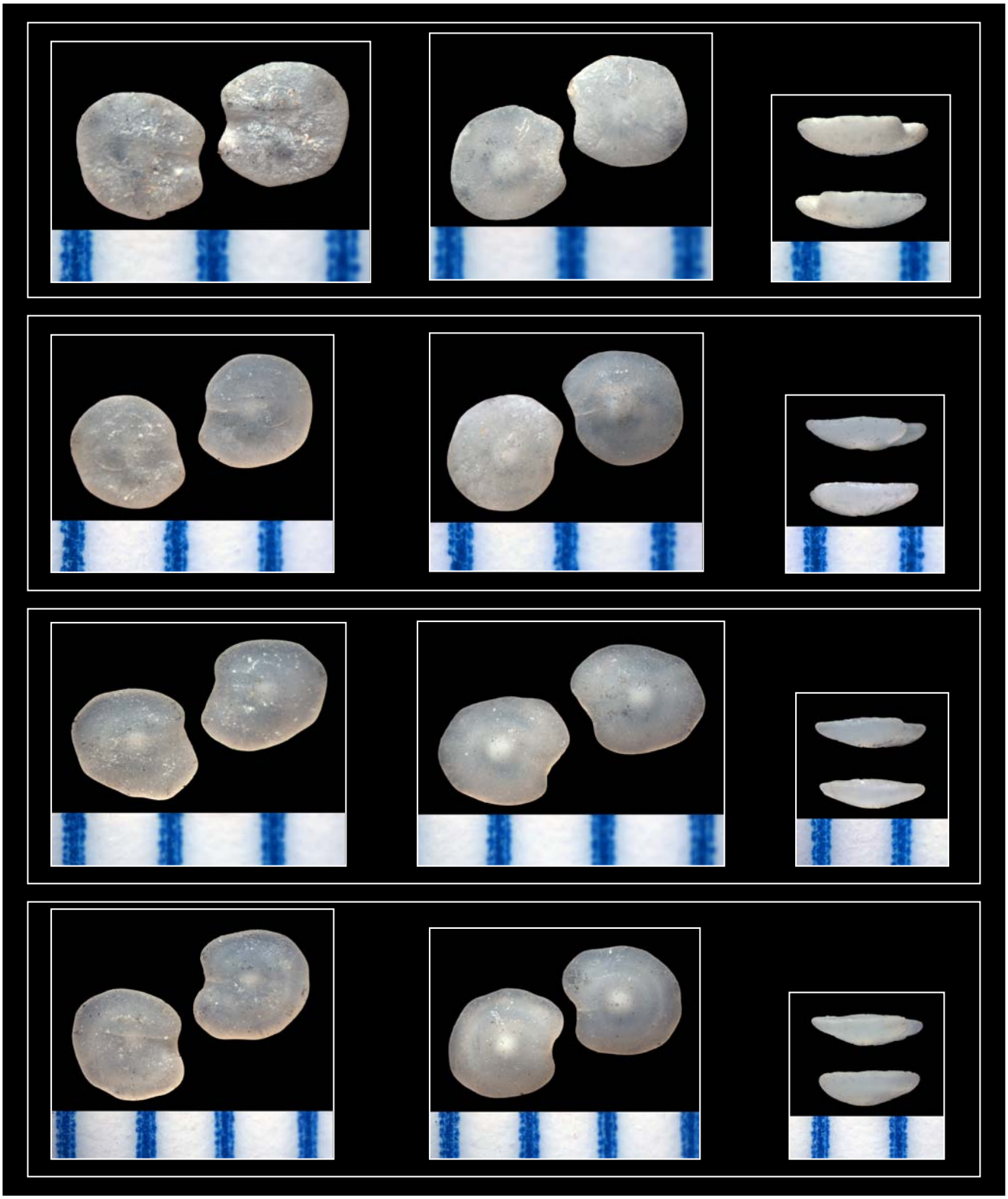


Myctophidae
Tarletonbenia crenularis, blue lanternfish, LACM 56594-1

Myctophidae
Tarletonbenia crenularis, blue lanternfish, LACM 56594-1



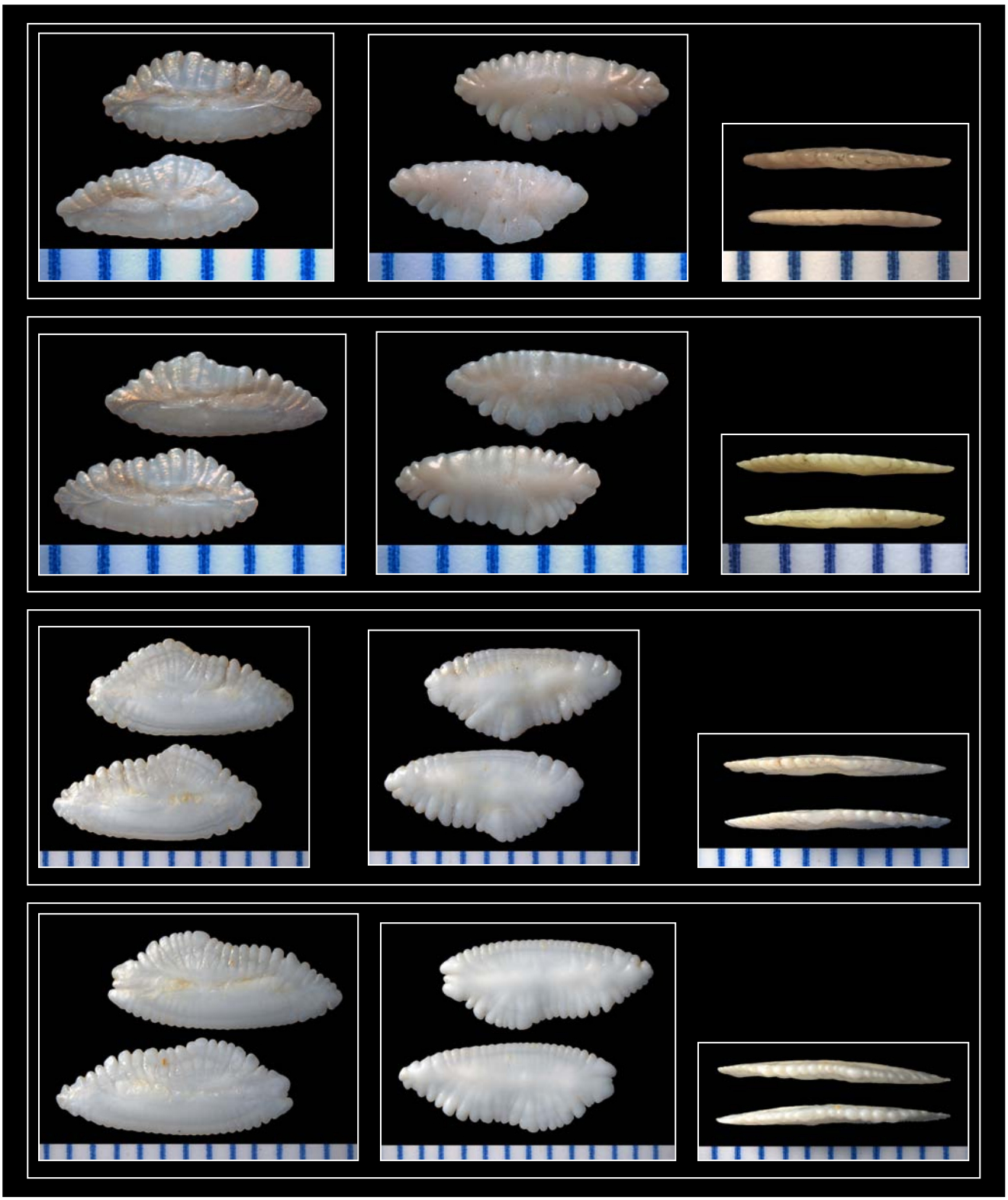
Myctophidae
Triphoturus mexicanus, Mexican lampfish, LACM 56926-1



Moridae

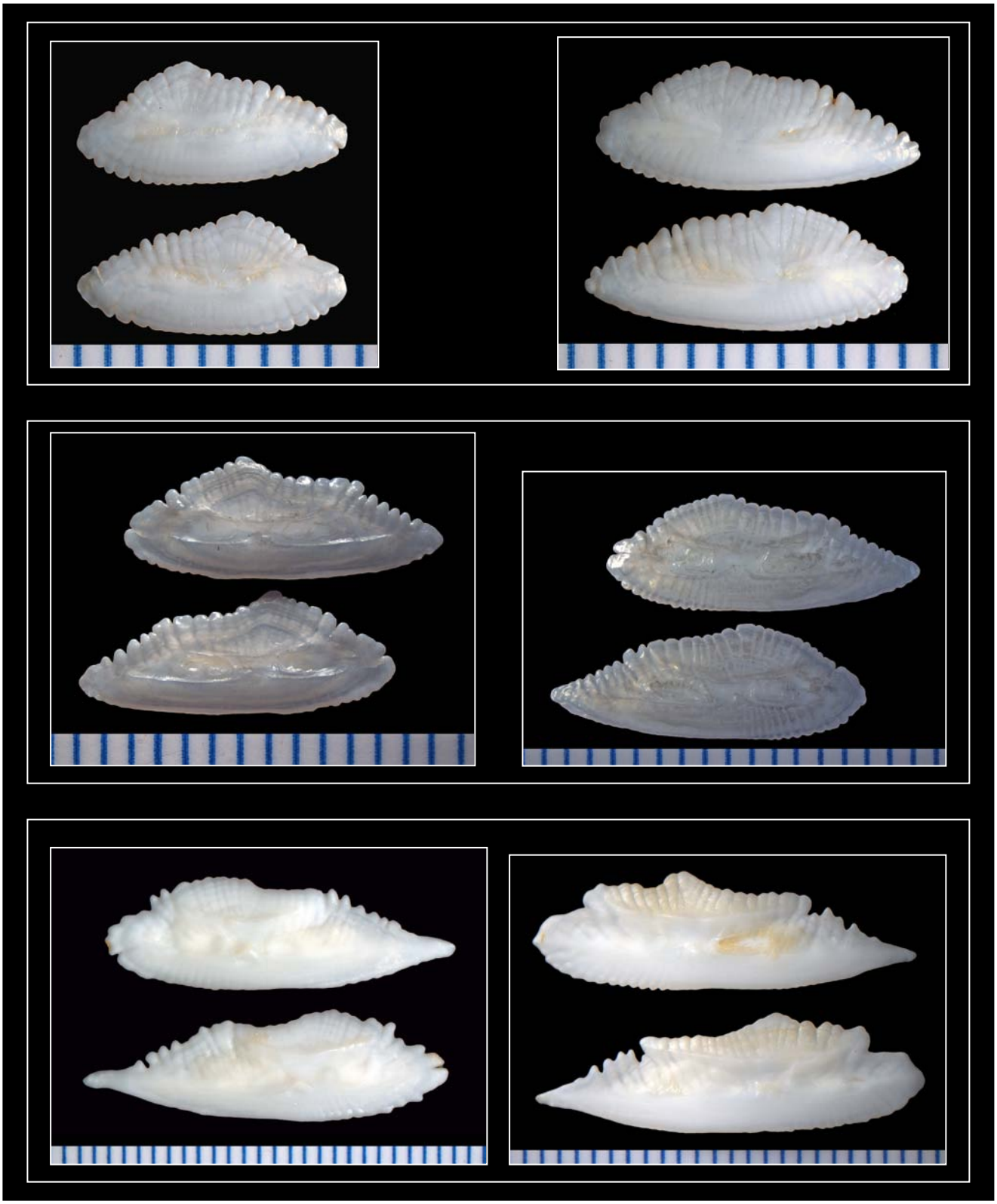
Physiculus rastrelliger, hundred-fathom codling, LACM 56710-1

Merluccidae
Merluccius productus, Pacific hake, LACM 56591-1

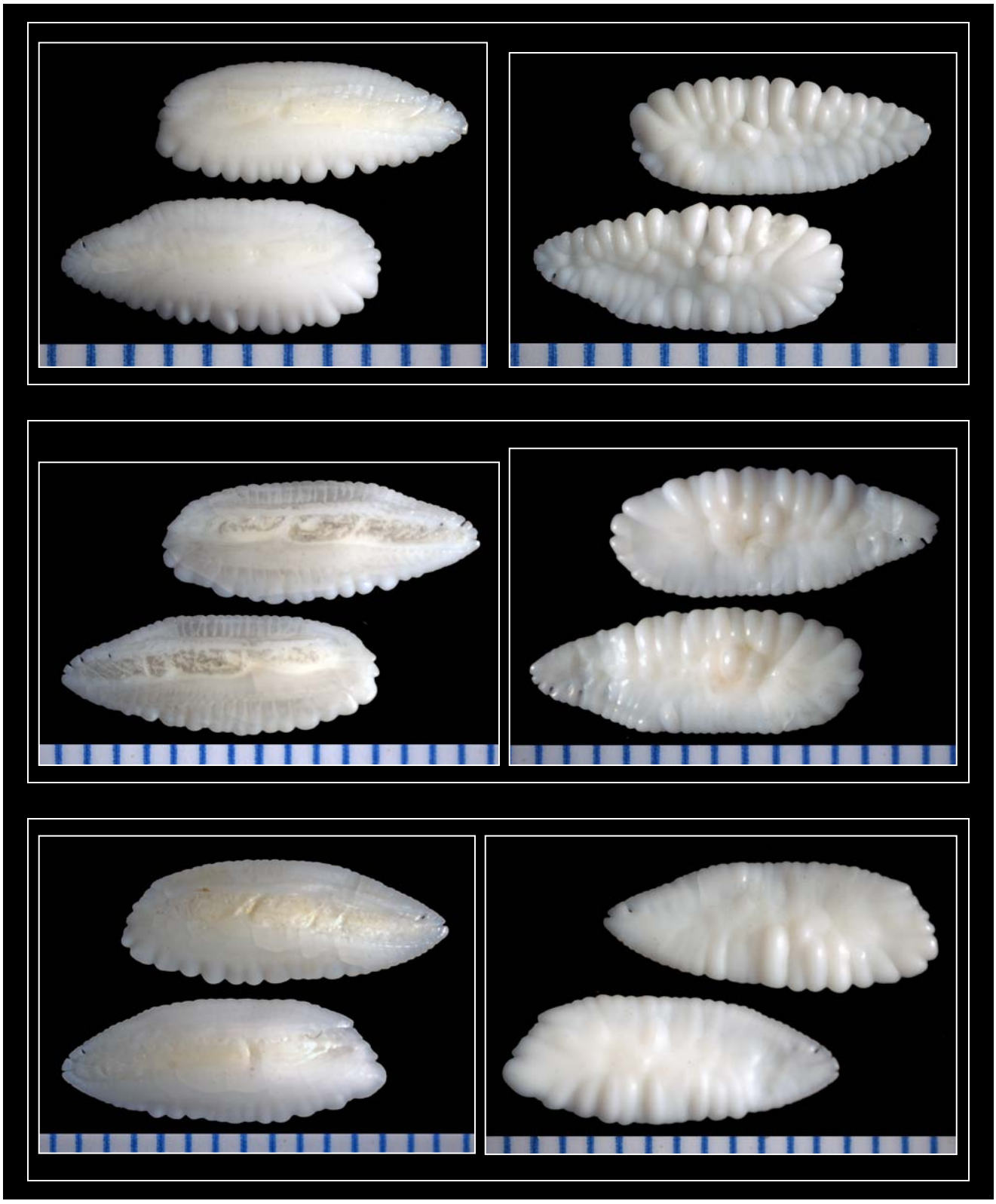


Merluccidae
Merluccius productus, Pacific hake, LACM 56591-1

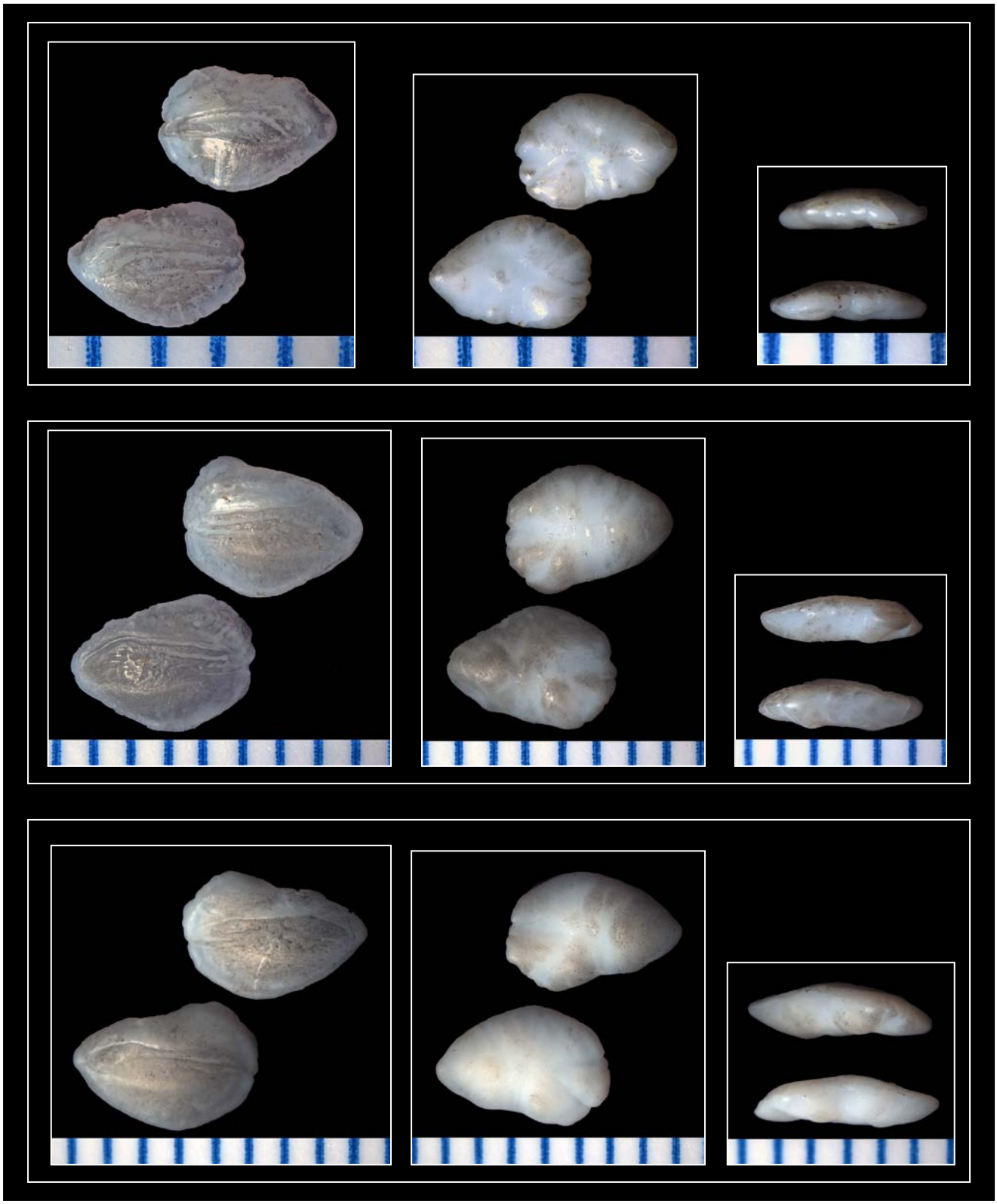
Merluccidae
Merluccius productus, Pacific hake, LACM 56591-1



Gadidae
Microgadus proximus, Pacific tomcod, LACM 56593-1

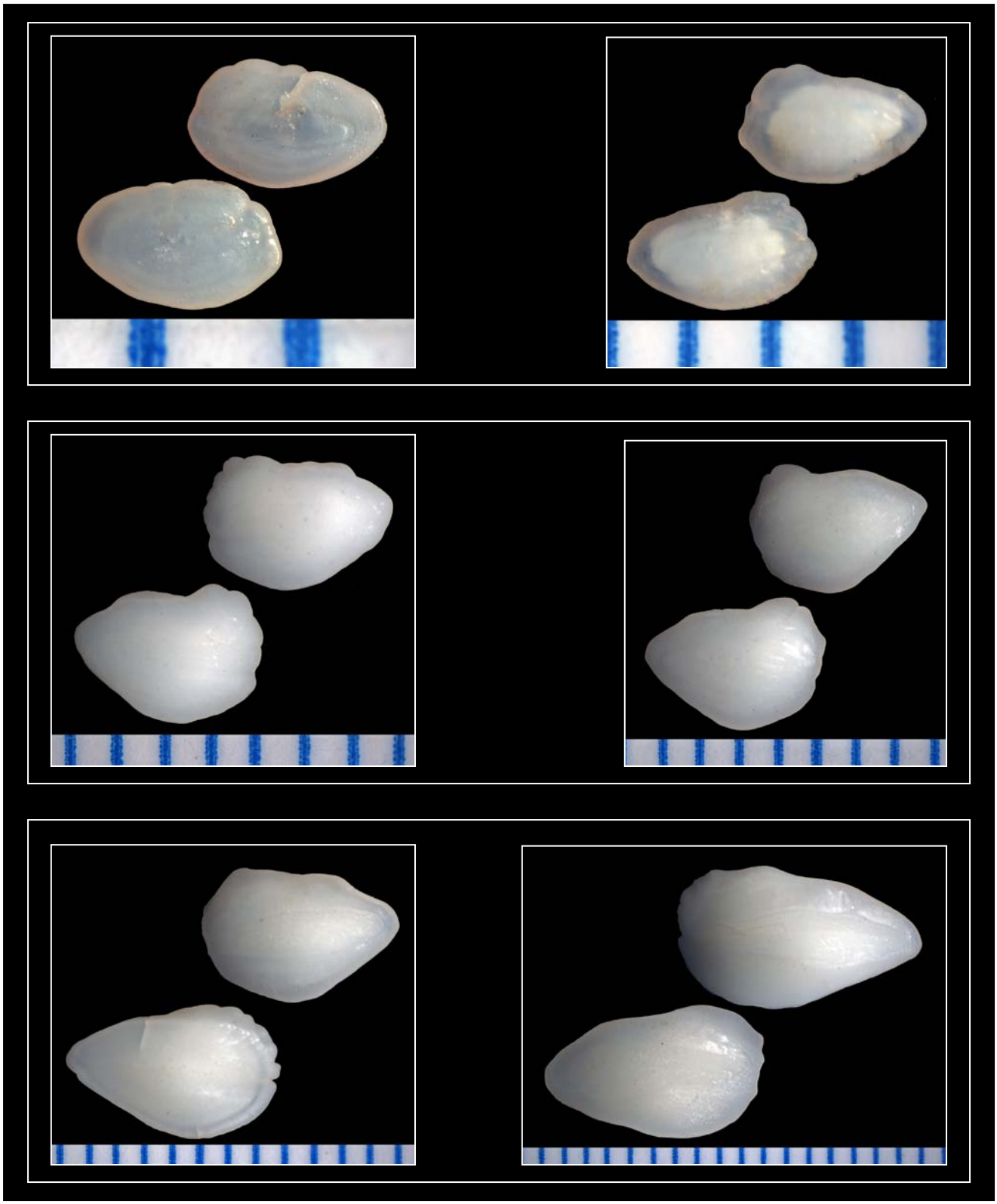


Ophidiidae
Chilara taylori, spotted cusk-eel, LACM 56603-1



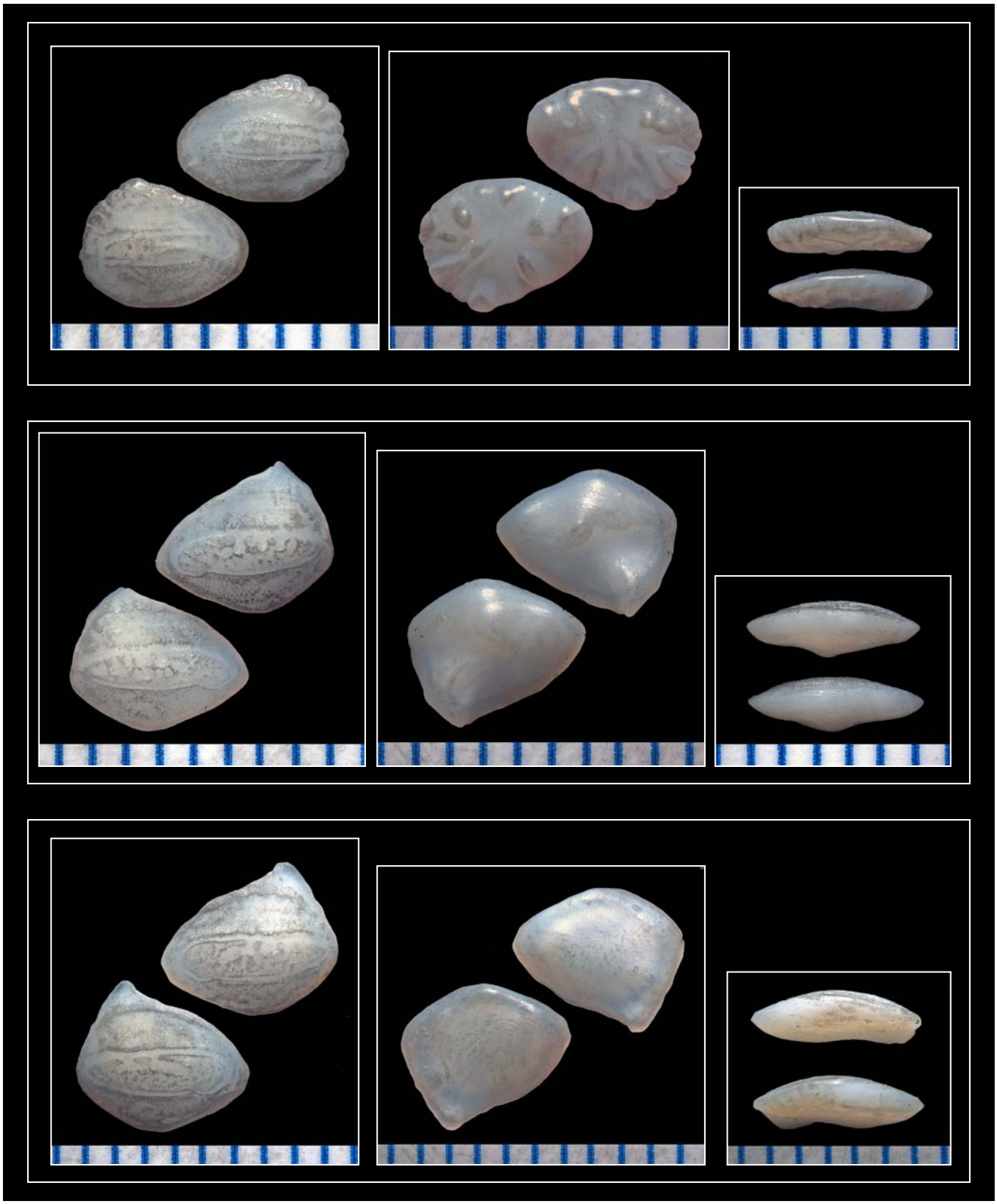
Ophidiidae
Chilara taylori, spotted cusk-eel, LACM 56603-1

Ophidiidae
Chilara taylori, spotted cusk-eel, LACM 56603-1



Ophidiidae

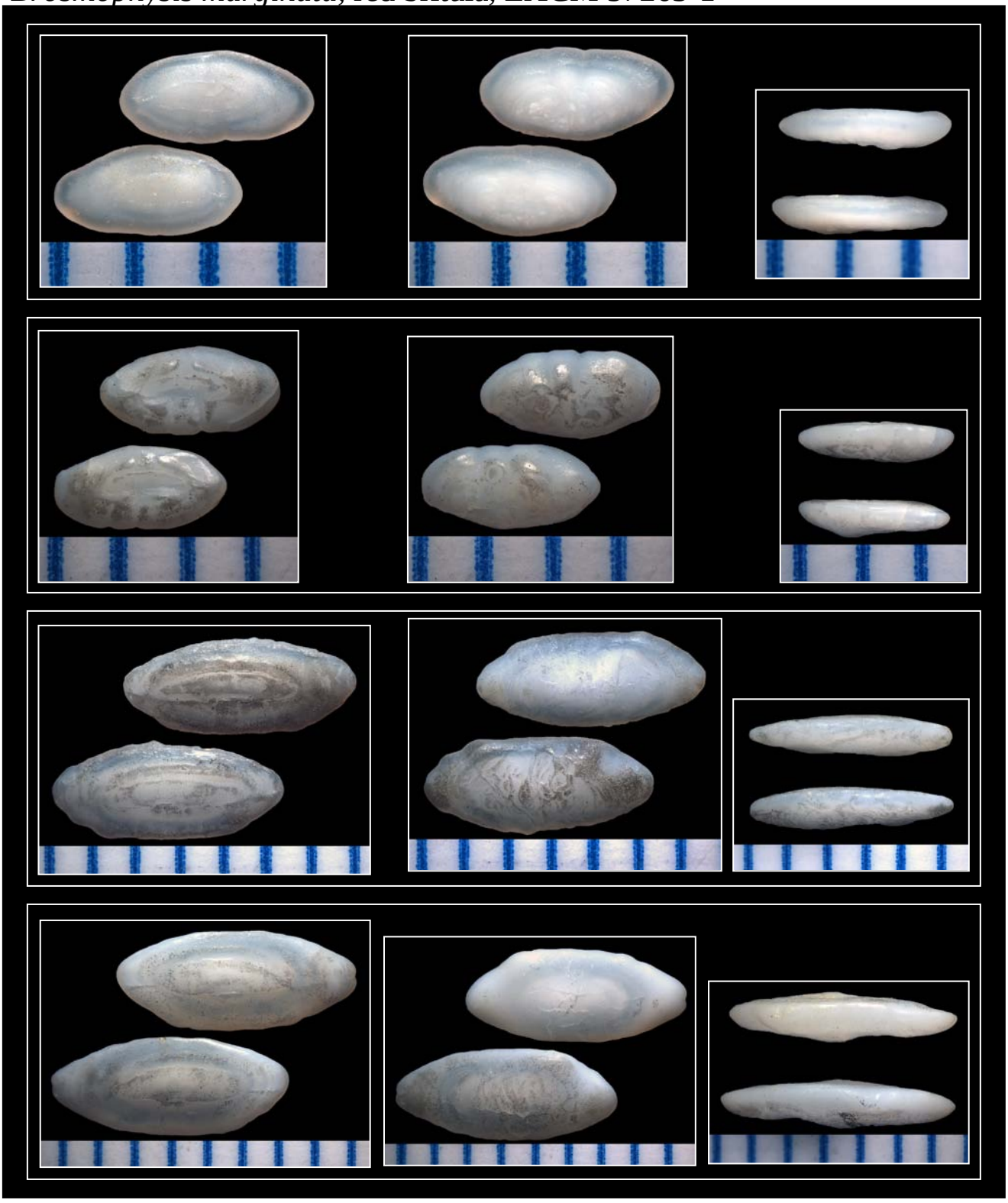
Ophidion scrippsae, basketweave cusk-eel, LACM 56722-1



Ophidiidae
Ophidion scrippsae, basketweave cusk-eel, LACM 56722-1

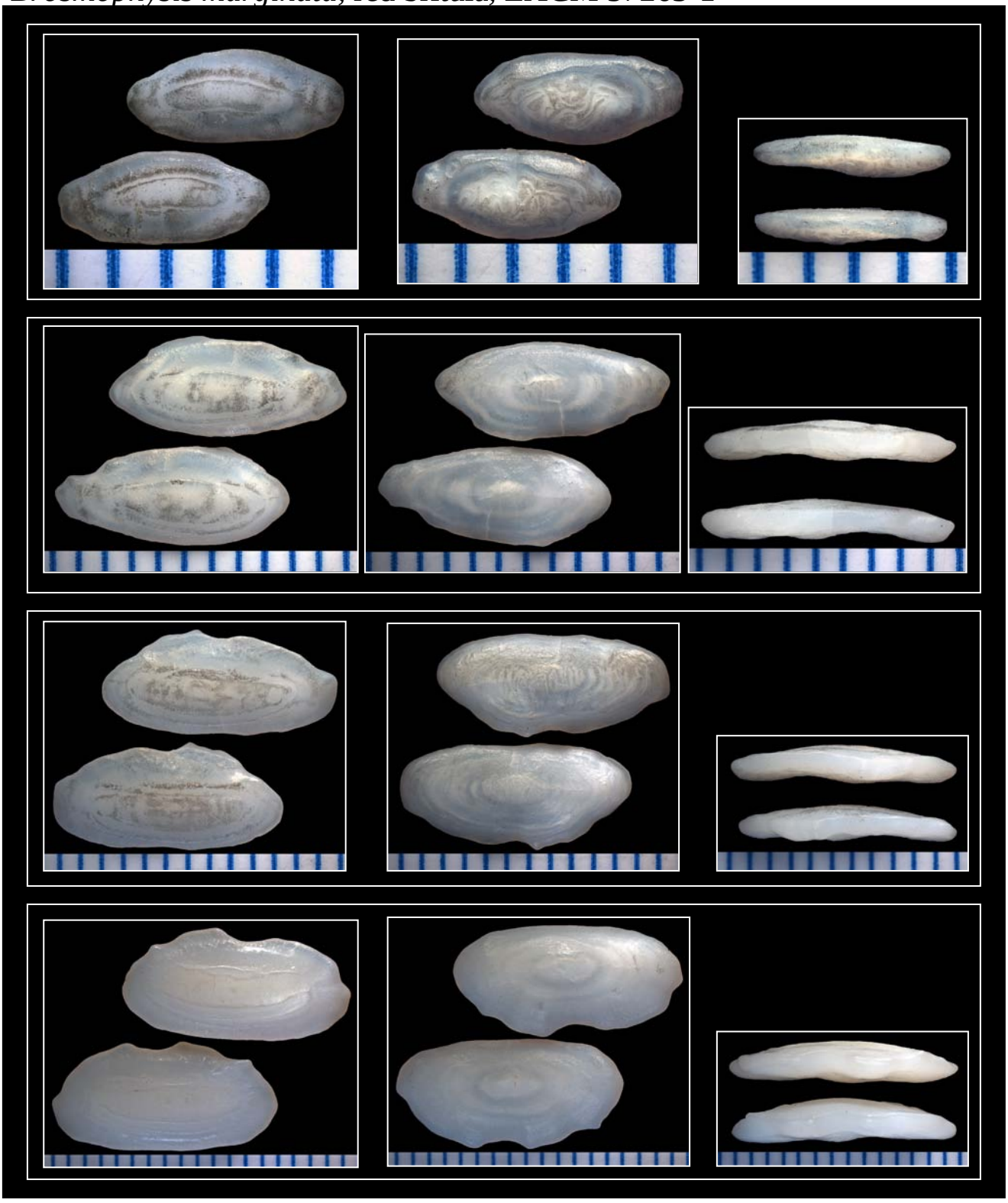
Bythitidae

Brosmophysis marginata, red britula, LACM 57263-1



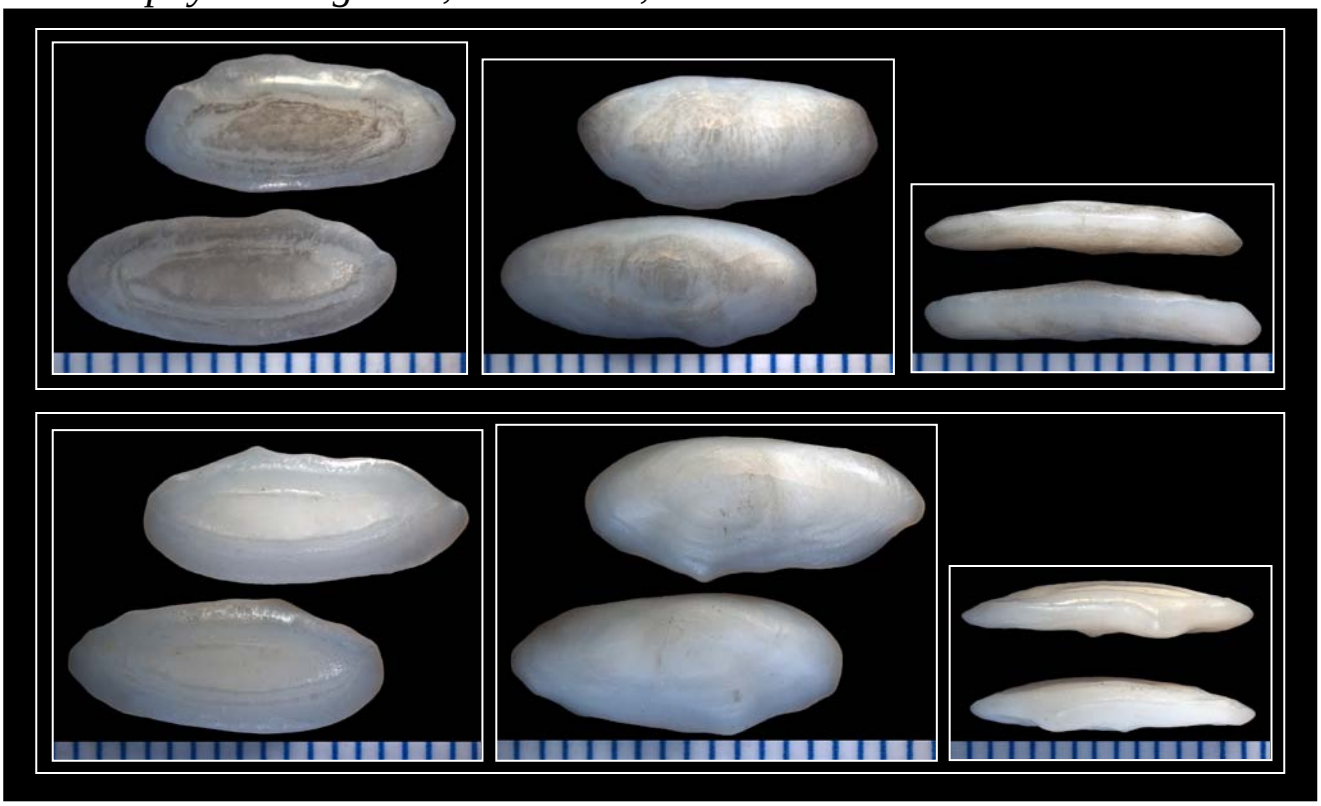
Bythitidae

Brosmophysis marginata, red britula, LACM 57263-1



Bythitidae

Brosmophysis marginata, red britula, LACM 57263-1

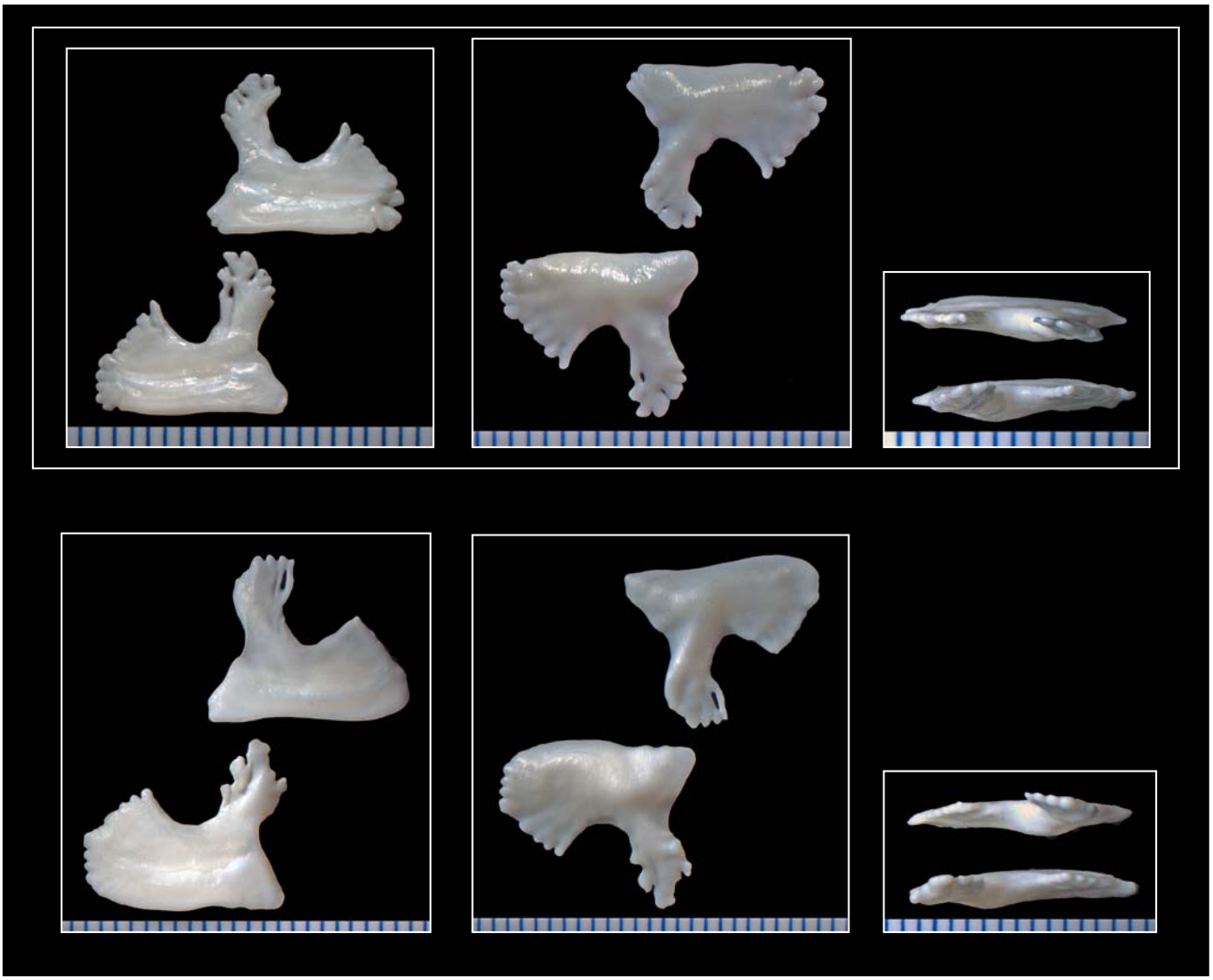


Batrachoididae

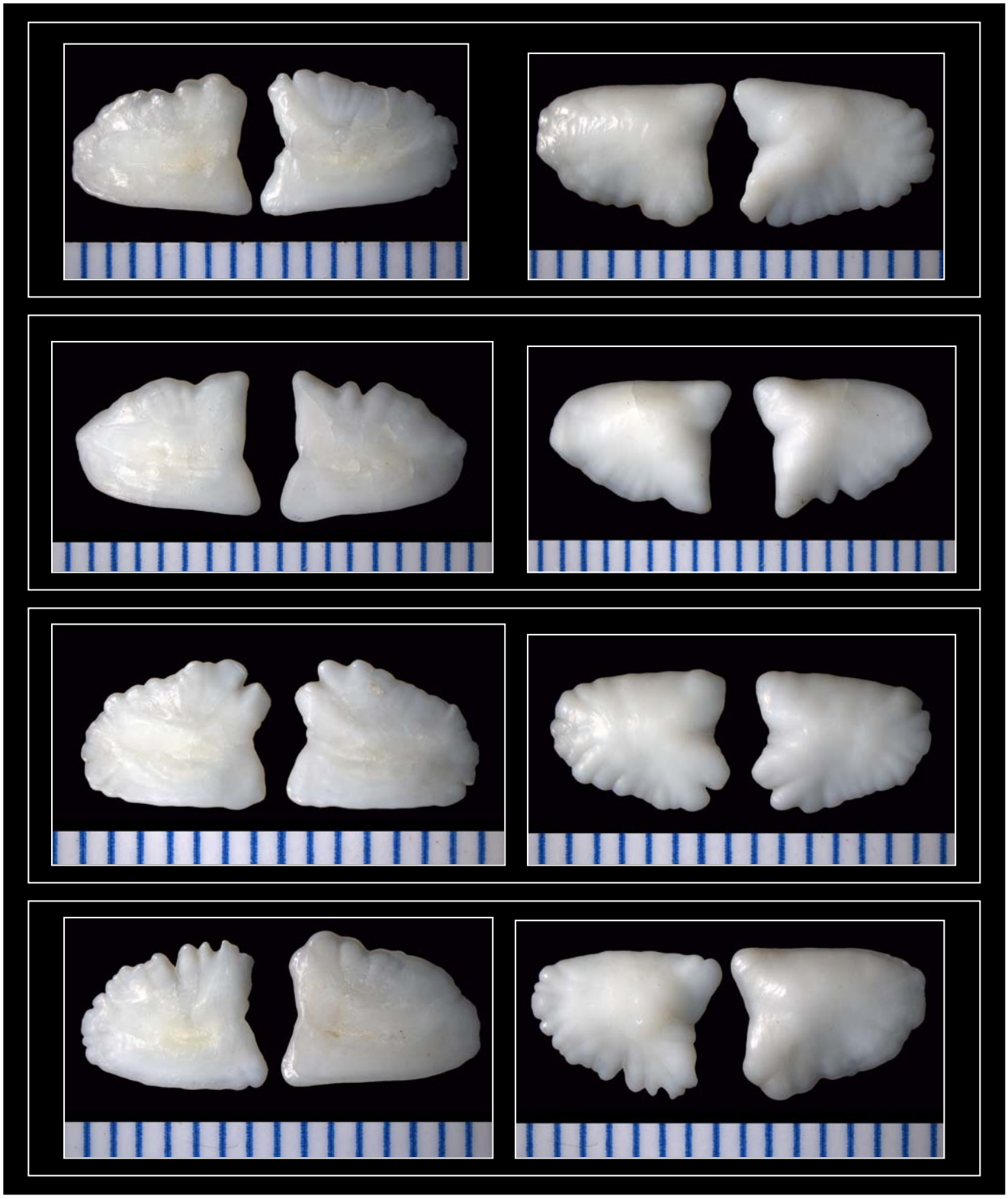
Porichthys myriaster, specklefin midshipman, LACM 56925-1

Batrachoididae
Porichthys myriaster, specklefin midshipman, LACM 56925-1

Batrachoididae
Porichthys myriaster, specklefin midshipman, LACM 56925-1

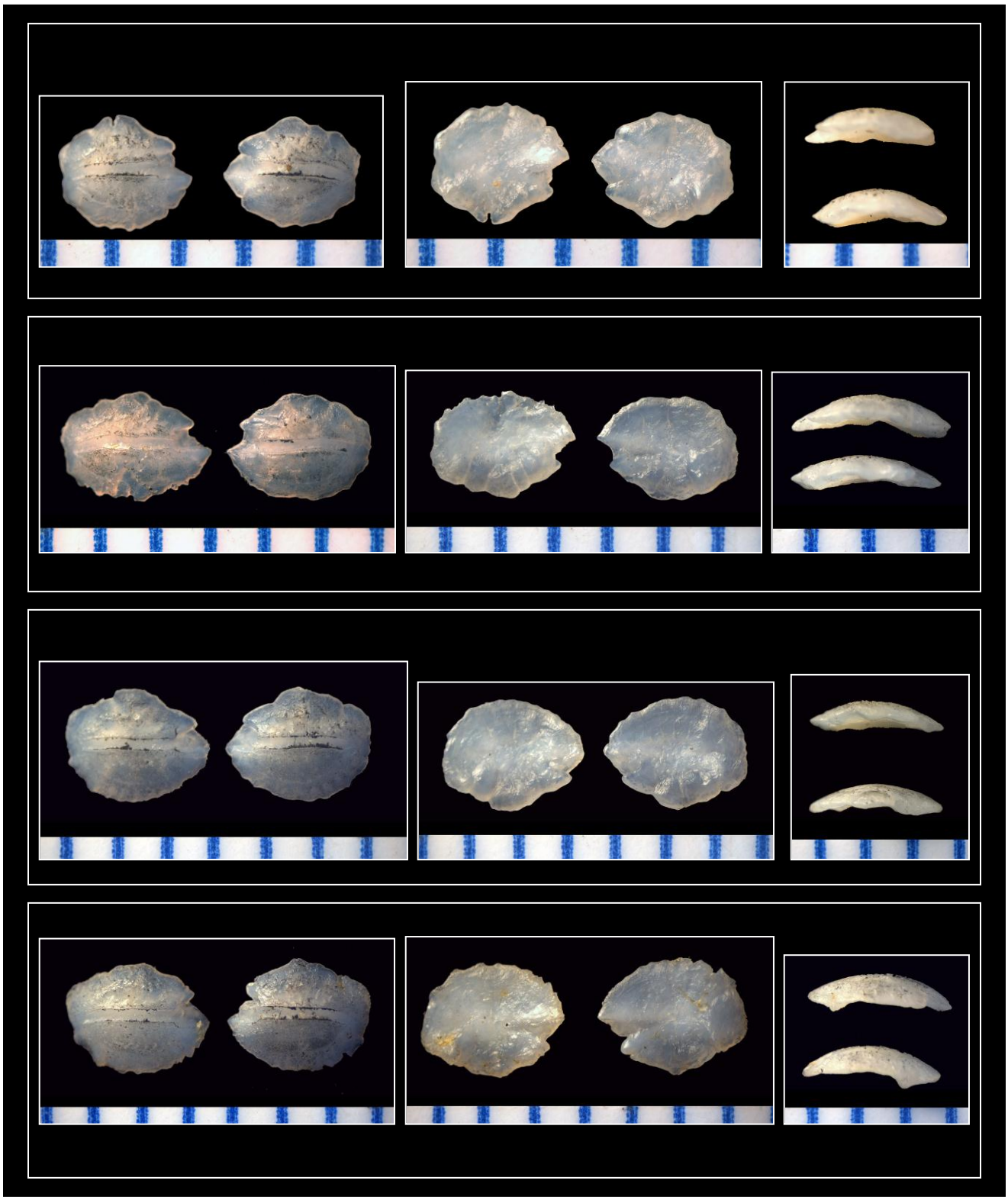


Batrachoididae
Porichthys notatus, plainfin midshipman, LACM 56644-1



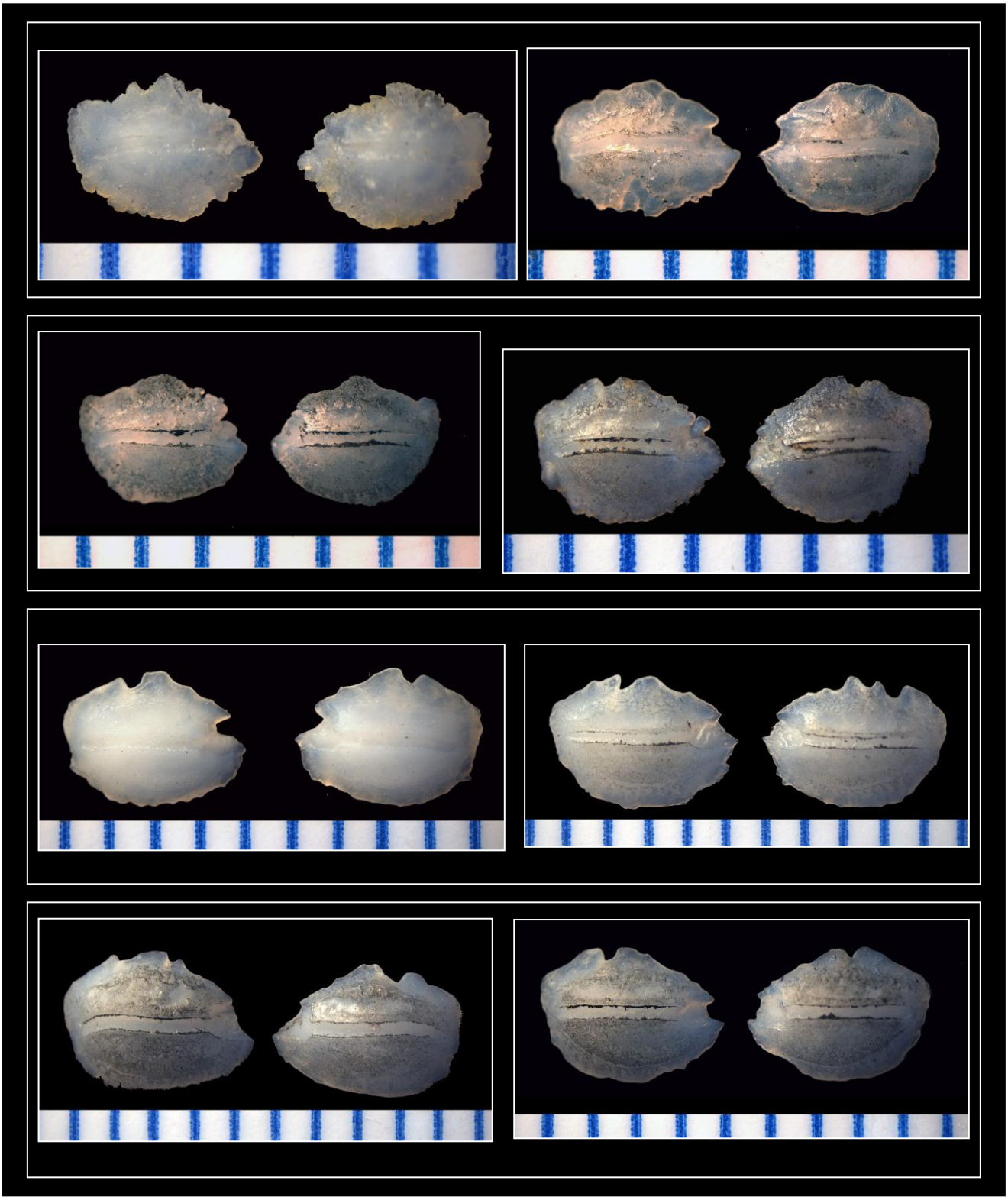
Batrachoididae
Porichthys notatus, plainfin midshipman, LACM 56644-1

Atherinopsidae
Atherinops affinis, topsmelt, LACM 56666-1



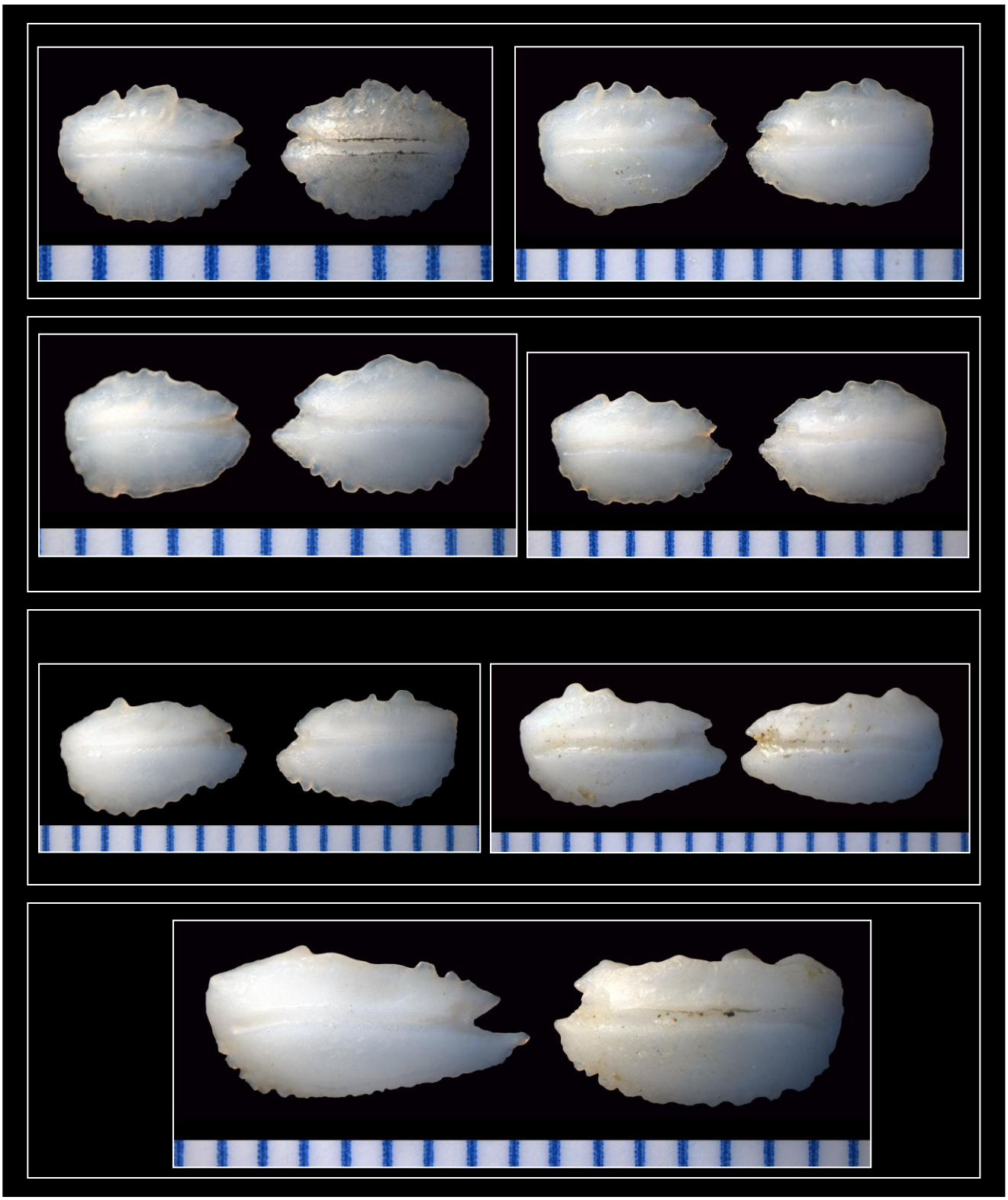
Atherinopsidae
Atherinops affinis, topsmelt, LACM 56666-1

Atherinopsidae
Atherinops affinis, topsmelt, LACM 56666-1

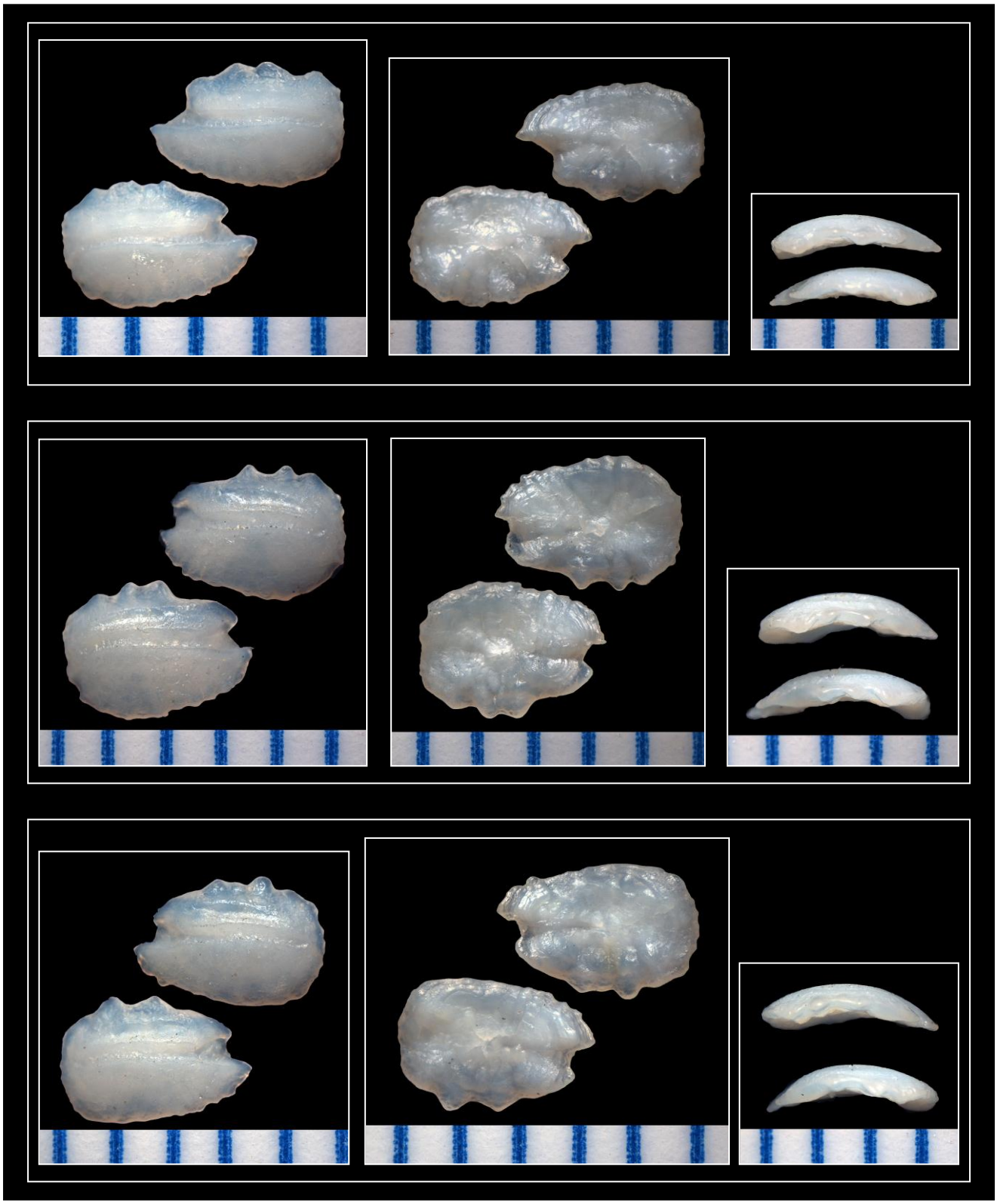


Atherinopsidae
Atherinopsis californiensis, jacksmelt, LACM 56667-1

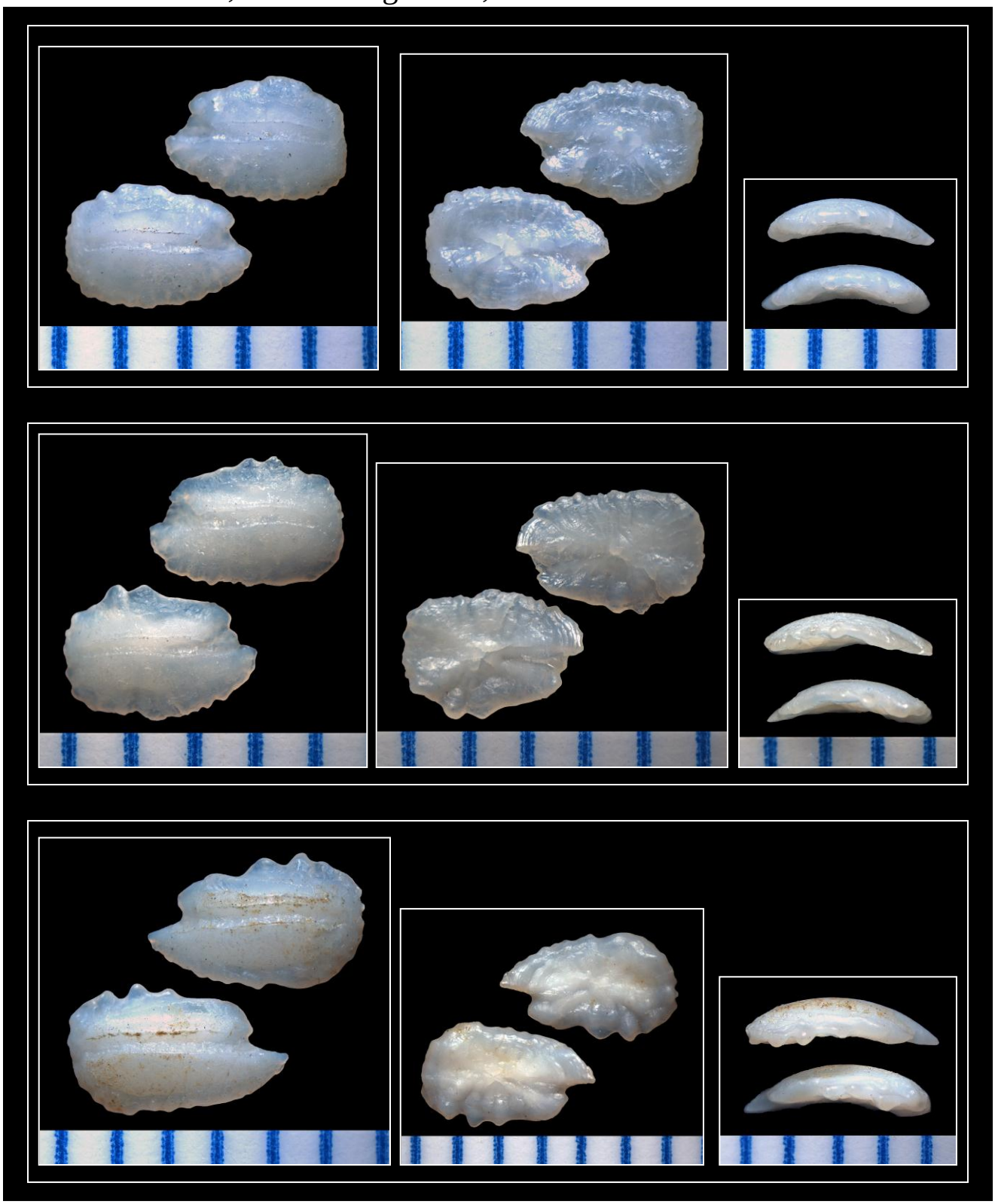
Atherinopsidae
Atherinopsis californiensis, jacksmelt, LACM 56667-1



Atherinopsidae
Leuresthes tenuis, California grunion, LACM 56928-1



Atherinopsidae
Leuresthes tenuis, California grunion, LACM 56928-1

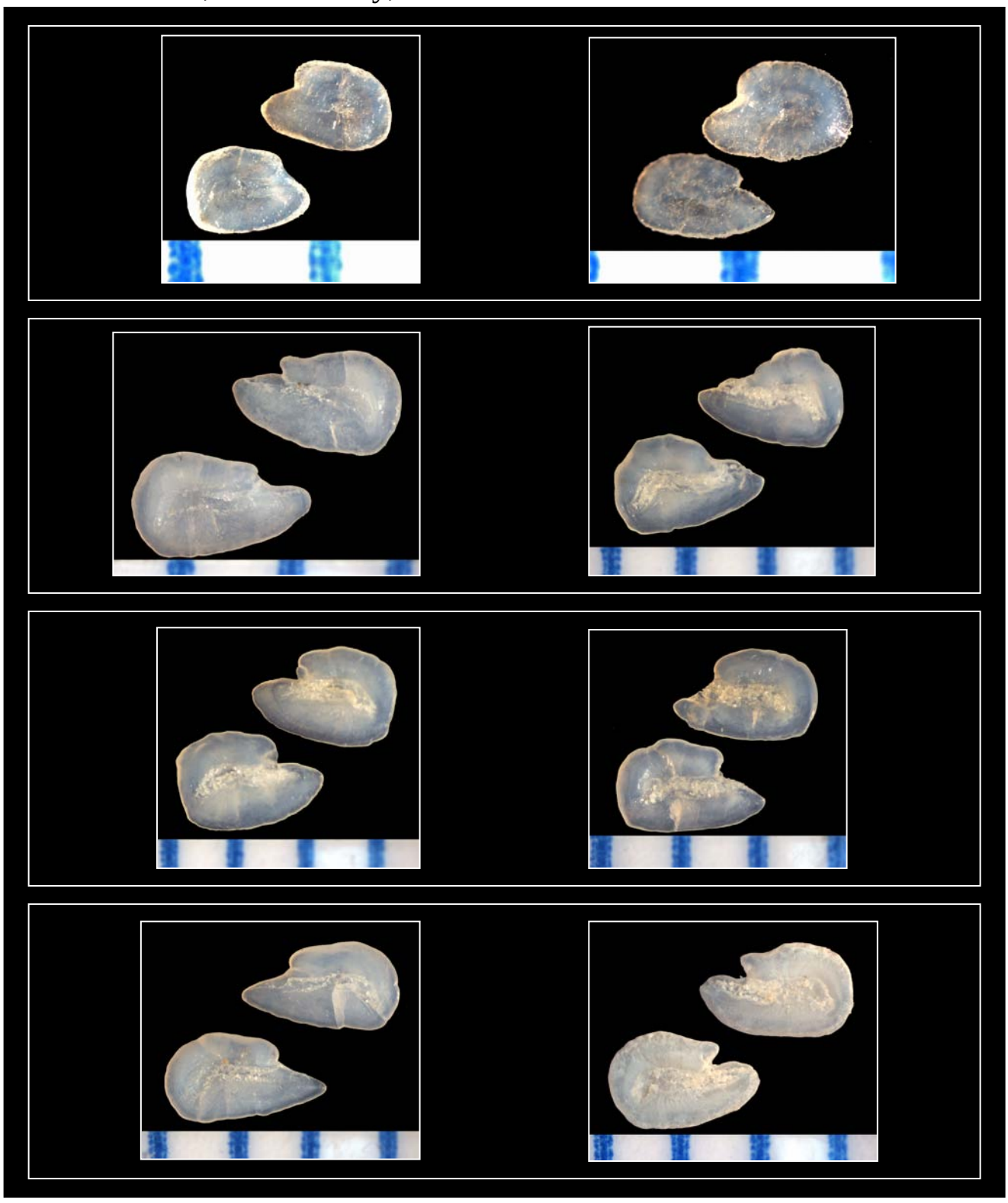


Exocoetidae
Cheilopogon pinnatibarbatus californicus, California flyingfish,
LACM 56683-1

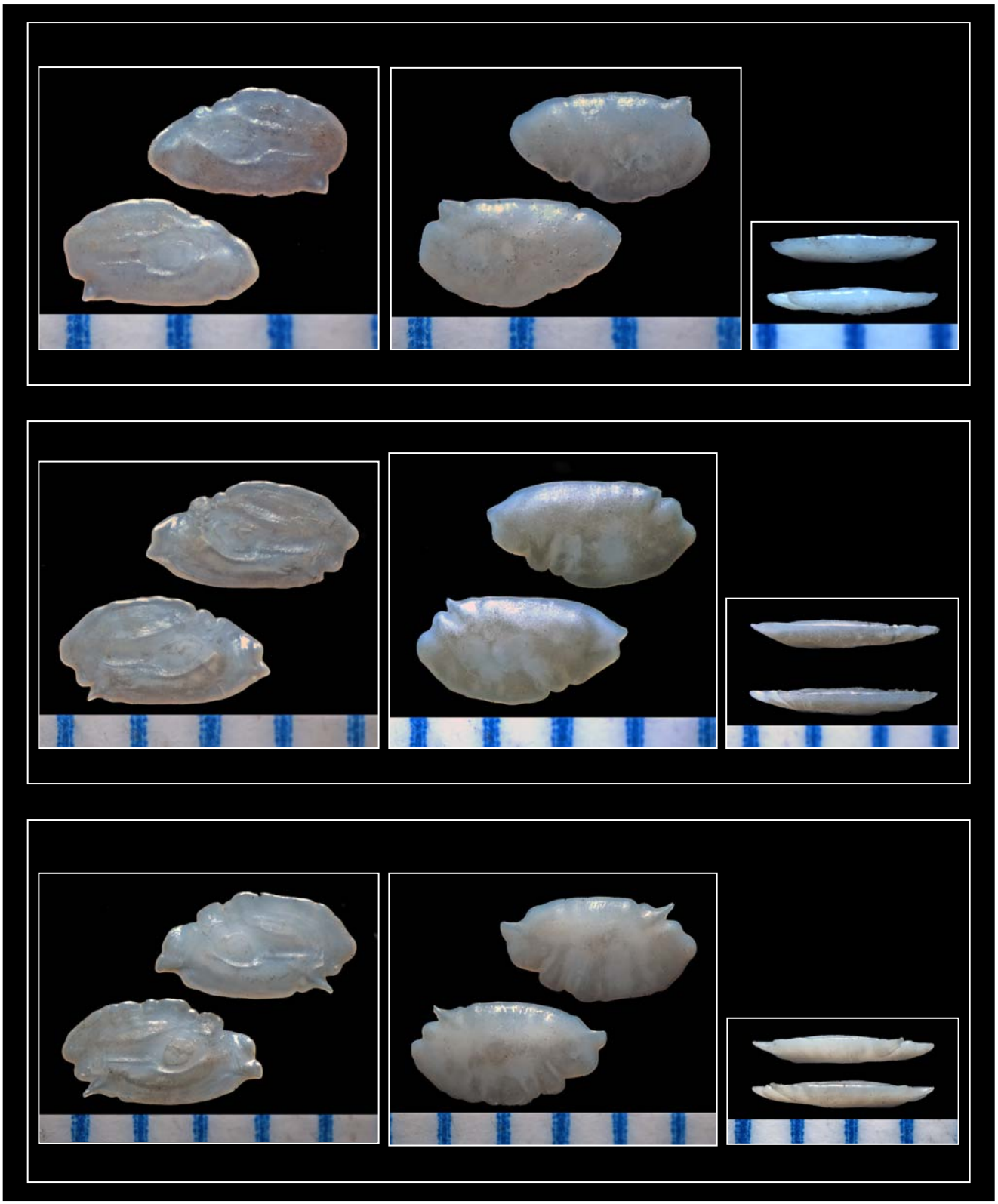
Belonidae
Strongylura exilis, California needlefish, LACM 56931-1

Belonidae
Strongylura exilis, California needlefish, LACM 56931-1

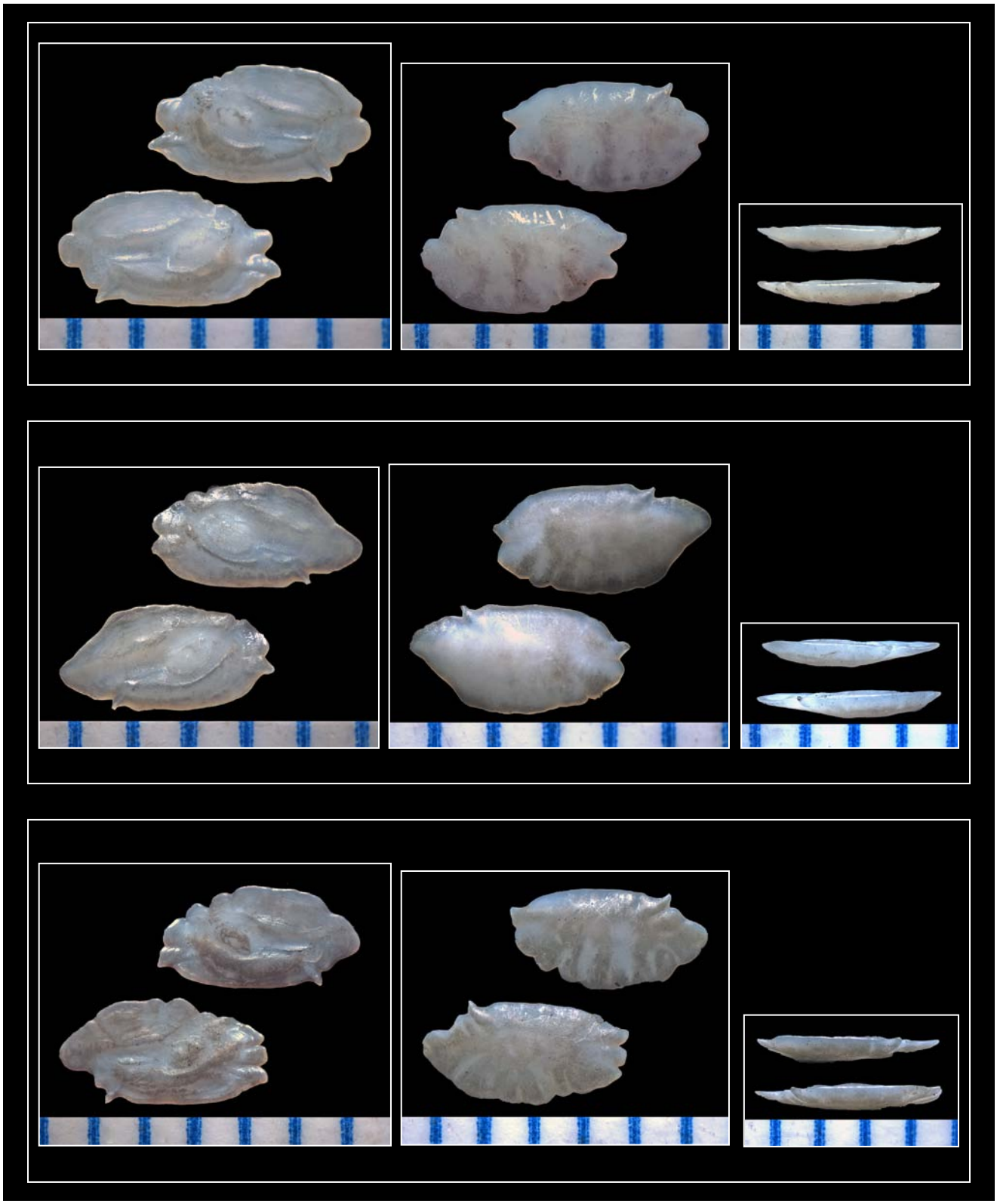
Scomberesocidae
Cololabis saira, Pacific saury, LACM 56605-1



Melamphaidae
Melamphaes lugubris, highsnout bigscale, LACM 56723-1



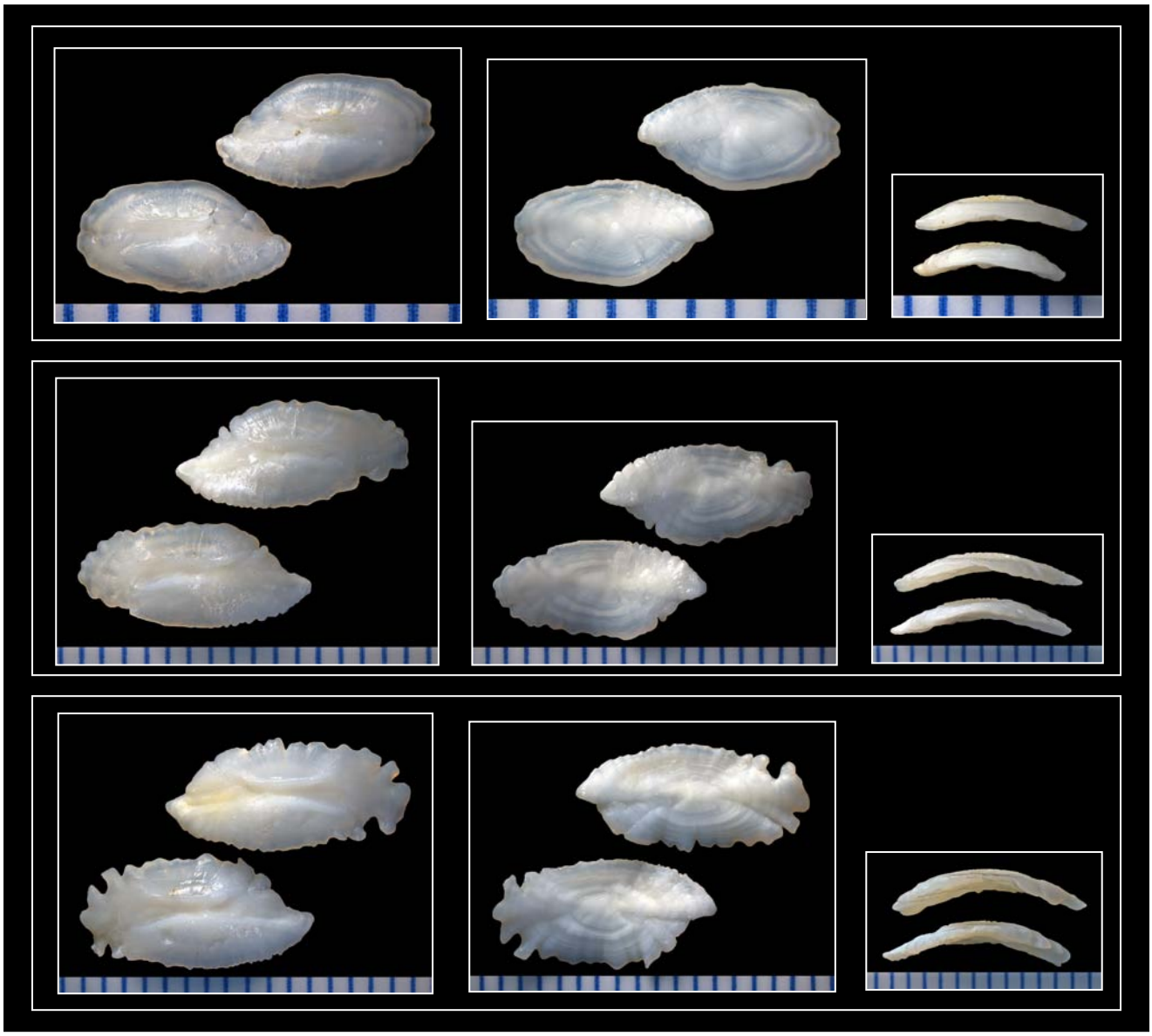
Melamphaidae
Melamphaes lugubris, highsnout bigscale, LACM 56723-1



Scorpaenidae
Sebastes aurora, aurora rockfish, LACM 56714-1

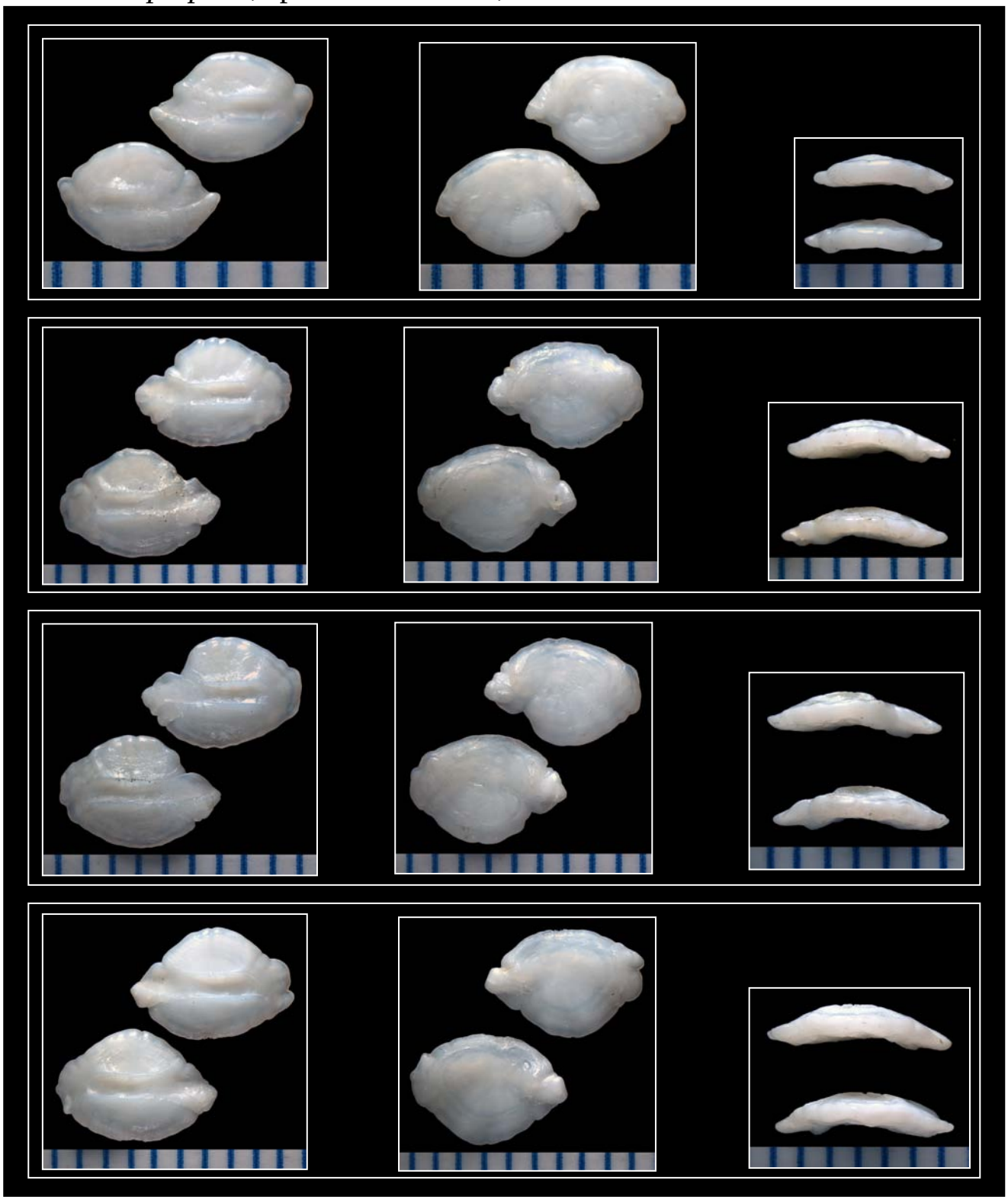
Scorpaenidae
Sebastes aurora, aurora rockfish, LACM 56714-1

Scorpaenidae
Sebastes caurinus, copper rockfish, LACM 56693-1



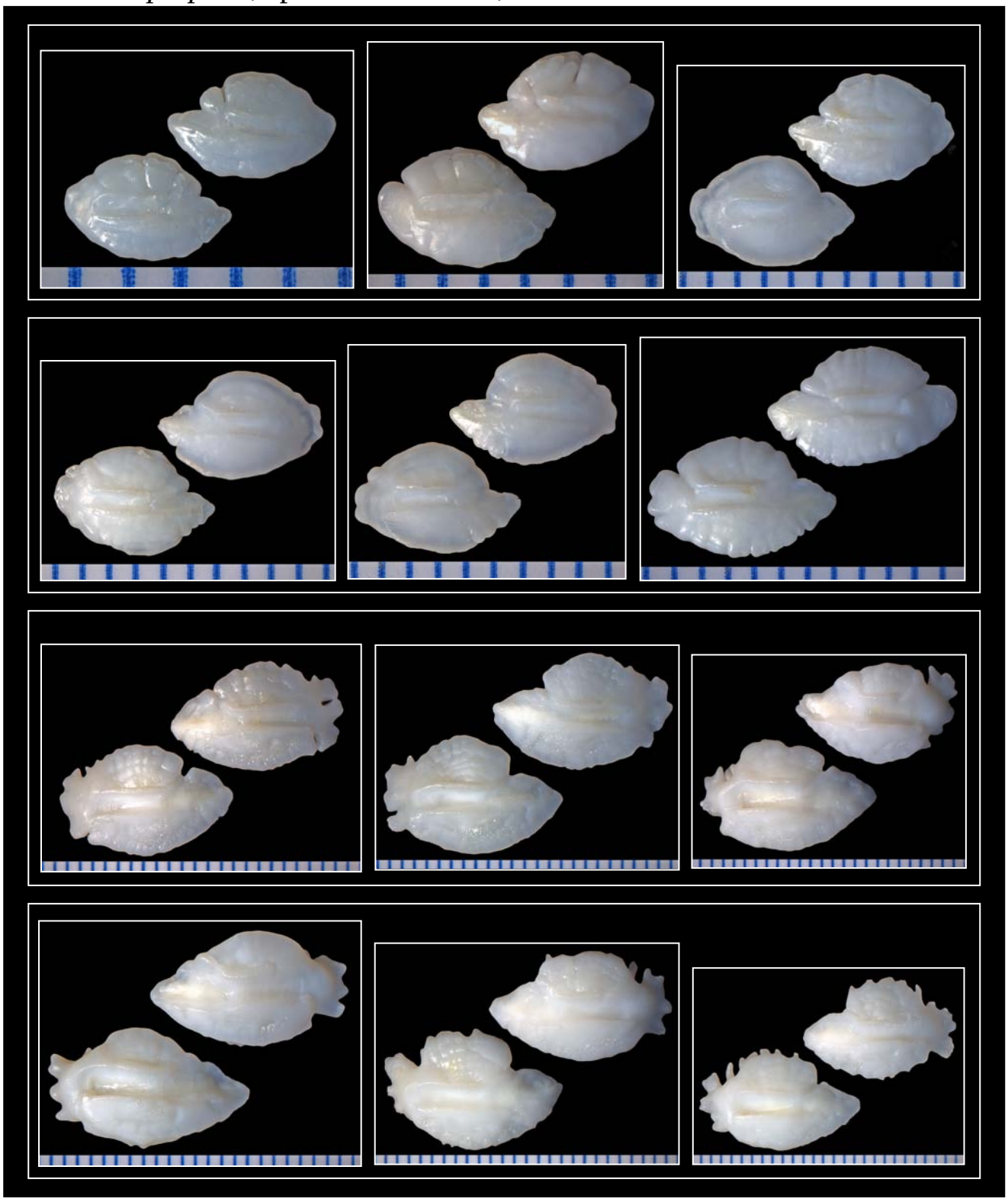
Scorpaenidae
Sebastes caurinus, copper rockfish, LACM 56693-1

Scorpaenidae
Sebastes diploproa, splitnose rockfish, LACM 56655-1

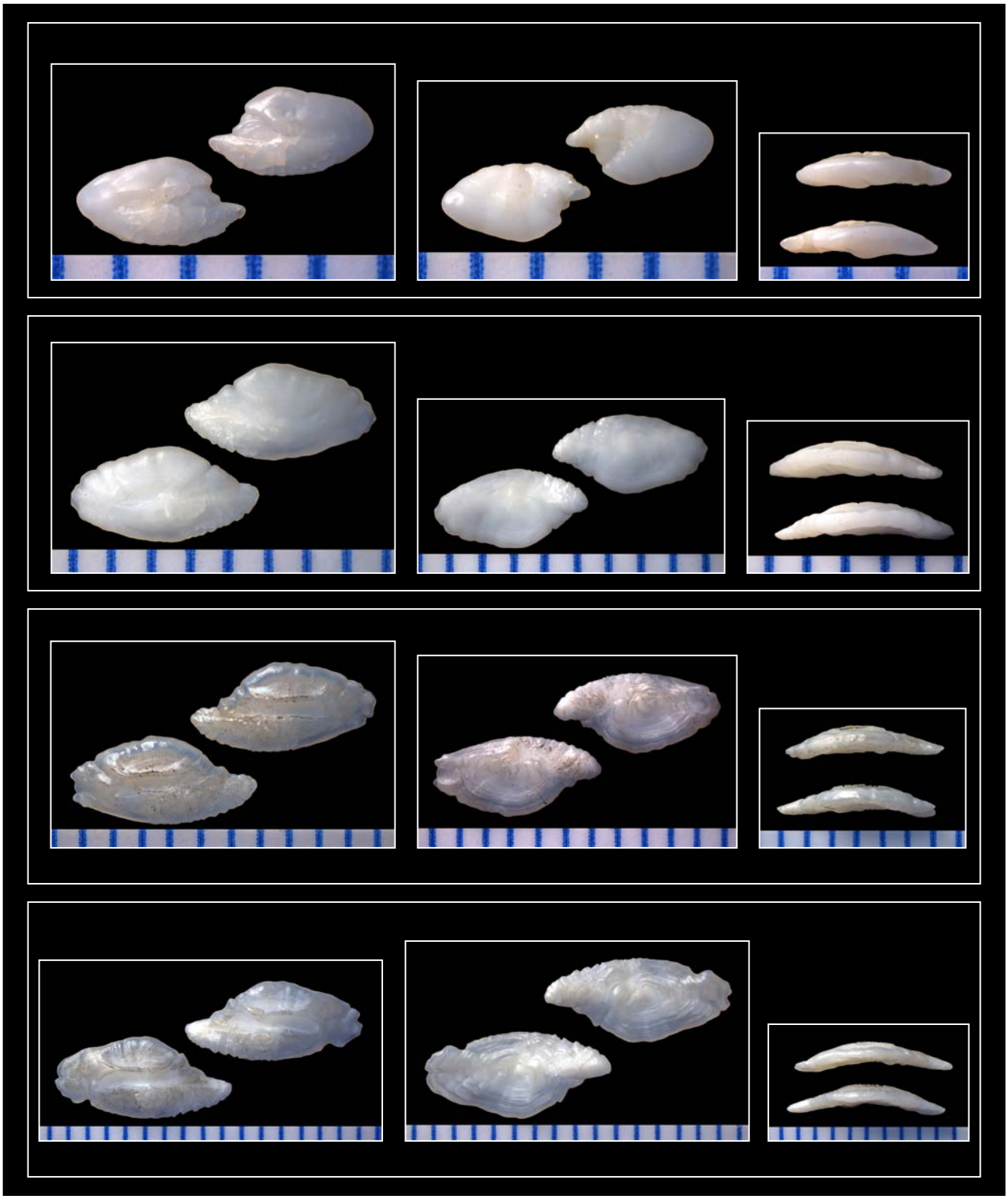


Scorpaenidae
Sebastes diploproa, splitnose rockfish, LACM 56655-1

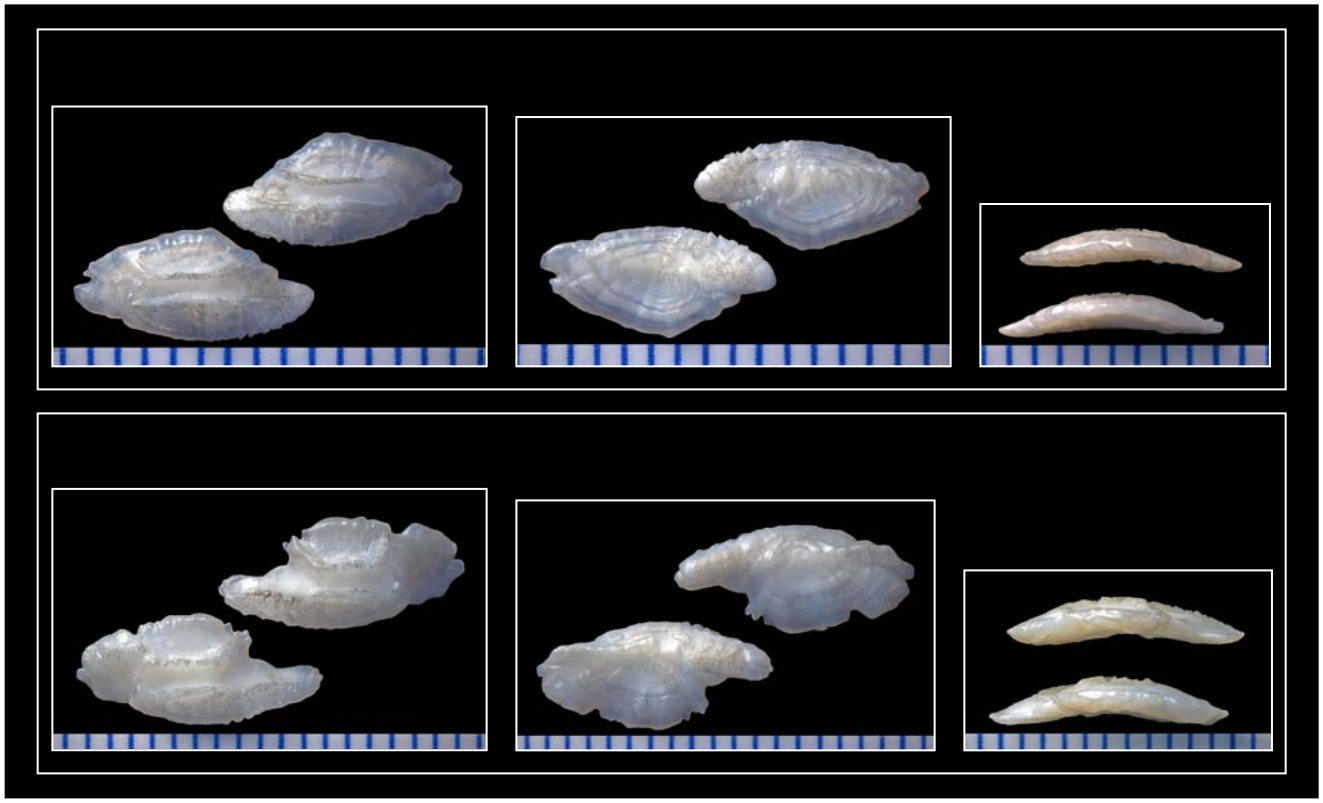
Scorpaenidae
Sebastes diploproa, splitnose rockfish, LACM 56655-1



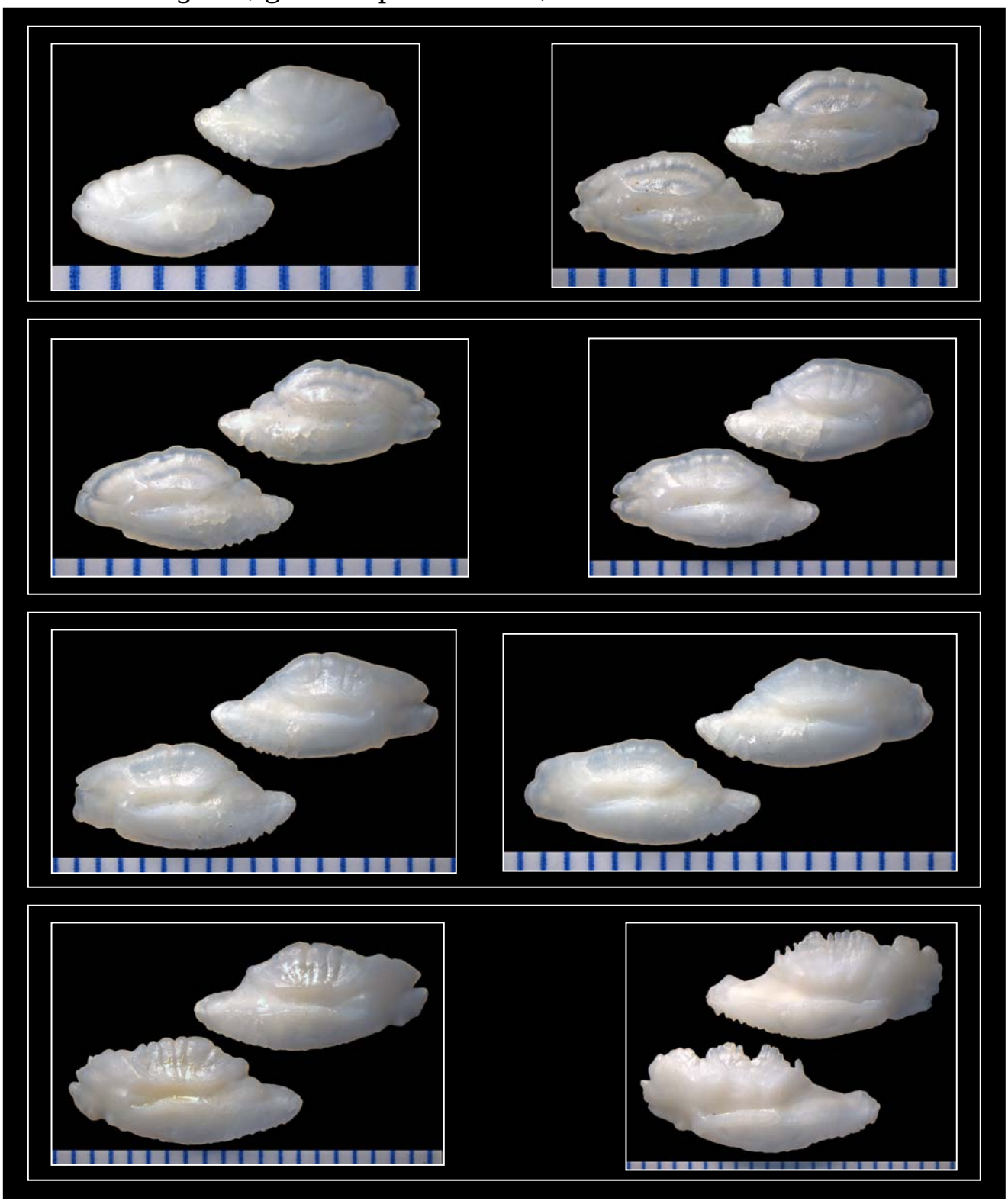
Scorpaenidae
Sebastes elongatus, greenstriped rockfish, LACM 56680-1



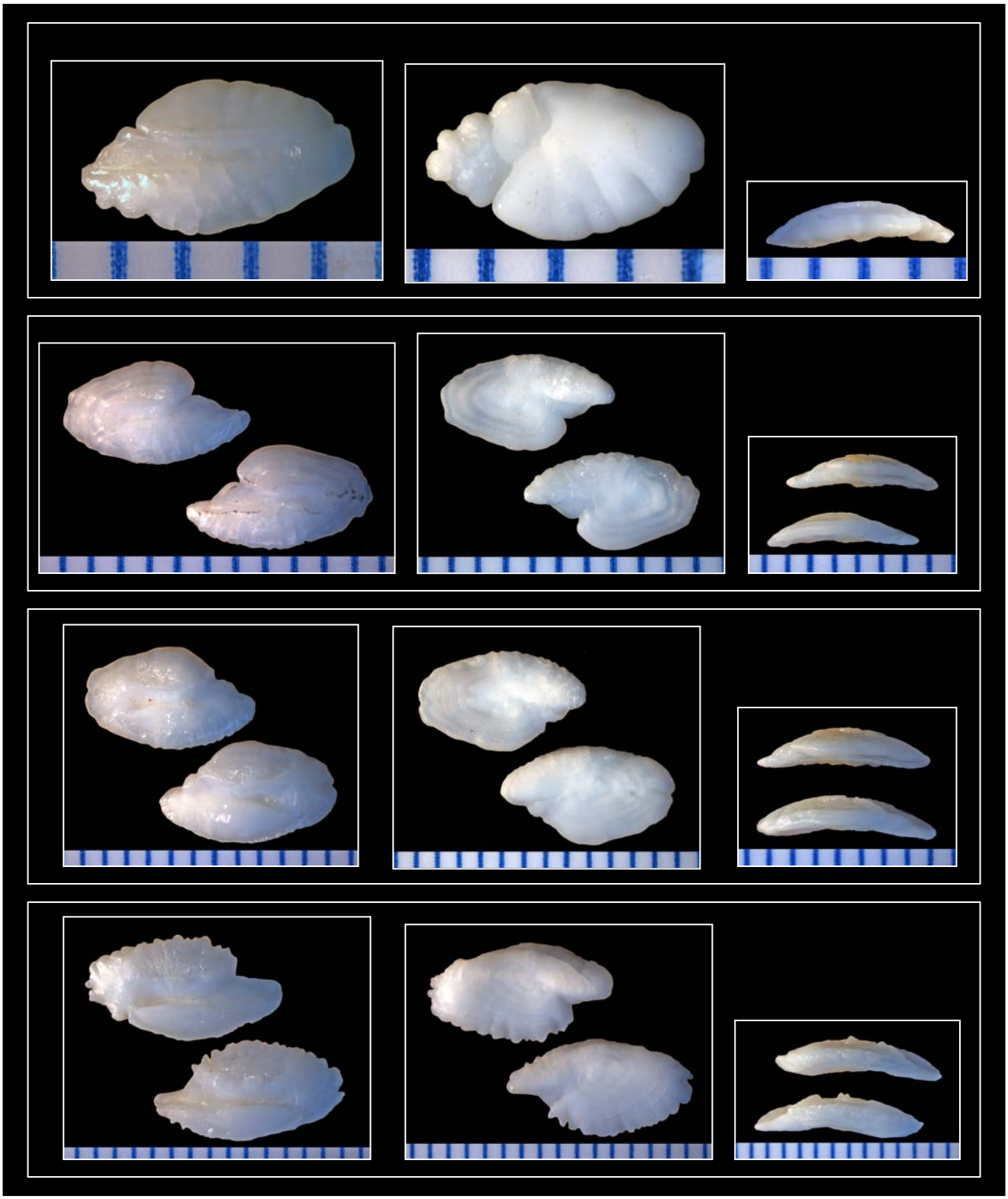
Scorpaenidae
Sebastes elongatus, greenstriped rockfish, LACM 56680-1



Scorpaenidae
Sebastes elongatus, greenstriped rockfish, LACM 56680-1



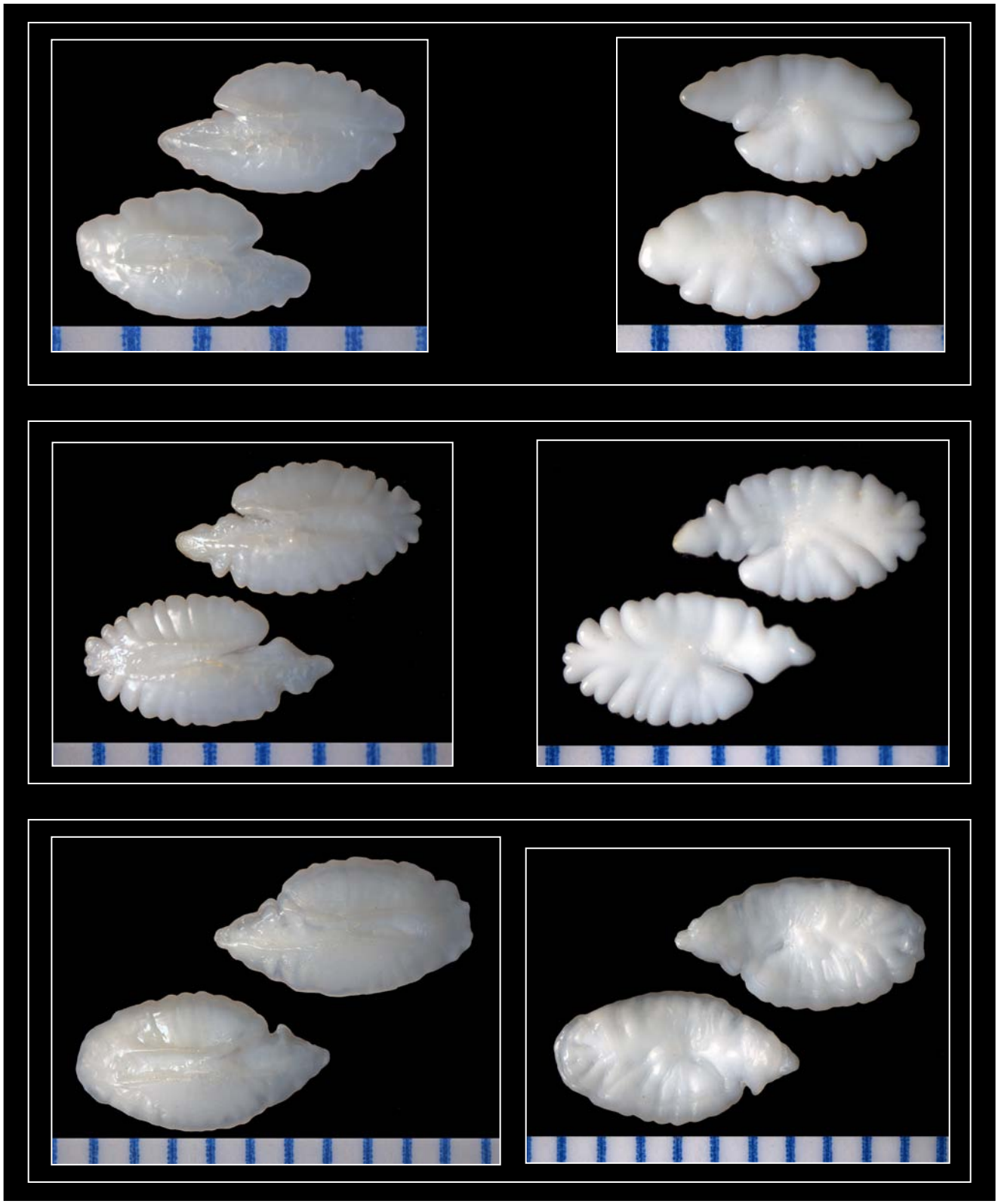
Scorpaenidae
Sebastes ensifer, swordspine rockfish, LACM 56657-1



Scorpaenidae
Sebastes ensifer, swordspine rockfish, LACM 56657-1

Scorpaenidae
Sebastes entomelas, widow rockfish, LACM 56704-1

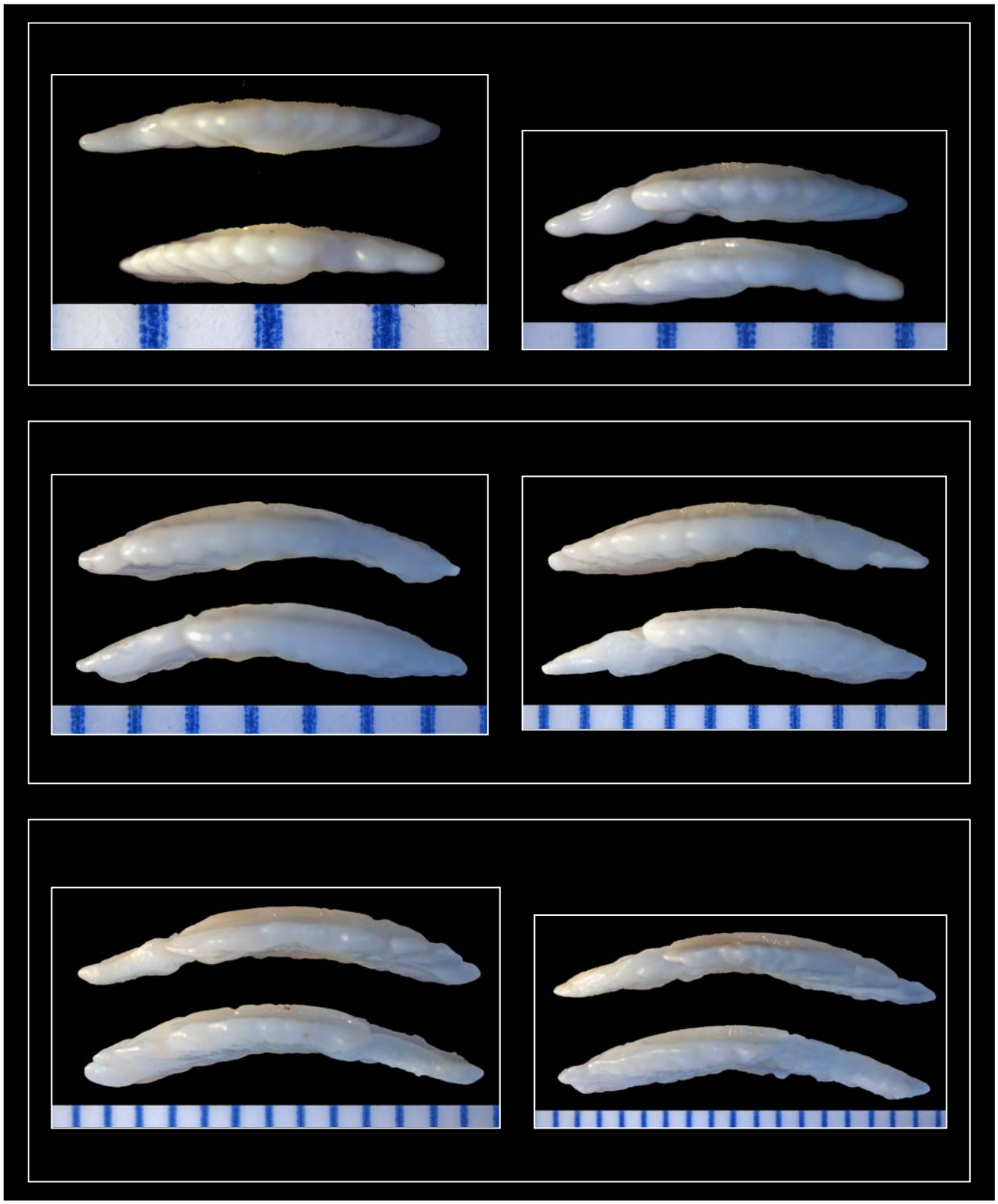
Scorpaenidae
Sebastes goodei, chilipeper, LACM 56651-1



Scorpaenidae
Sebastes goodei, chilipeper, LACM 56651-1

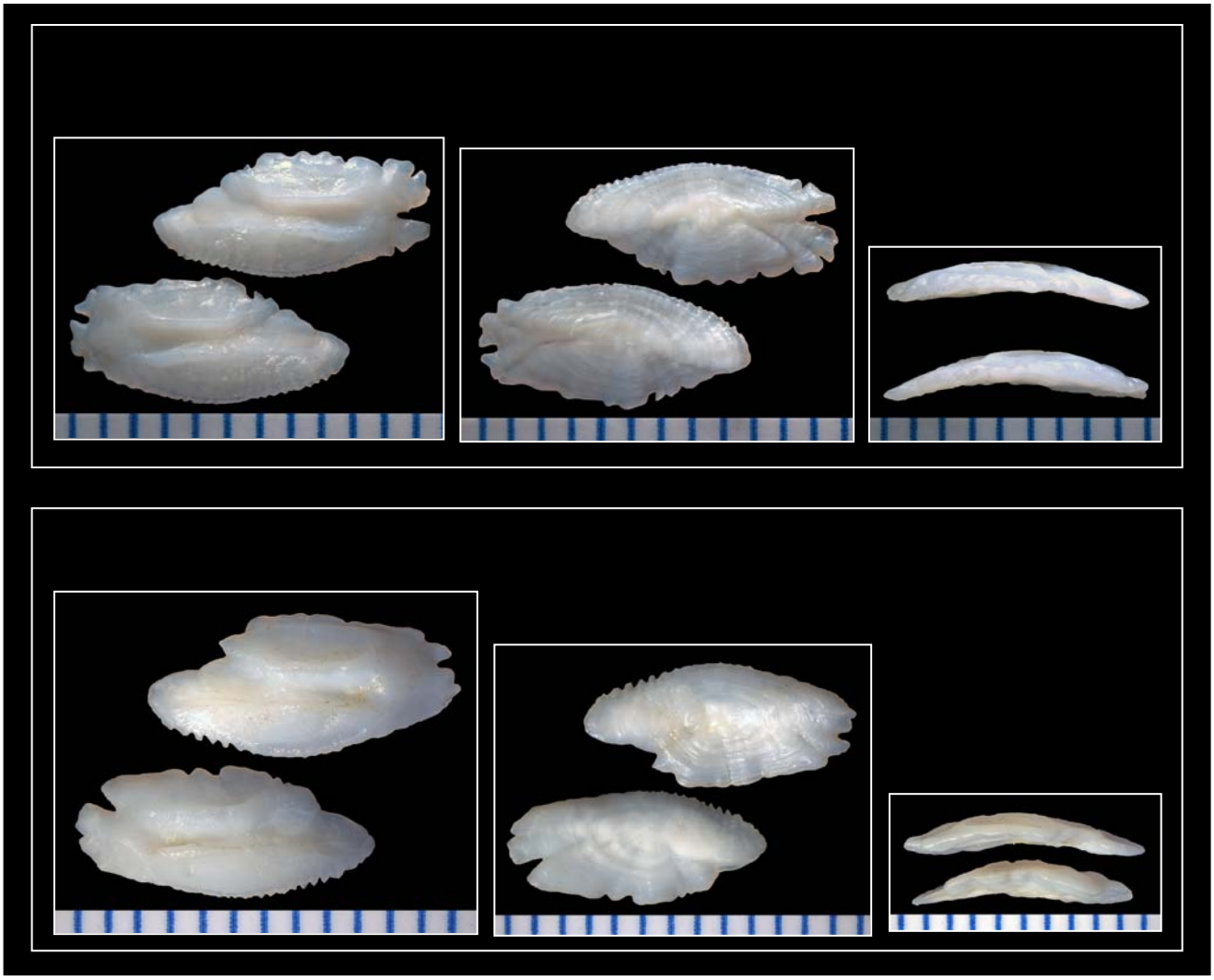
Scorpaenidae
Sebastes goodei, chilipeper, LACM 56651-1

Scorpaenidae
Sebastes goodei, chilipeper, LACM 56651-1

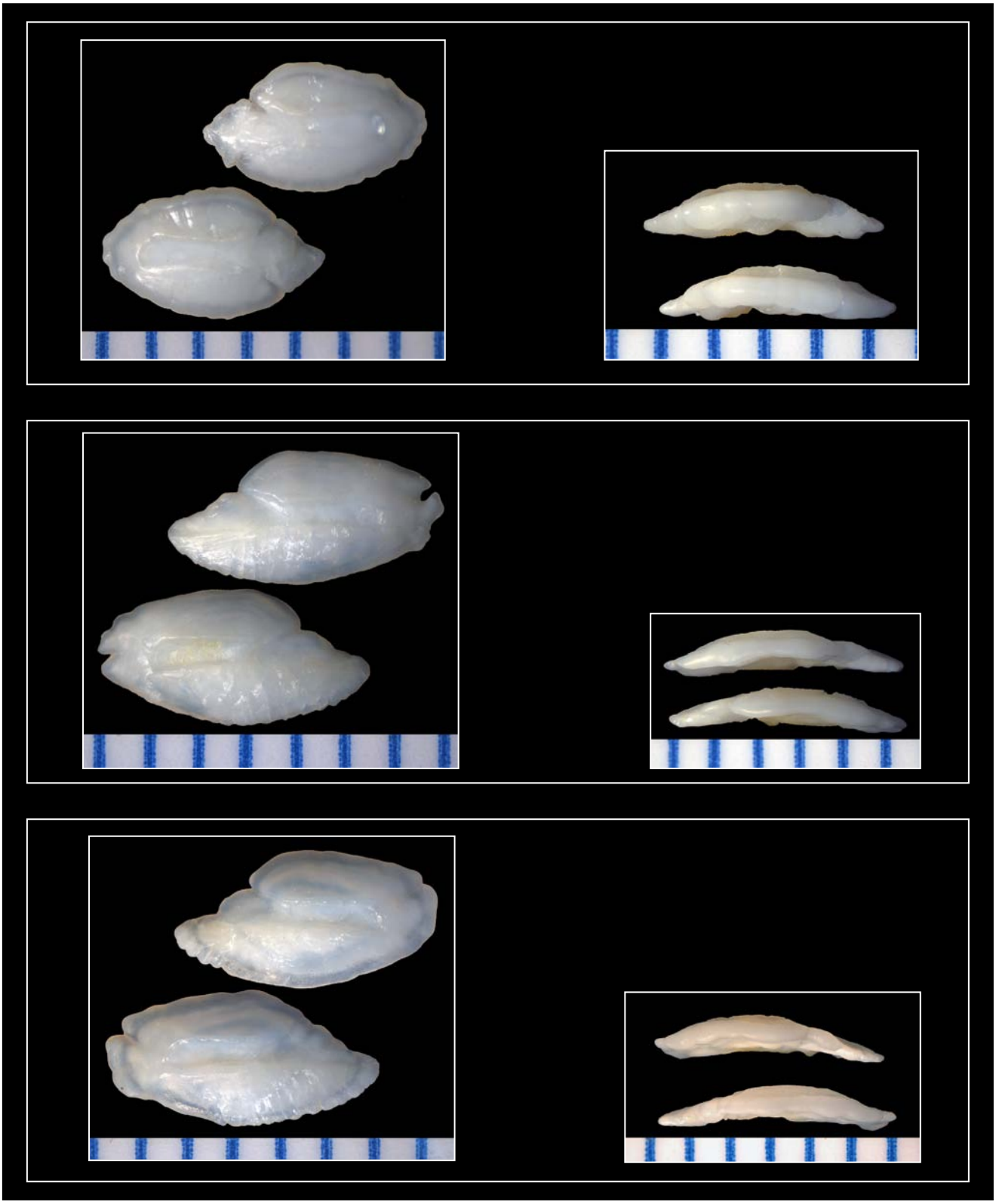


Scorpaenidae
Sebastes hopkinsi, squarespot rockfish, LACM 56671-1

Scorpaenidae
Sebastes hopkinsi, squarespot rockfish, LACM 56671-1

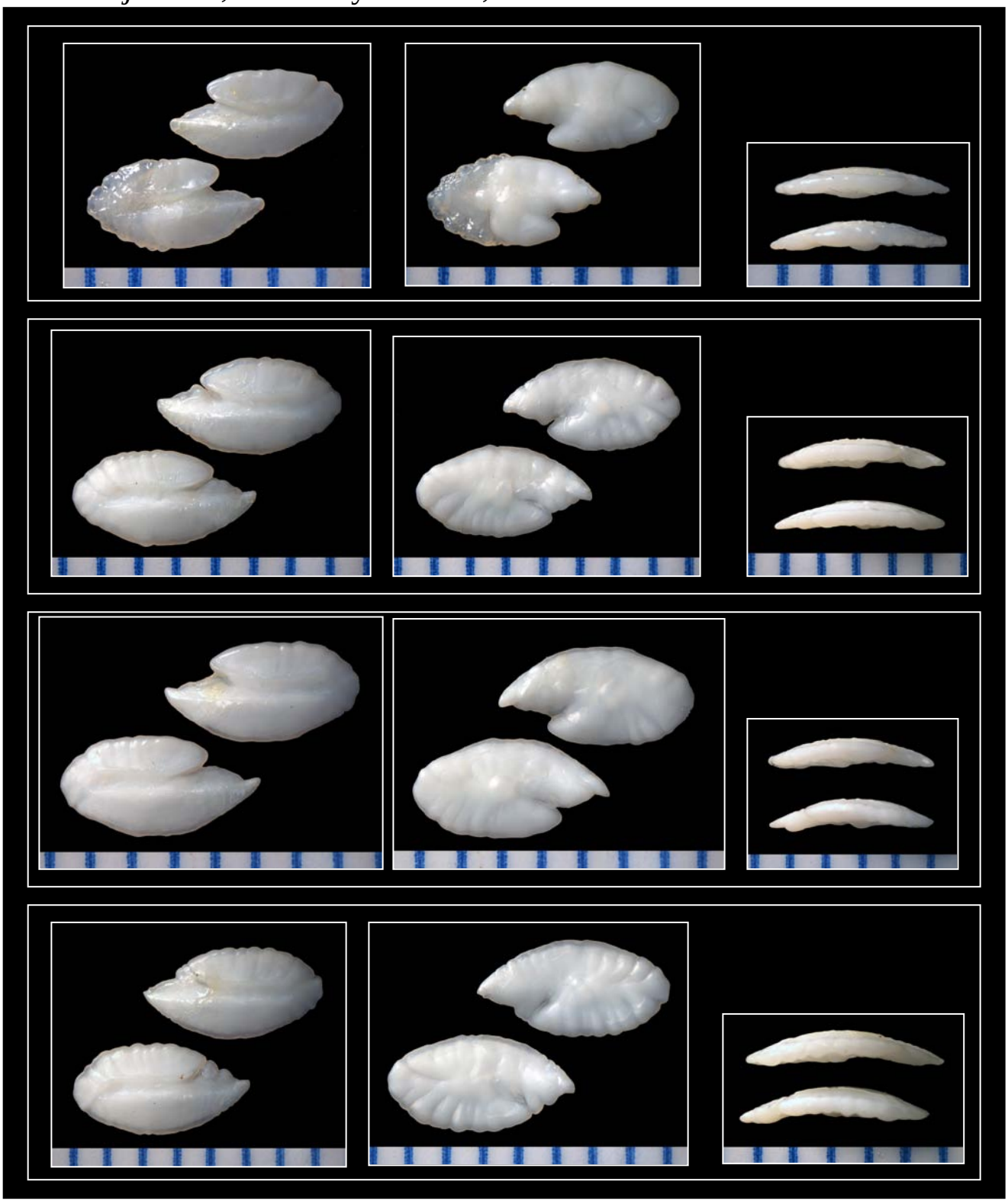


Scorpaenidae
Sebastes hopkinsi, squarespot rockfish, LACM 56671-1



Scorpaenidae
Sebastes hopkinsi, squarespot rockfish, LACM 56671-1

Scorpaenidae
Sebastes jordani, shortbelly rockfish, LACM 56607-1



Scorpaenidae
Sebastes jordani, shortbelly rockfish, LACM 56607-1

Scorpaenidae
Sebastes jordani, shortbelly rockfish, LACM 56607-1

Scorpaenidae
Sebastes lentiginosus, freckled rockfish, LACM 56705-1

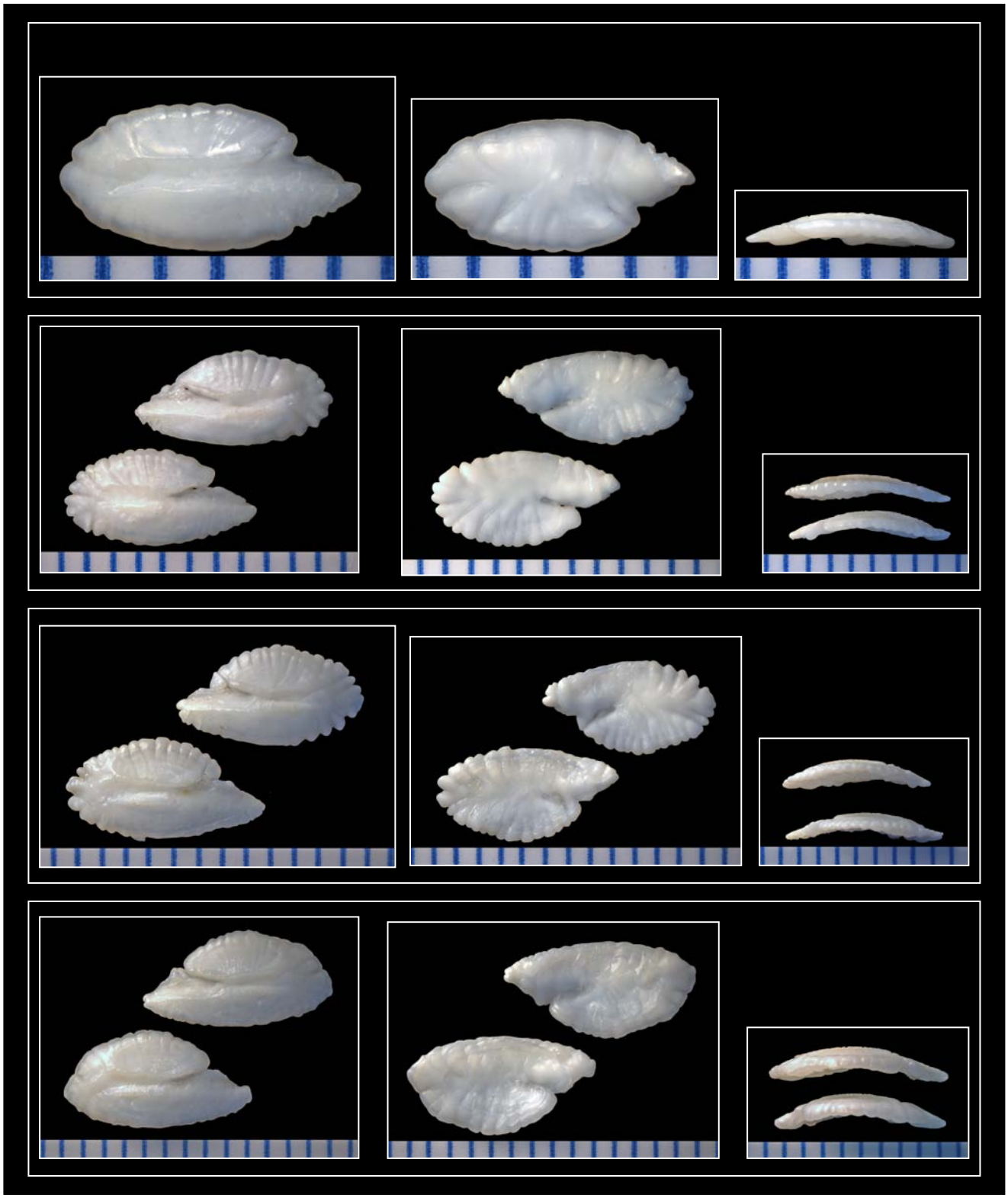
Scorpaenidae
Sebastes miniatus, vermilion rockfish, LACM 56707-1

Scorpaenidae
Sebastes miniatus, vermilion rockfish, LACM 56707-1

Scorpaenidae
Sebastes mystinus, blue rockfish, LACM 56678-1

Scorpaenidae
Sebastes mystinus, blue rockfish, LACM 56678-1

Scorpaenidae
Sebastes paucispinis, Bocaccio, LACM 56690-1



Scorpaenidae
Sebastes paucispinis, Bocaccio, LACM 56690-1

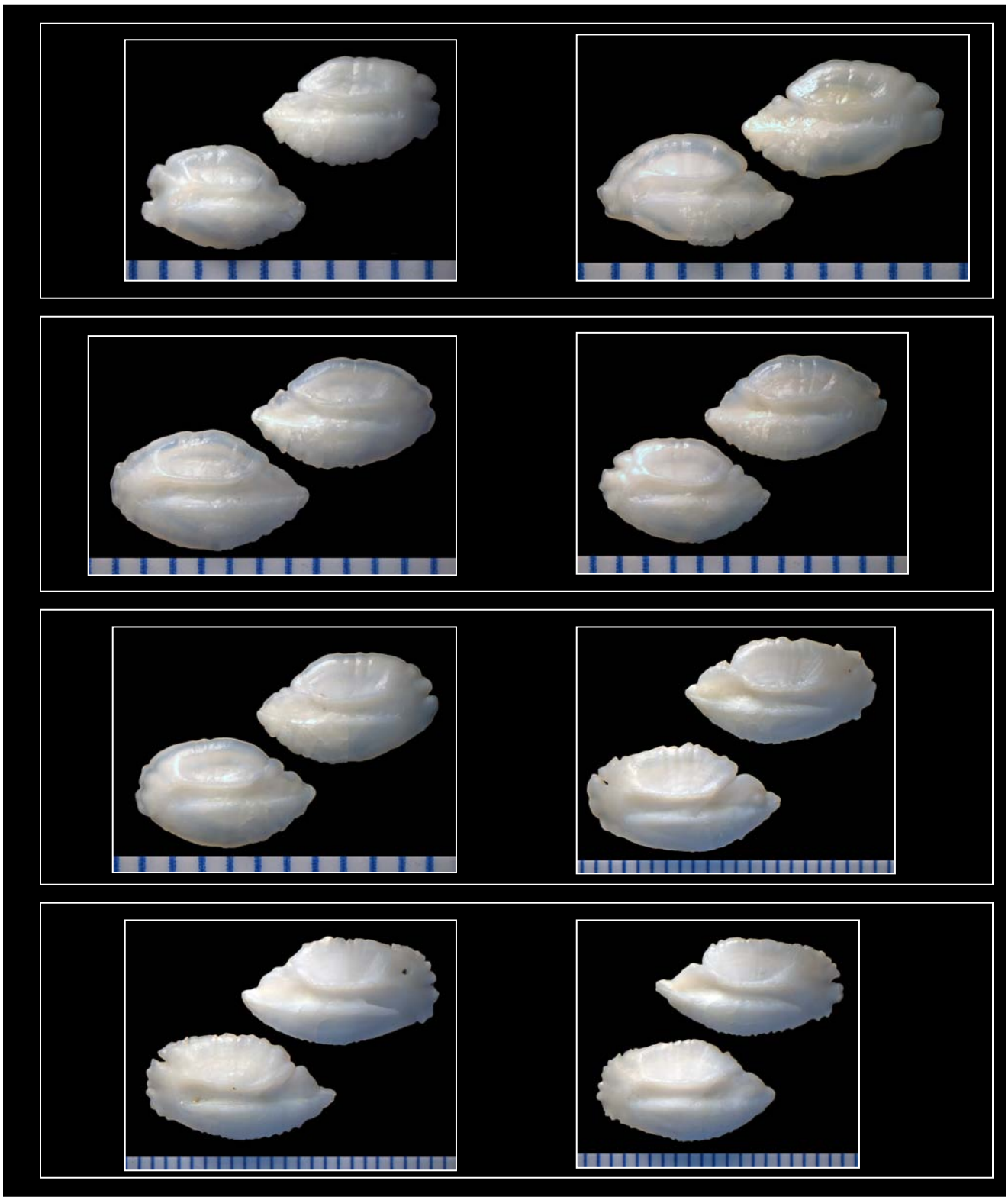
Scorpaenidae
Sebastes paucispinis, Bocaccio, LACM 56690-1

Scorpaenidae
Sebastes proriger, Redstripe rockfish, LACM 56717-1

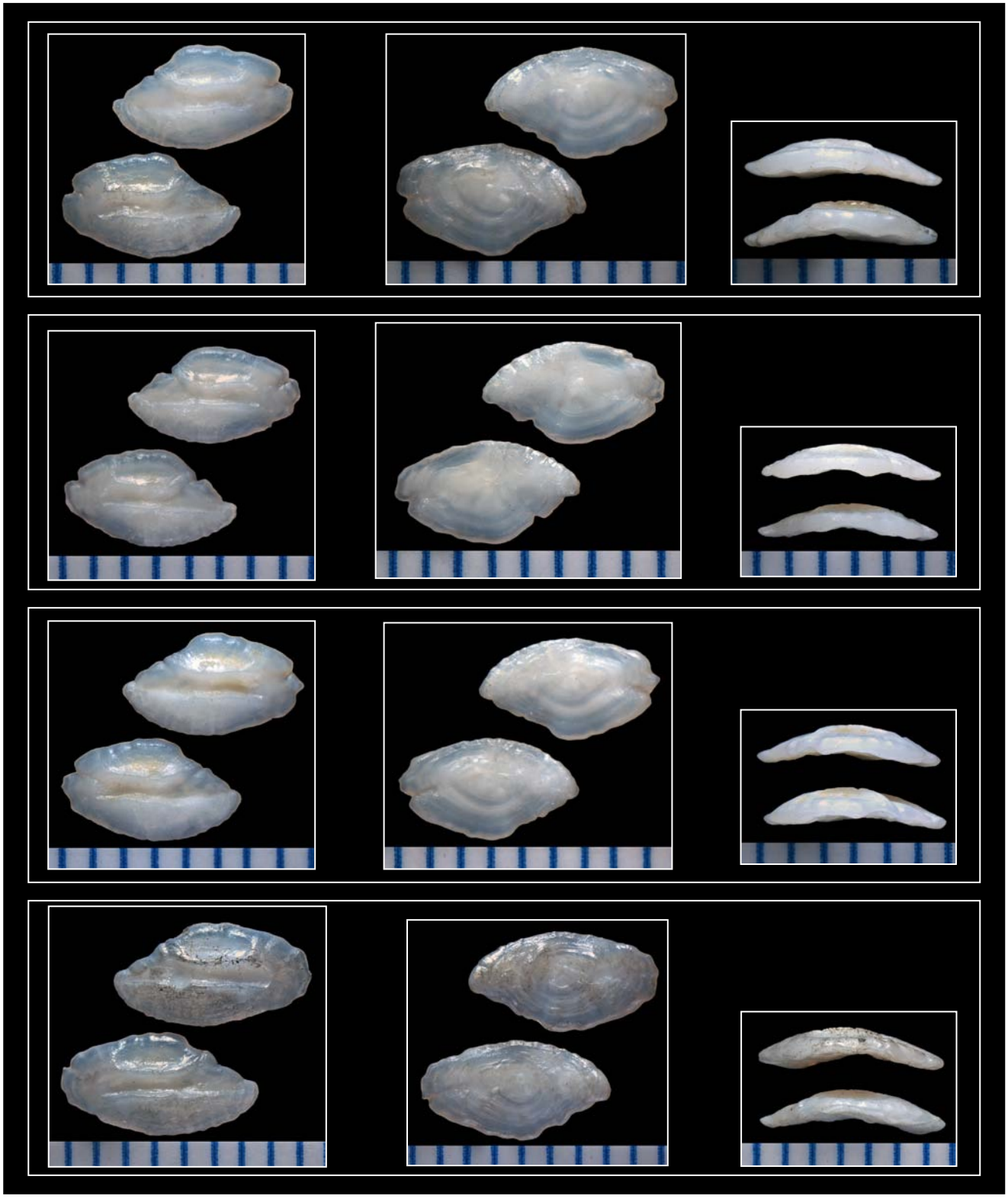
Scorpaenidae
Sebastes rufus, Bank rockfish, LACM 56720-1

Scorpaenidae
Sebastes saxicola, Stripetail rockfish, LACM 56677-1

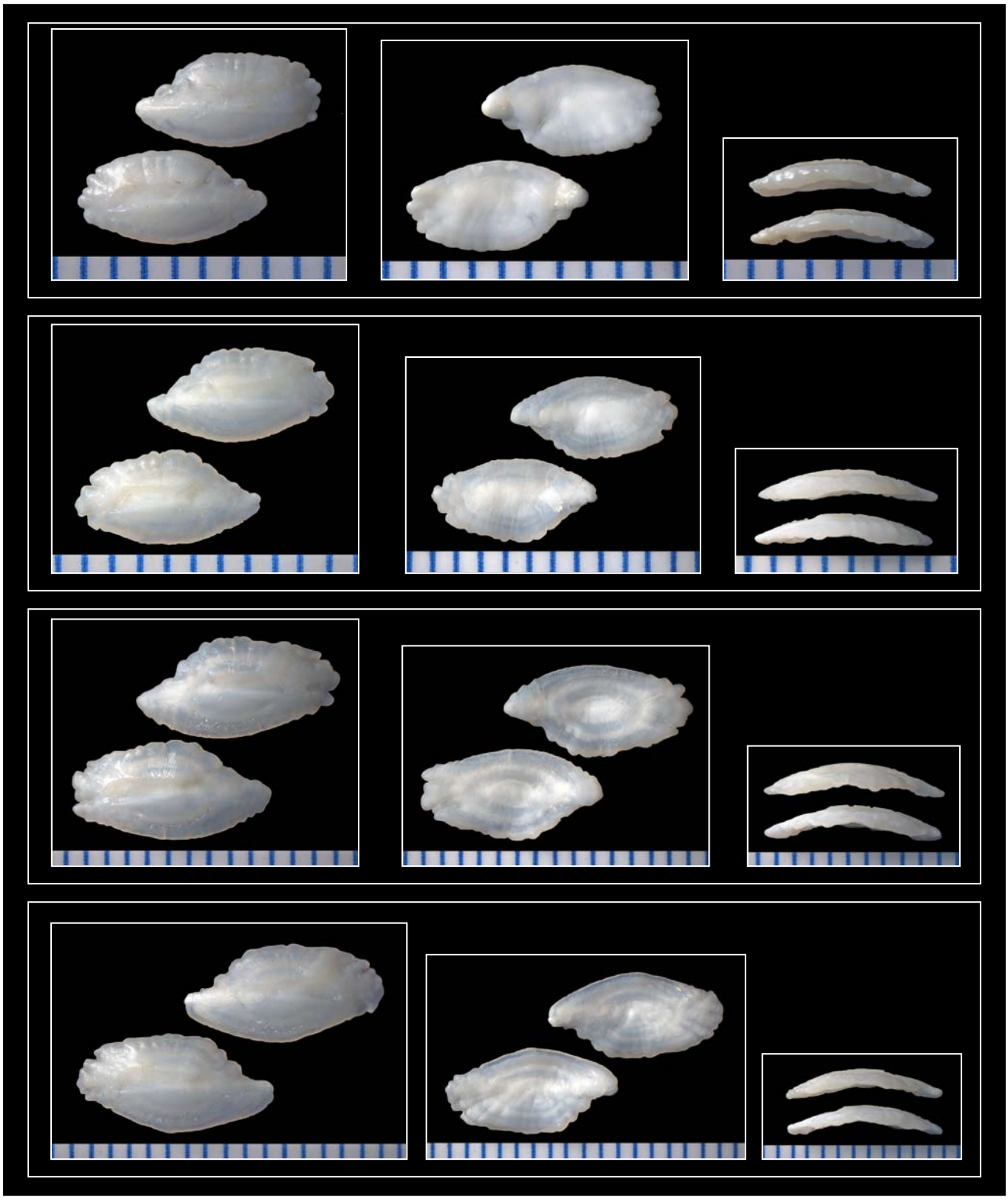
Scorpaenidae
Sebastes saxicola, Stripetail rockfish, LACM 56677-1



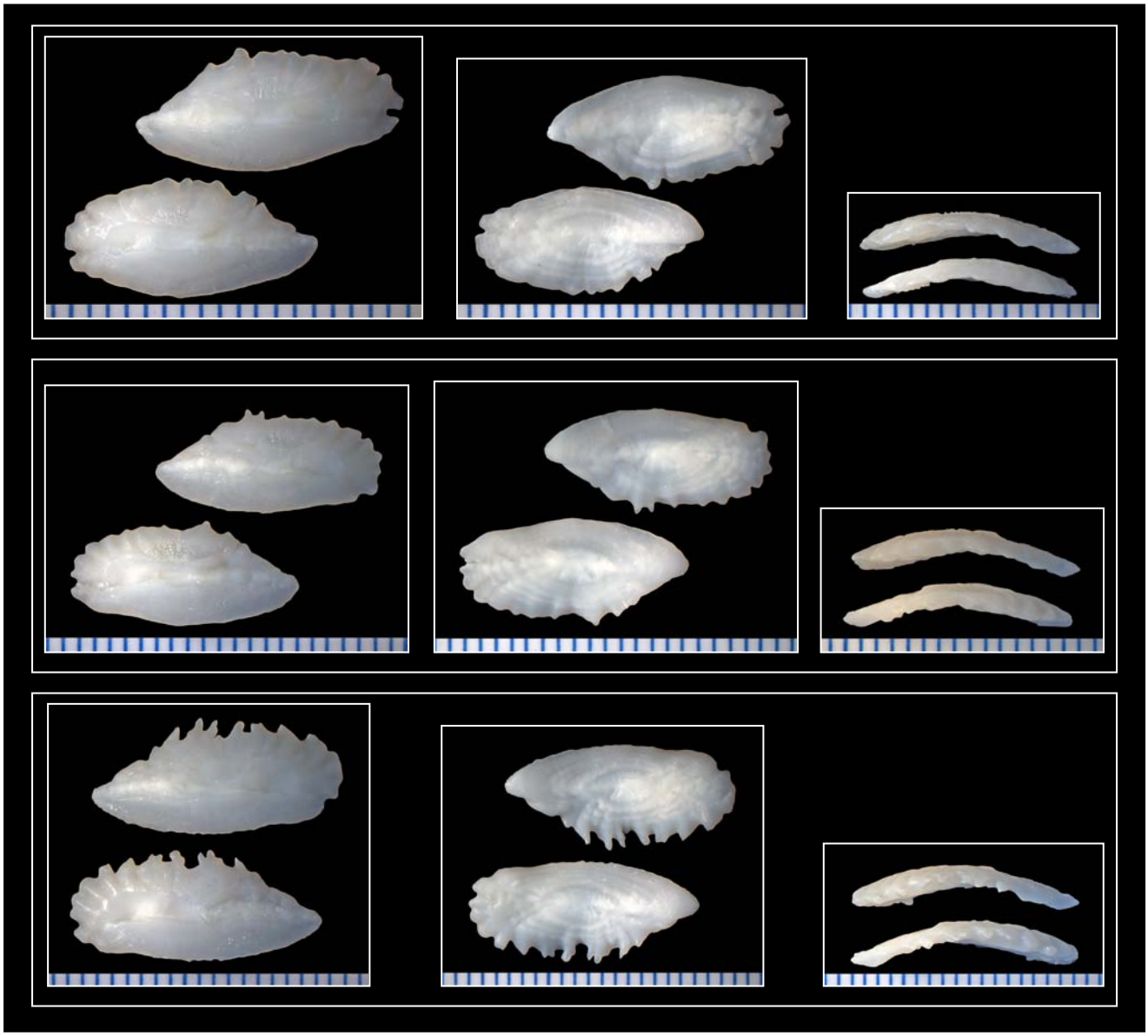
Scorpaenidae
Sebastes semicinctus, halfbanded rockfish, LACM 56606-1



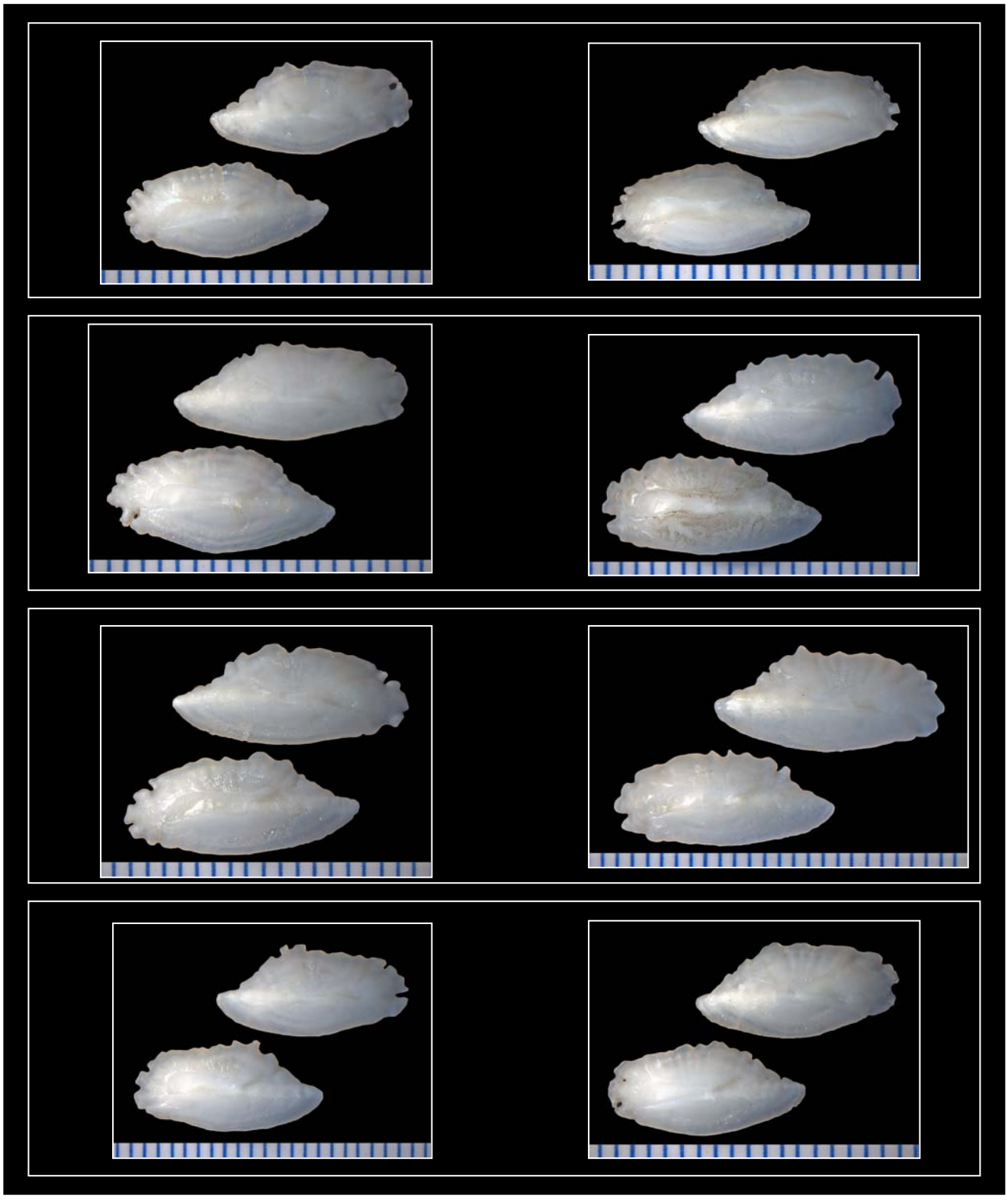
Scorpaenidae
Sebastes serranoides, Olive rockfish, LACM 56708-1



Scorpaenidae
Sebastes serranoides, Olive rockfish, LACM 56708-1



Scorpaenidae
Sebastes serranoides, Olive rockfish, LACM 56708-1

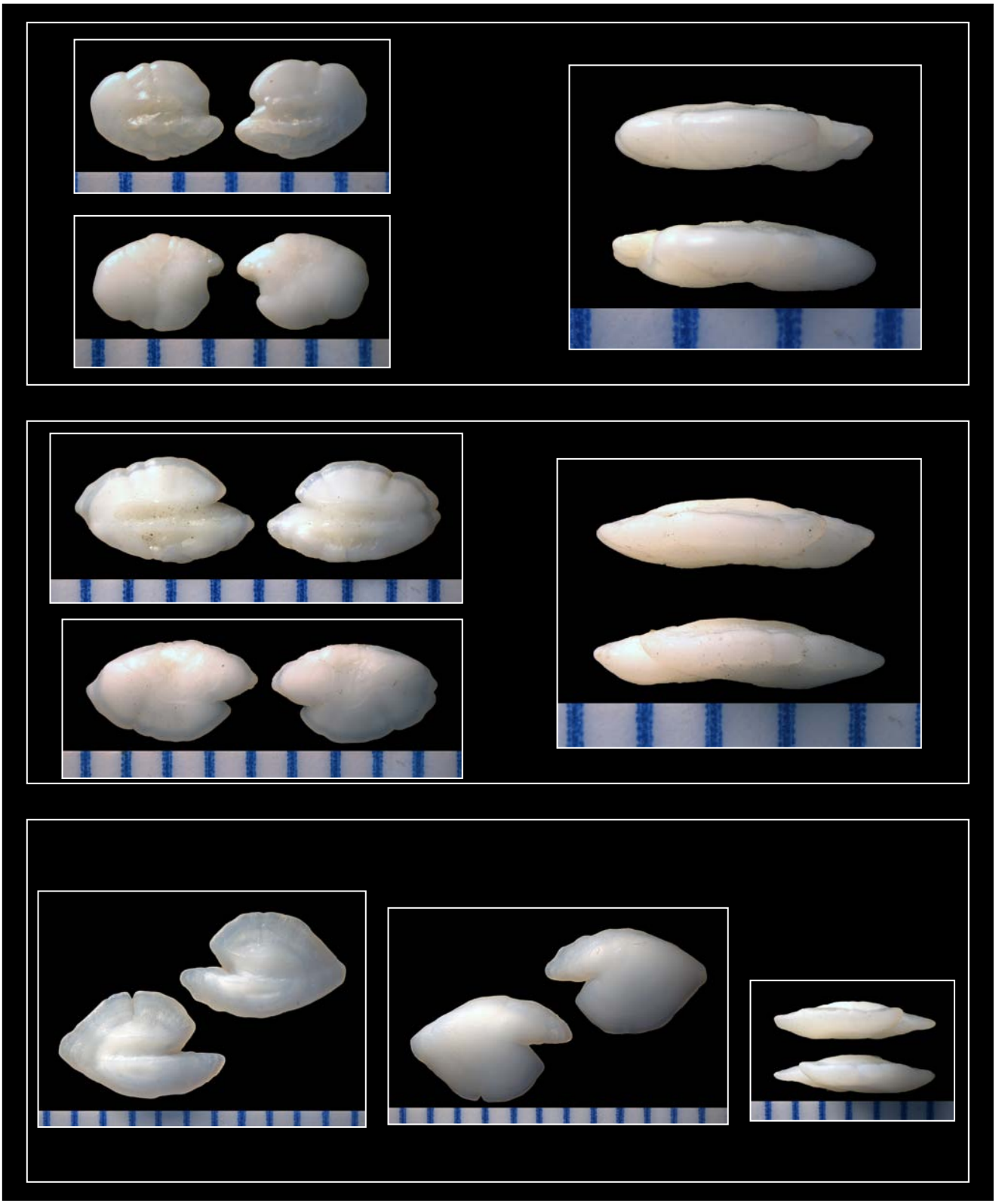


Scorpaenidae
Sebastes umbrosus, Honeycomb rockfish, LACM 56046-1

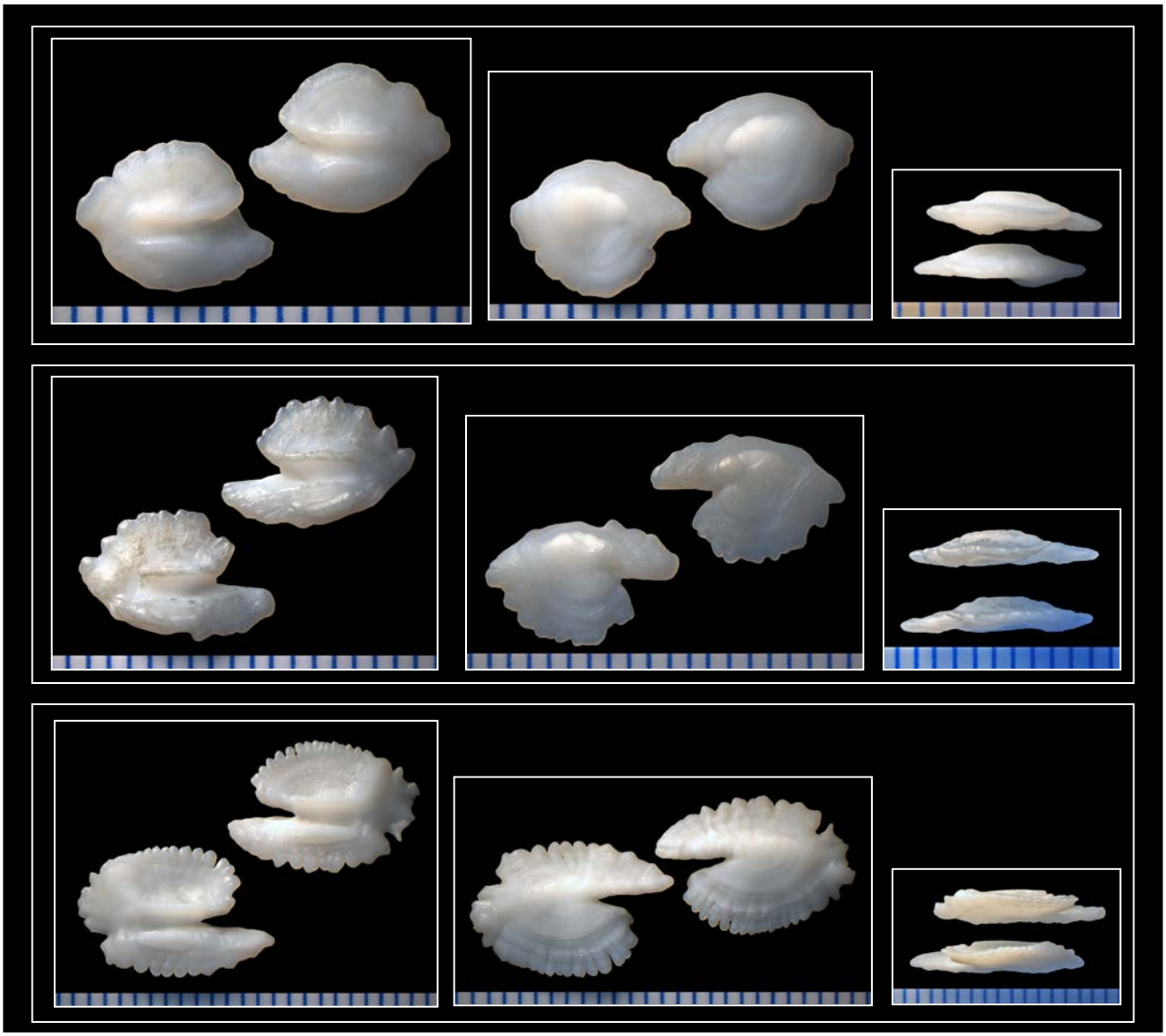
Scorpaenidae
Sebastes wilsoni, Pygmy rockfish, LACM 56692-1

Scorpaenidae
Sebastes wilsoni, Pygmy rockfish, LACM 56692-1

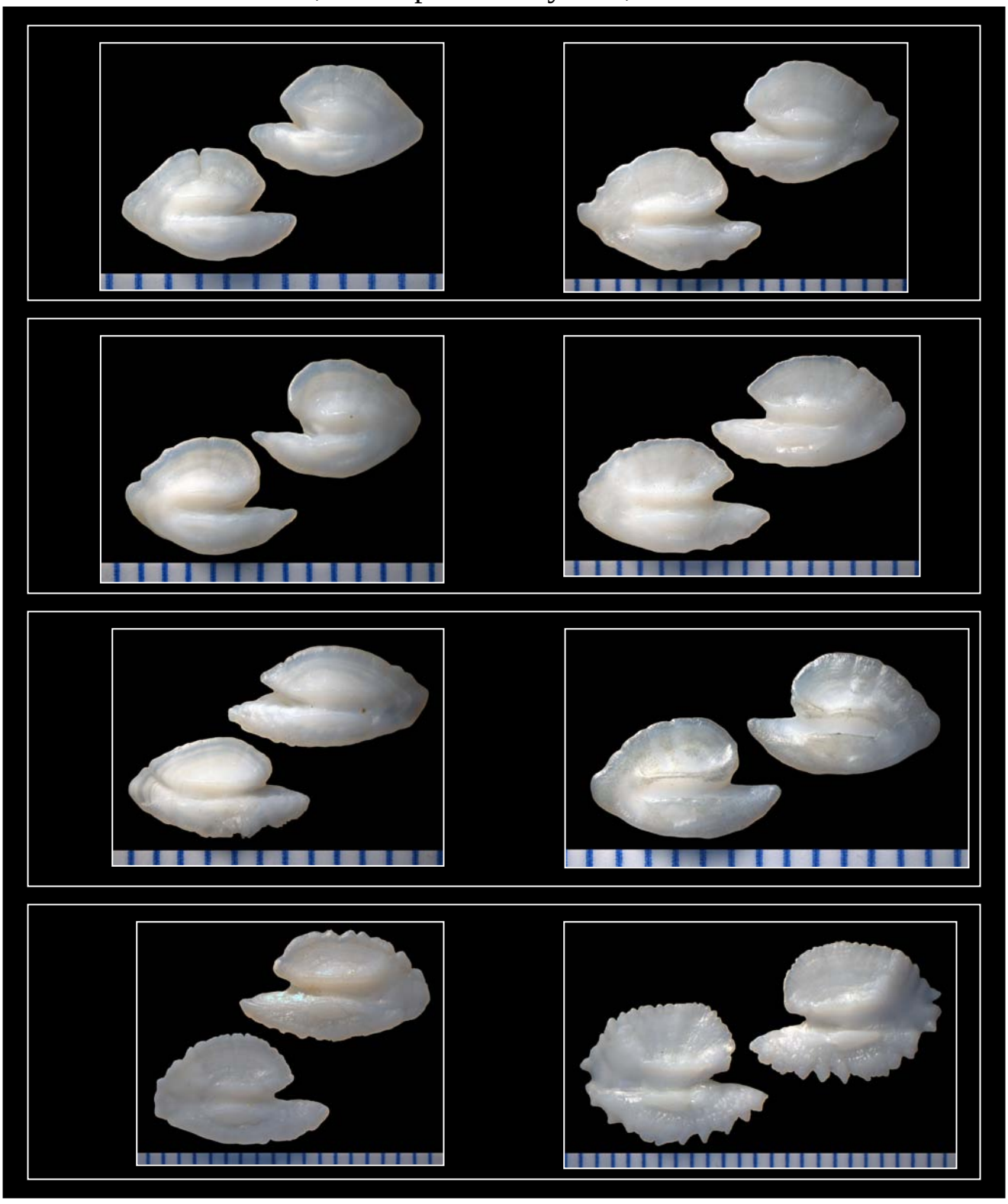
Scorpaenidae
Sebastolobus alascanus, Shortspine thornyhead, LACM 56676-1



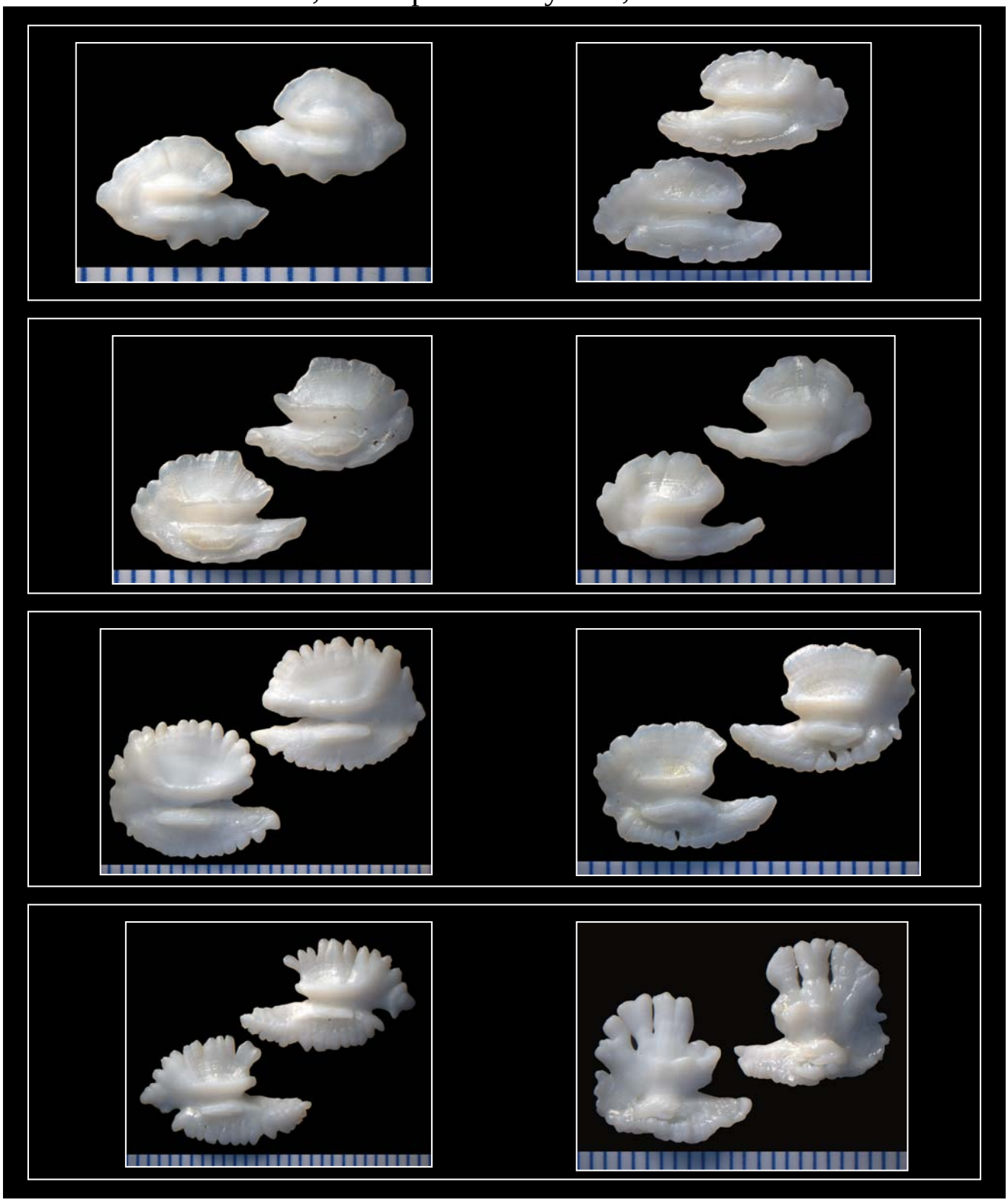
Scorpaenidae
Sebastolobus alascanus, Shortspine thornyhead, LACM 56676-1



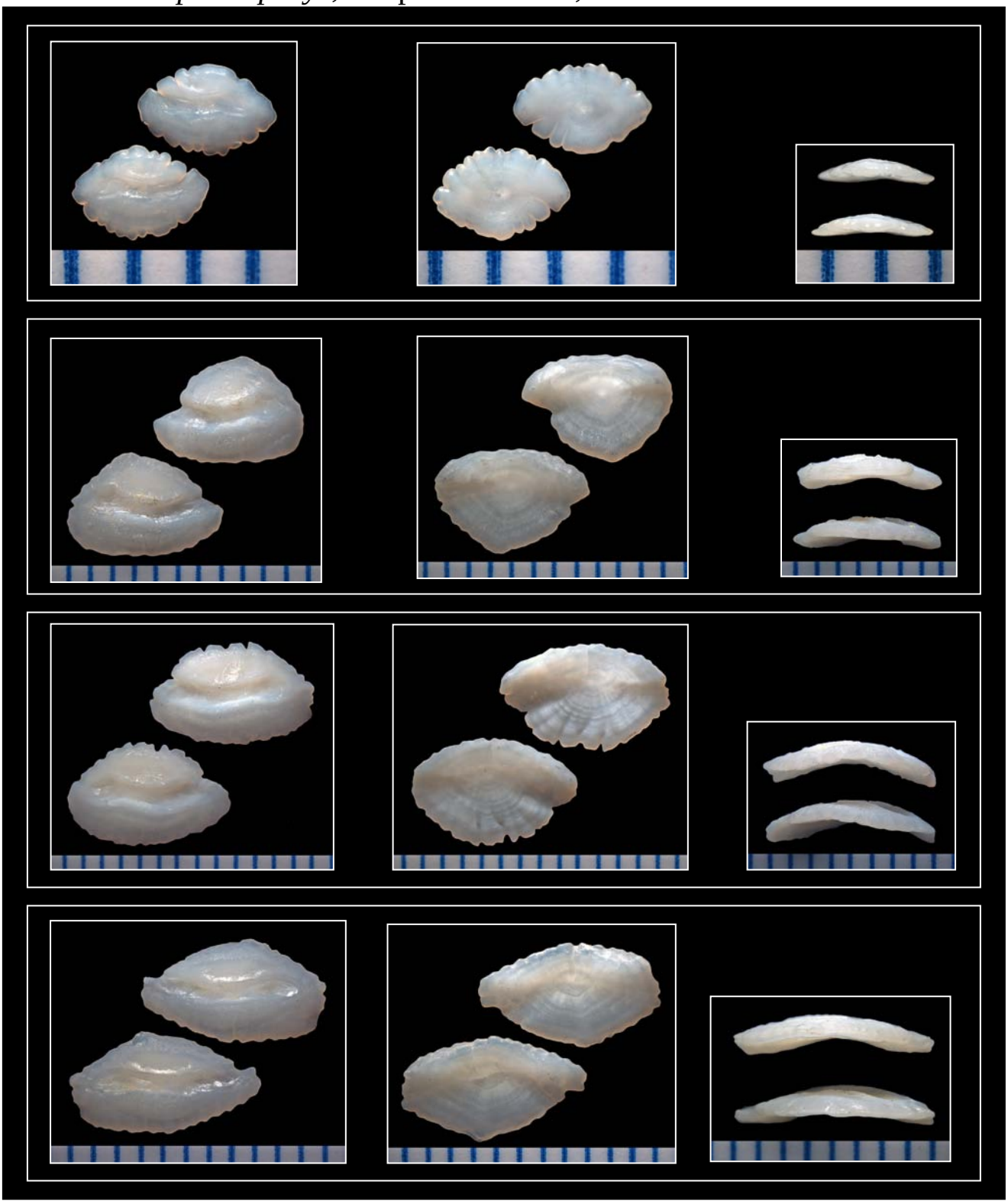
Scorpaenidae
Sebastolobus alascanus, Shortspine thornyhead, LACM 56676-1



Scorpaenidae
Sebastolobus alascanus, Shortspine thornyhead, LACM 56676-1



Triglidae
Prionotus stephanophrys, lumptail searobin, LACM 56933-1



Triglidae
Prionotus stephanophrys, lumptail searobin, LACM 56933-1

Anoplopomatidae
Anoplopoma fimbria, sablefish, LACM 56713-1

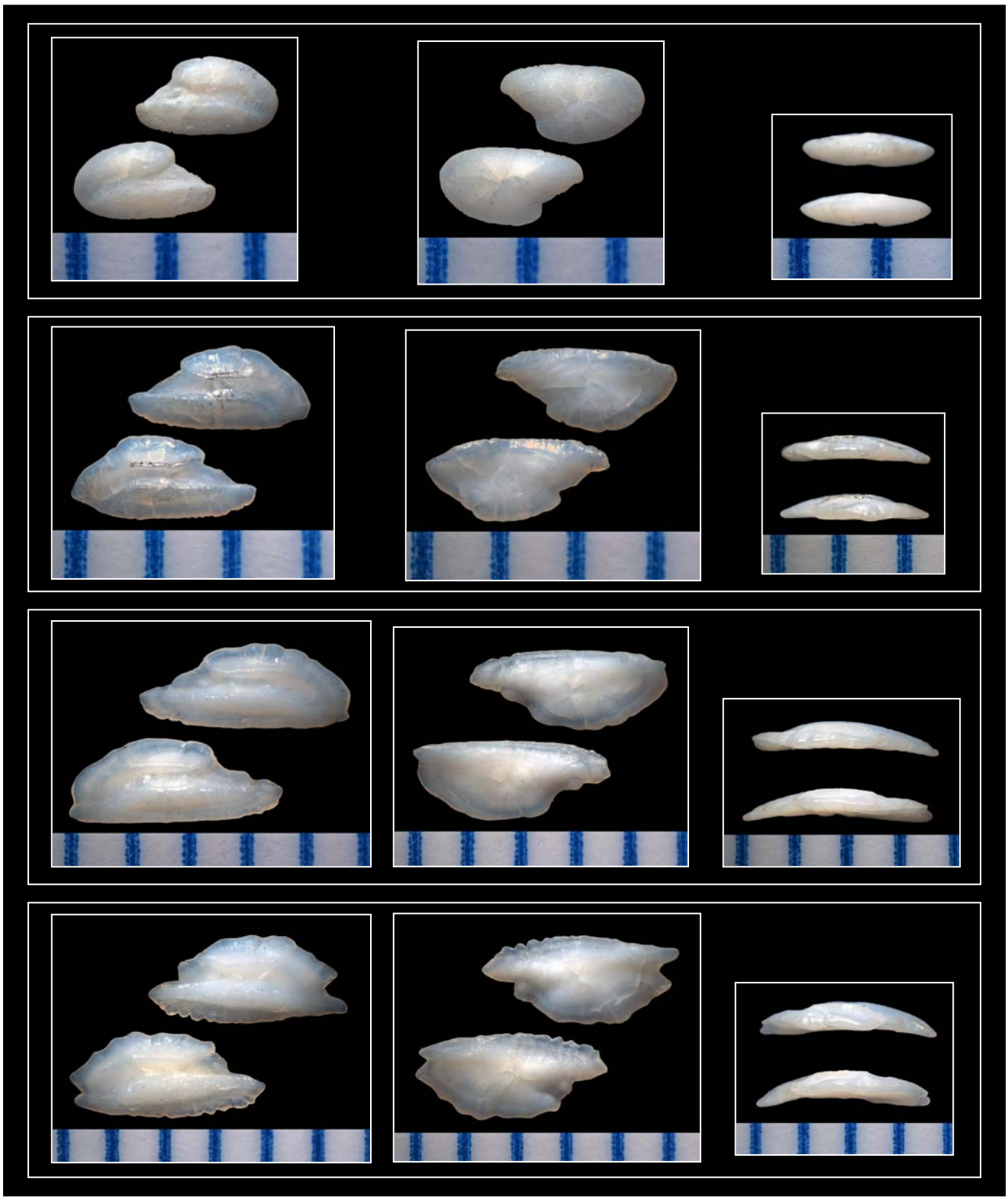
Anoplopomatidae
Anoplopoma fimbria, sablefish, LACM 56713-1

Hexagrammidae
Ophiodon elongatus, lingcod, LACM 57264-1

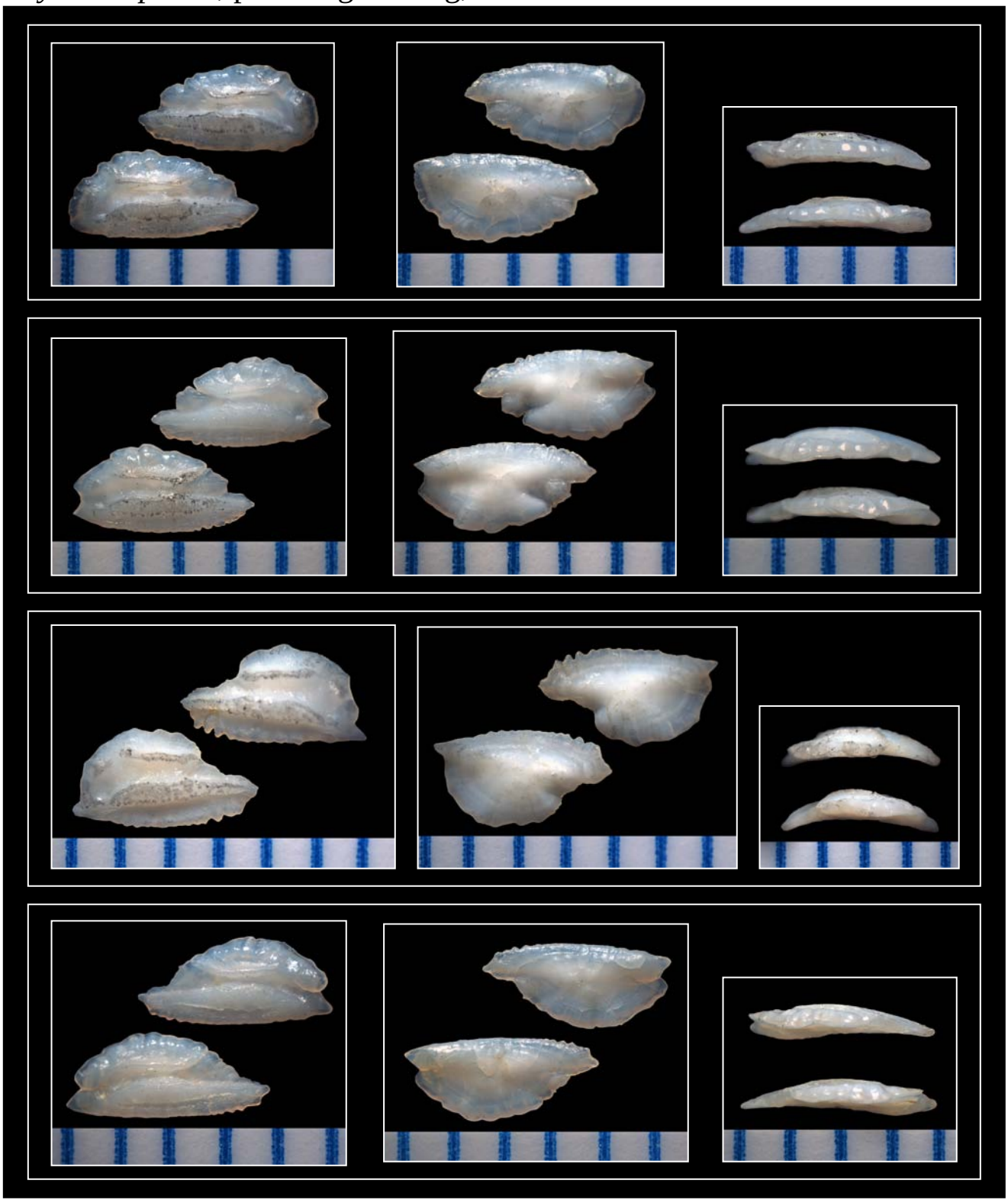
Hexagrammidae
Ophiodon elongatus, lingcod, LACM 57264-1

Hexagrammidae
Ophiodon elongatus, lingcod, LACM 57264-1

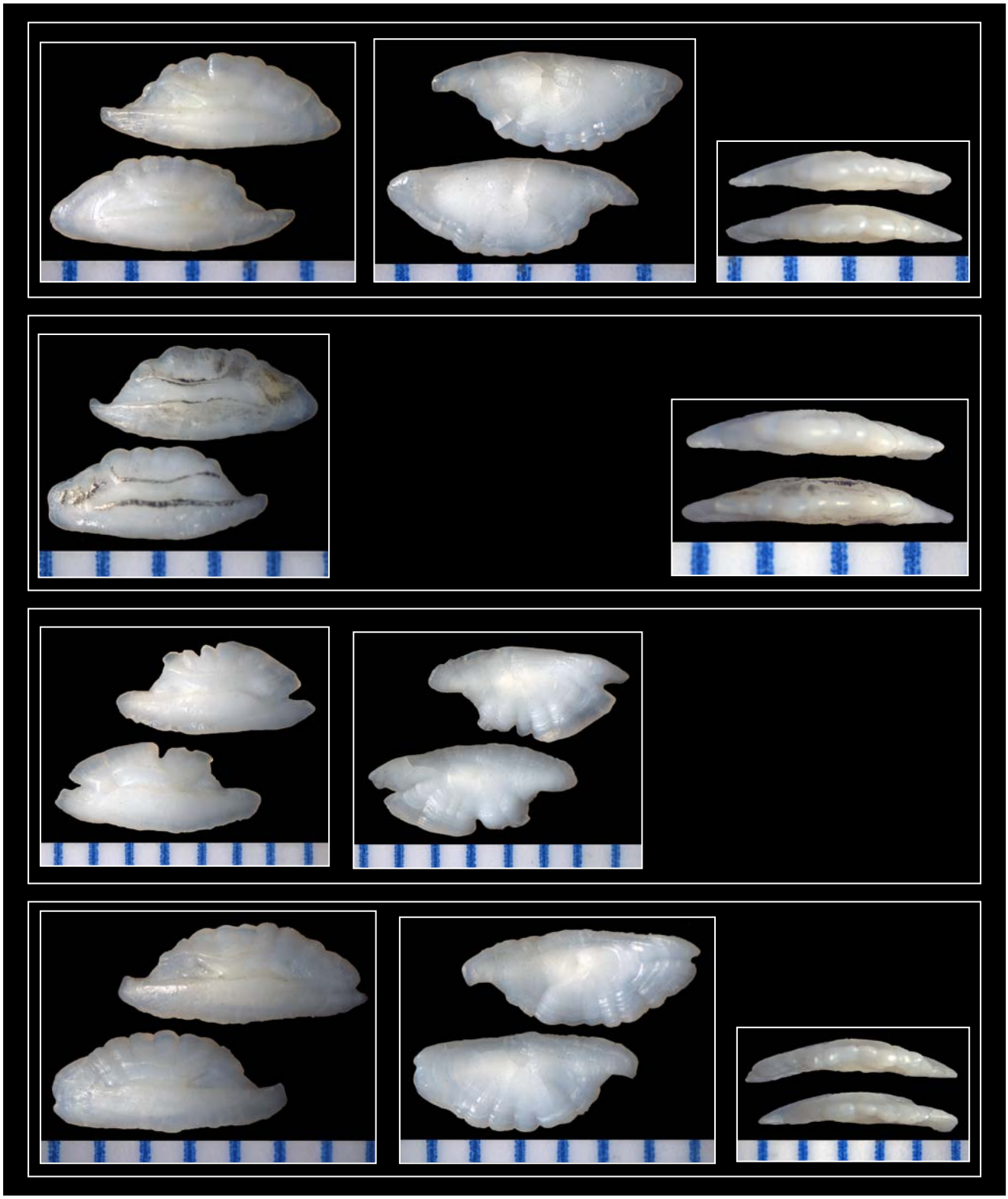
Hexagrammidae
Oxylebius pictus, painted greenling, LACM 56932-1



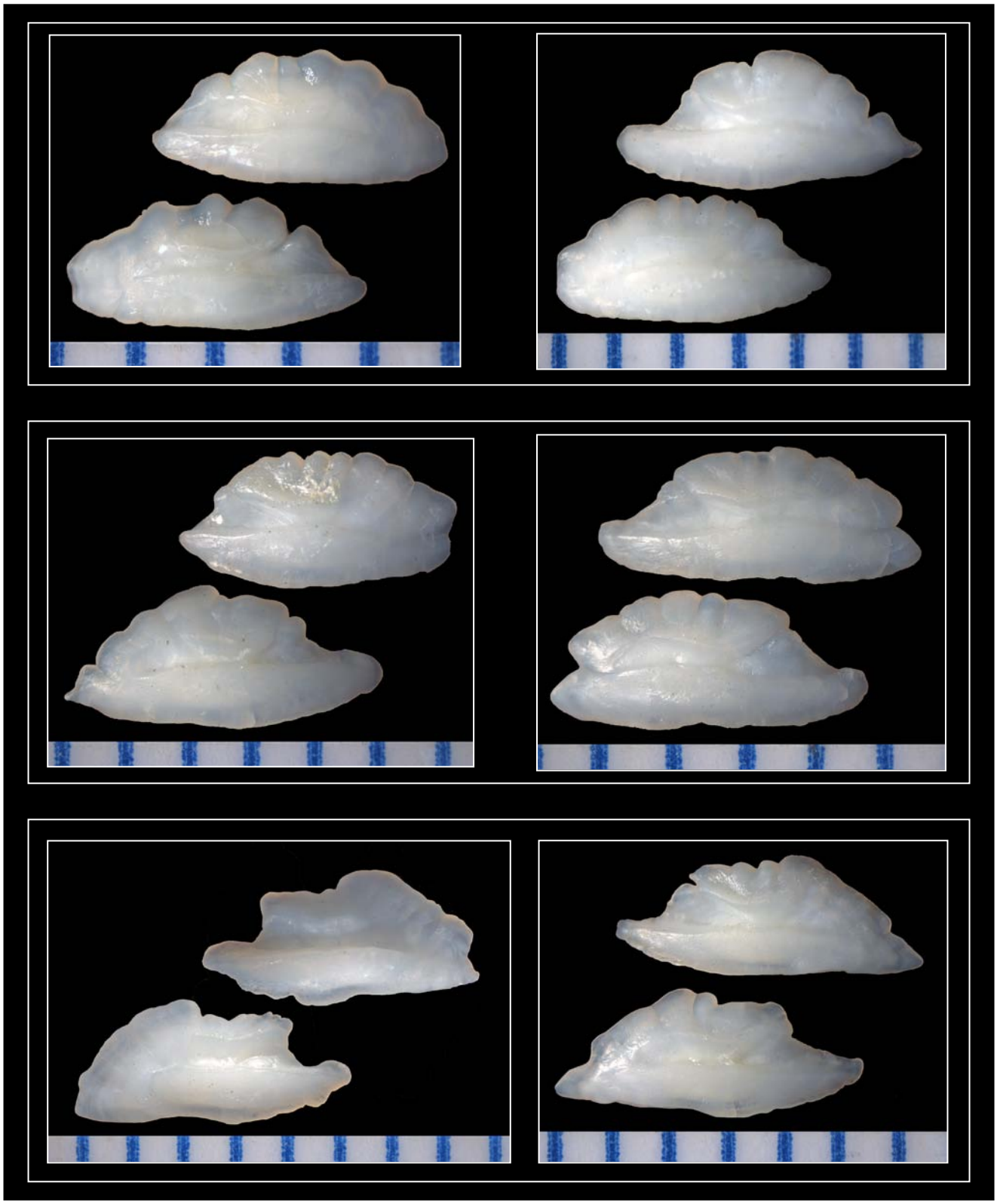
Hexagrammidae
Oxylebius pictus, painted greenling, LACM 56932-1



Hexagrammidae
Zaniolepis frenata, shortspine combfish, LACM 56653-1

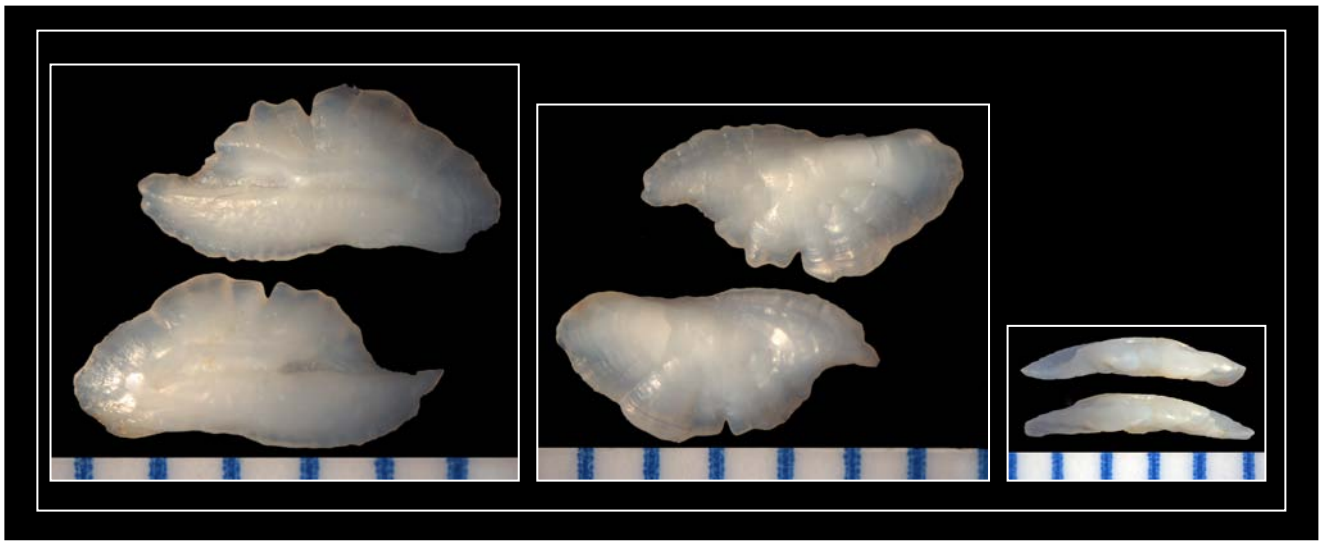


Hexagrammidae
Zaniolepis frenata, shortspine combfish, LACM 56653-1

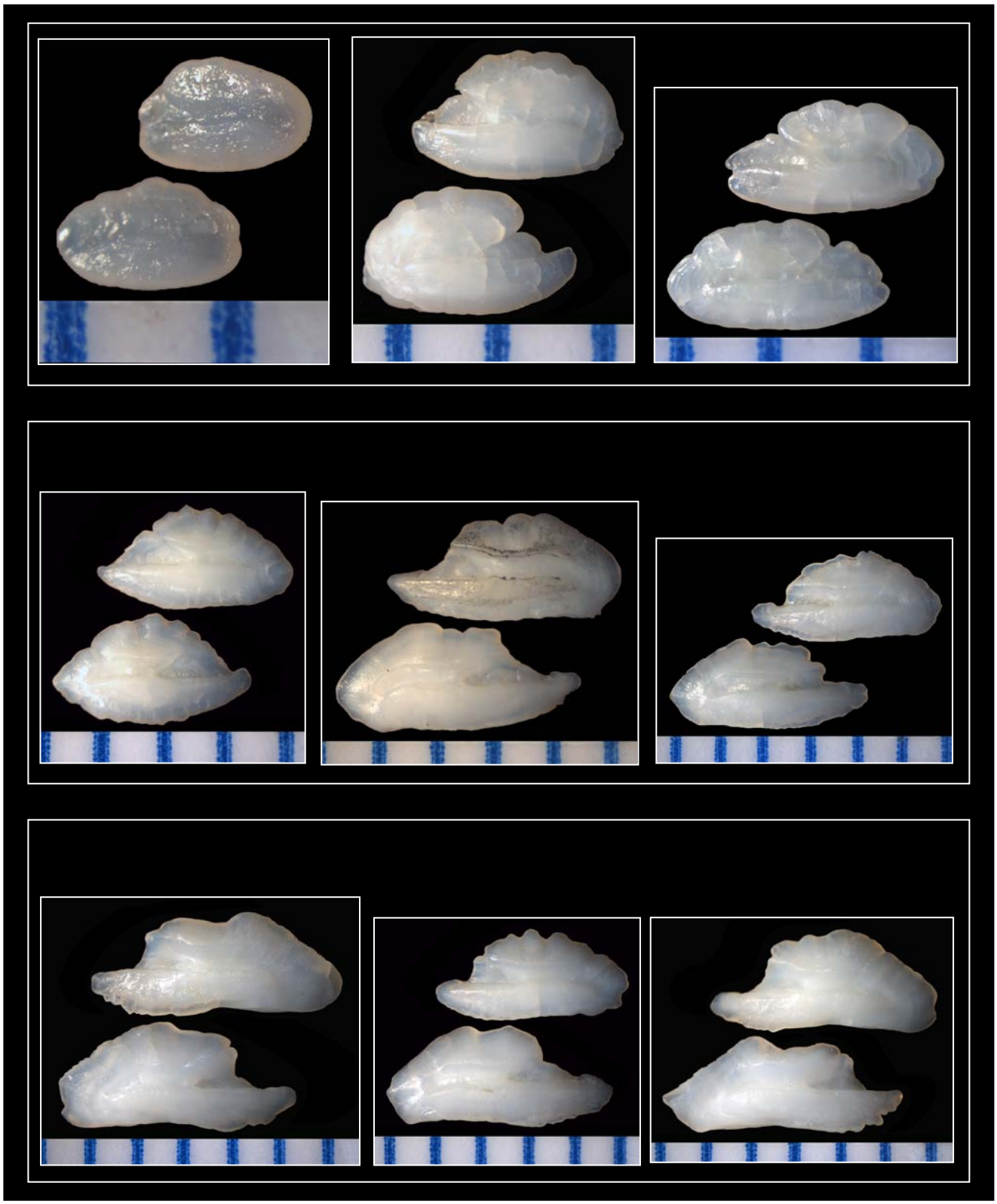


Hexagrammidae
Zaniolepis latipinnis, longspine combfish, LACM 56652-1

Hexagrammidae
Zaniolepis latipinnis, longspine combfish, LACM 56652-1



Hexagrammidae
Zaniolepis latipinnis, longspine combfish, LACM 56652-1



Cottidae

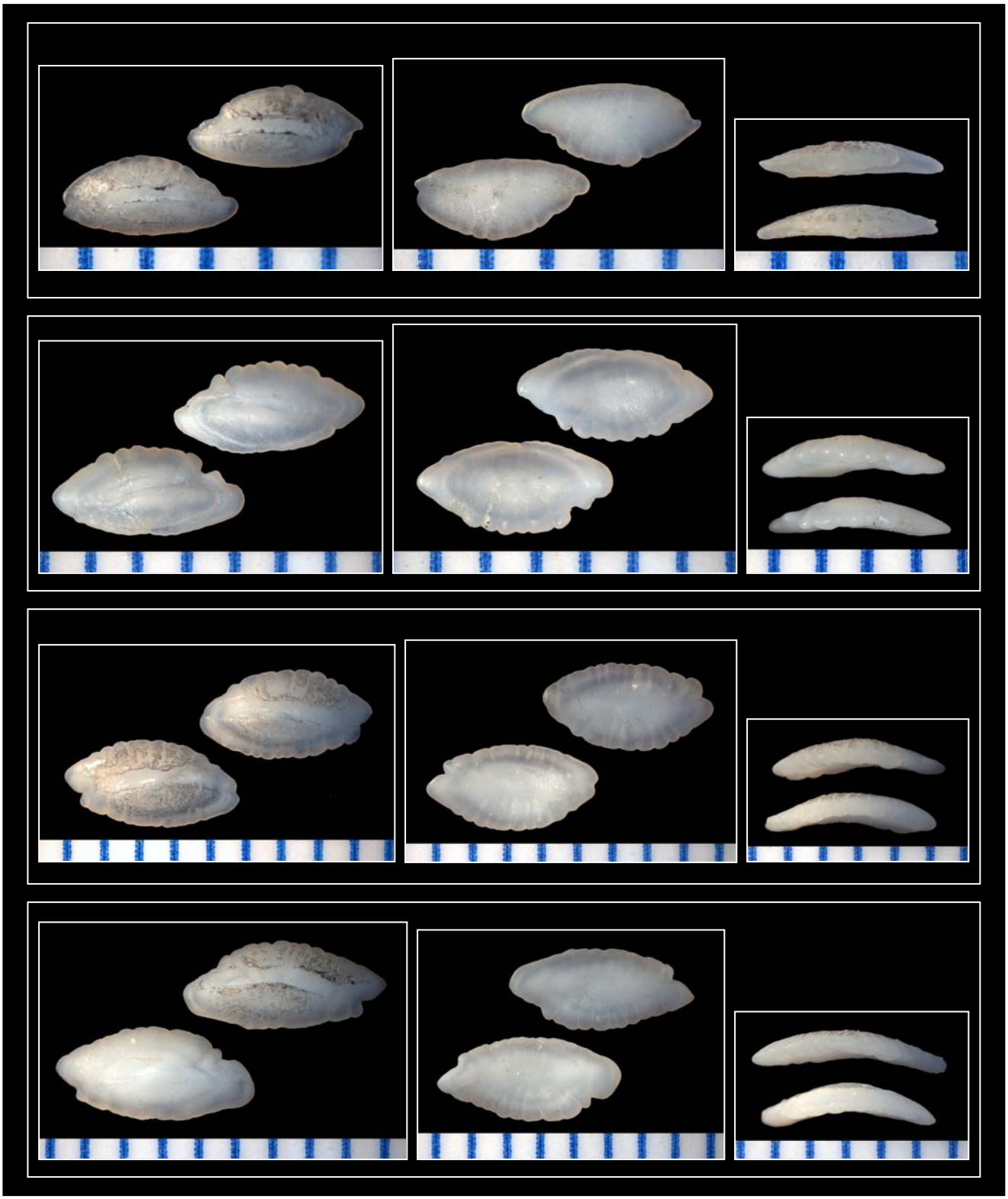
Artedius corallinus, coralline sculpin, LACM 56700-1

Cottidae

Artedius corallinus, coralline sculpin, LACM 56700-1

Cottidae

Artedius notospilotus, bonyhead sculpin, LACM 56709-1



Cottidae

Artedius notospilotus, bonyhead sculpin, LACM 56709-1

Cottidae

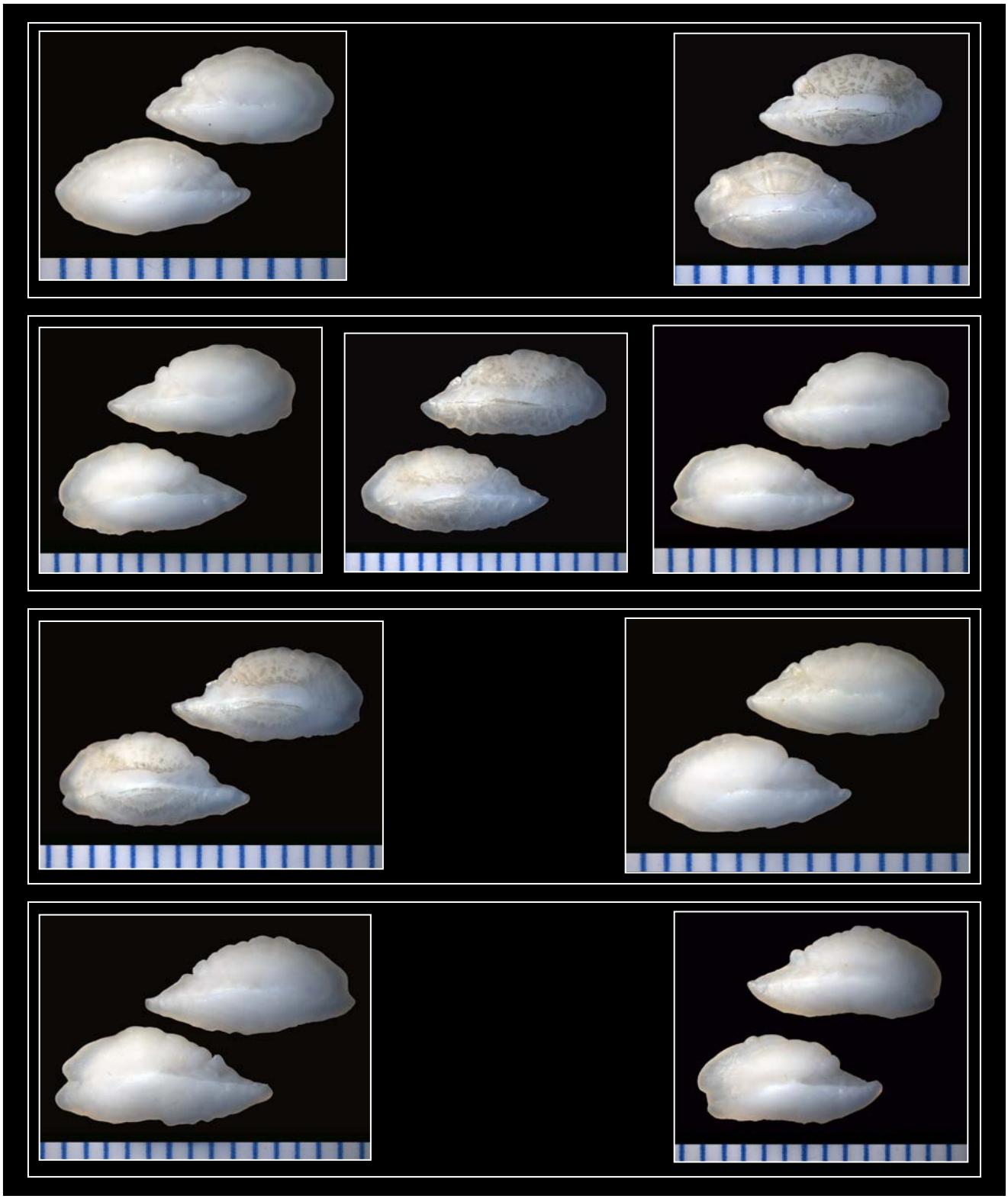
Artedius notospilotus, bonyhead sculpin, LACM 56709-1

Cottidae

Icelinus filamentosus, threadfin sculpin, LACM 56668-1

Cottidae

Icelinus filamentosus, threadfin sculpin, LACM 56668-1

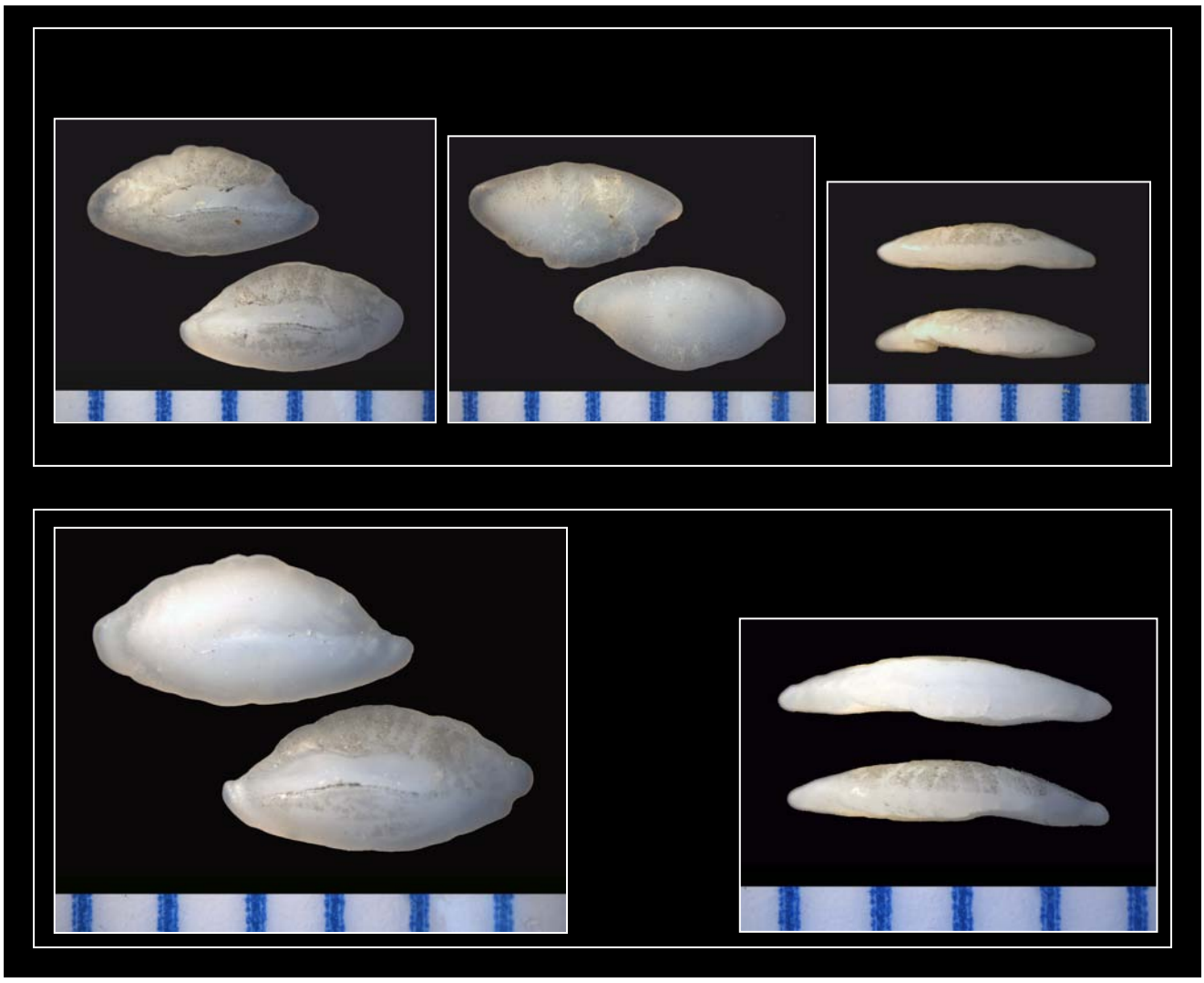


Cottidae
Icelinus fimbriatus, fringed sculpin, LACM 56674-1

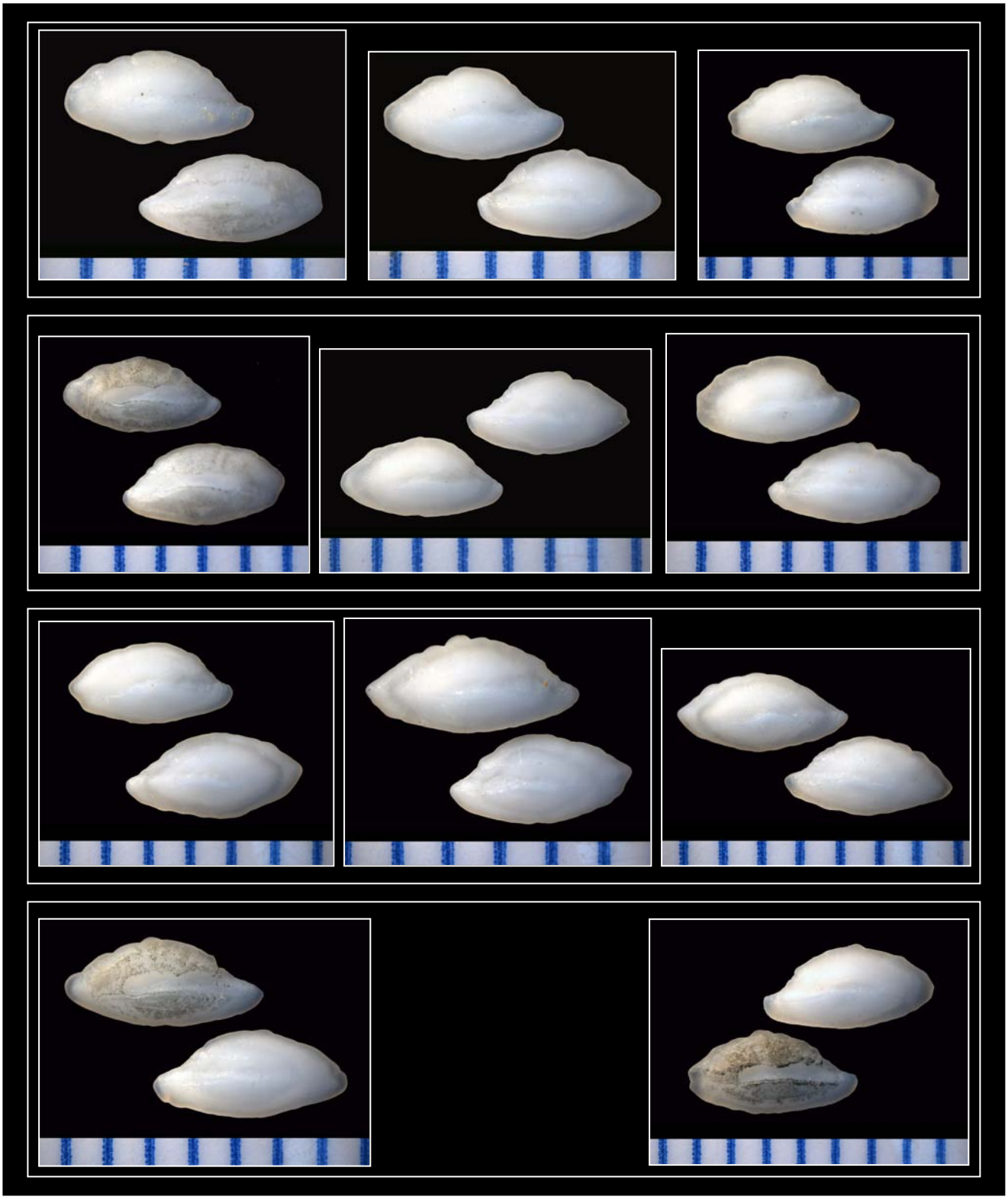
Cottidae

Icelinus fimbriatus, fringed sculpin, LACM 56674-1

Cottidae
Icelinus tenuis, spotfin sculpin, LACM 56669-1

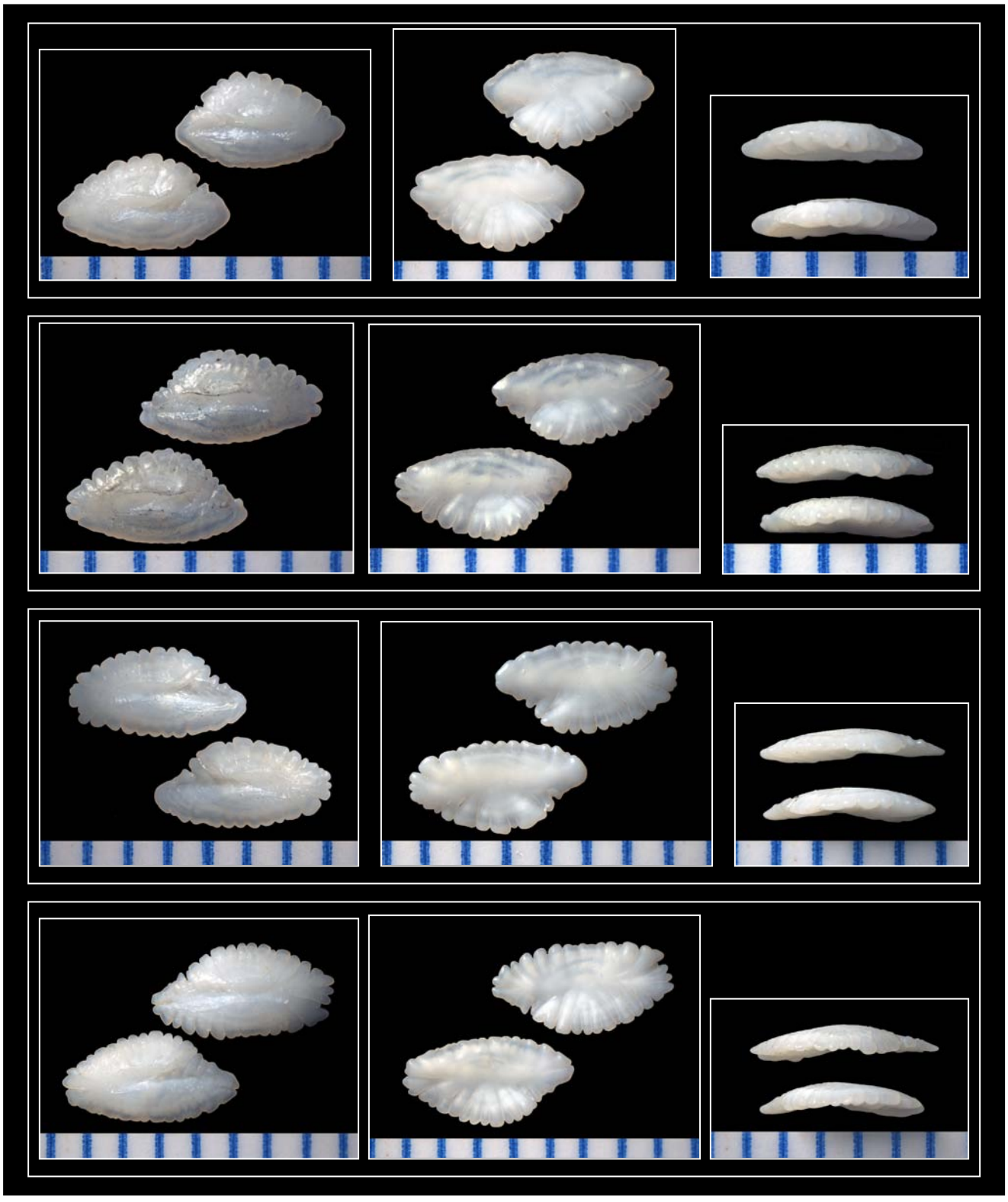


Cottidae
Icelinus tenuis, spotfin sculpin, LACM 56669-1



Cottidae

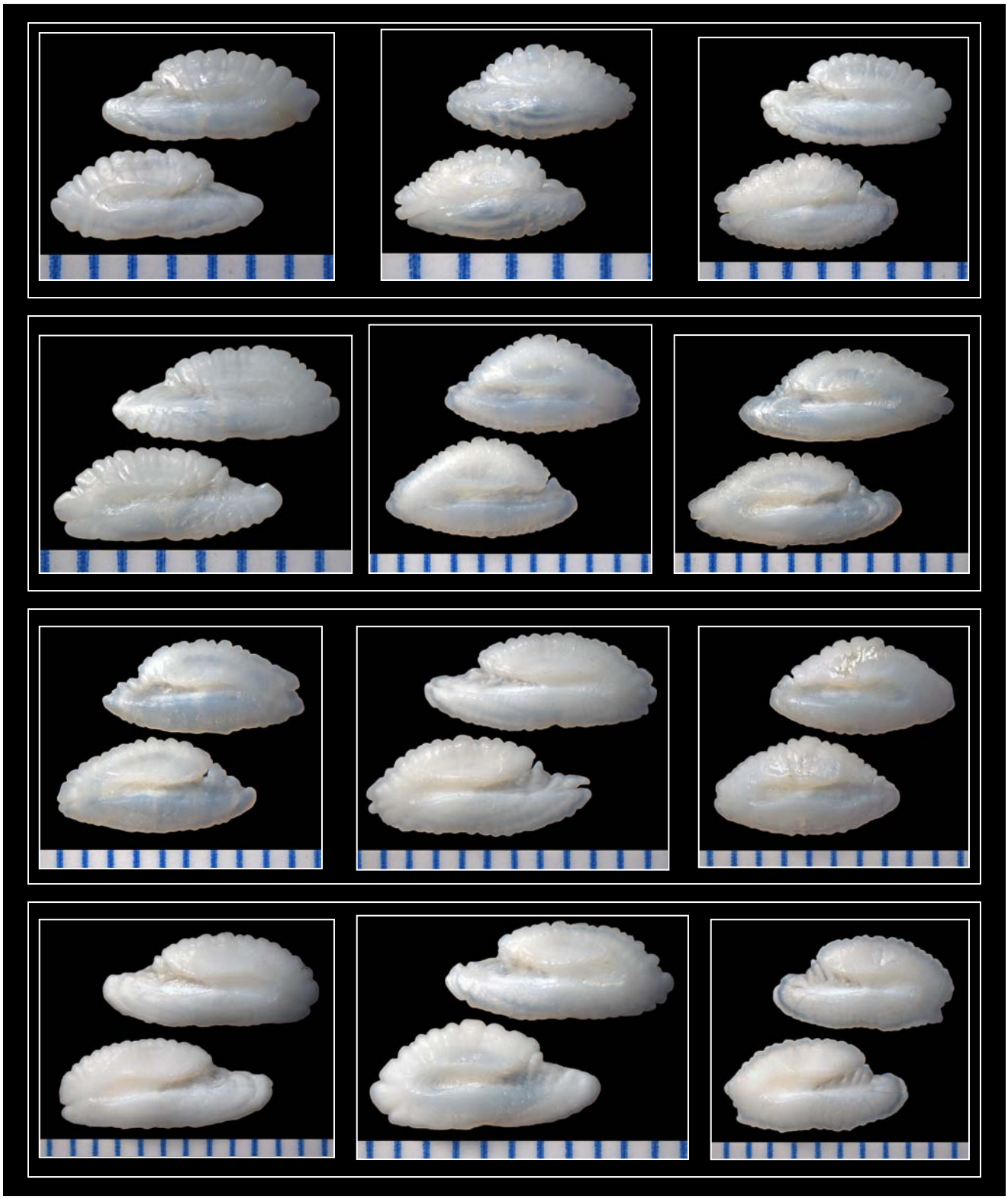
Leptocottus armatus, staghorn sculpin, LACM 56706-1



Cottidae
Leptocottus armatus, staghorn sculpin, LACM 56706-1

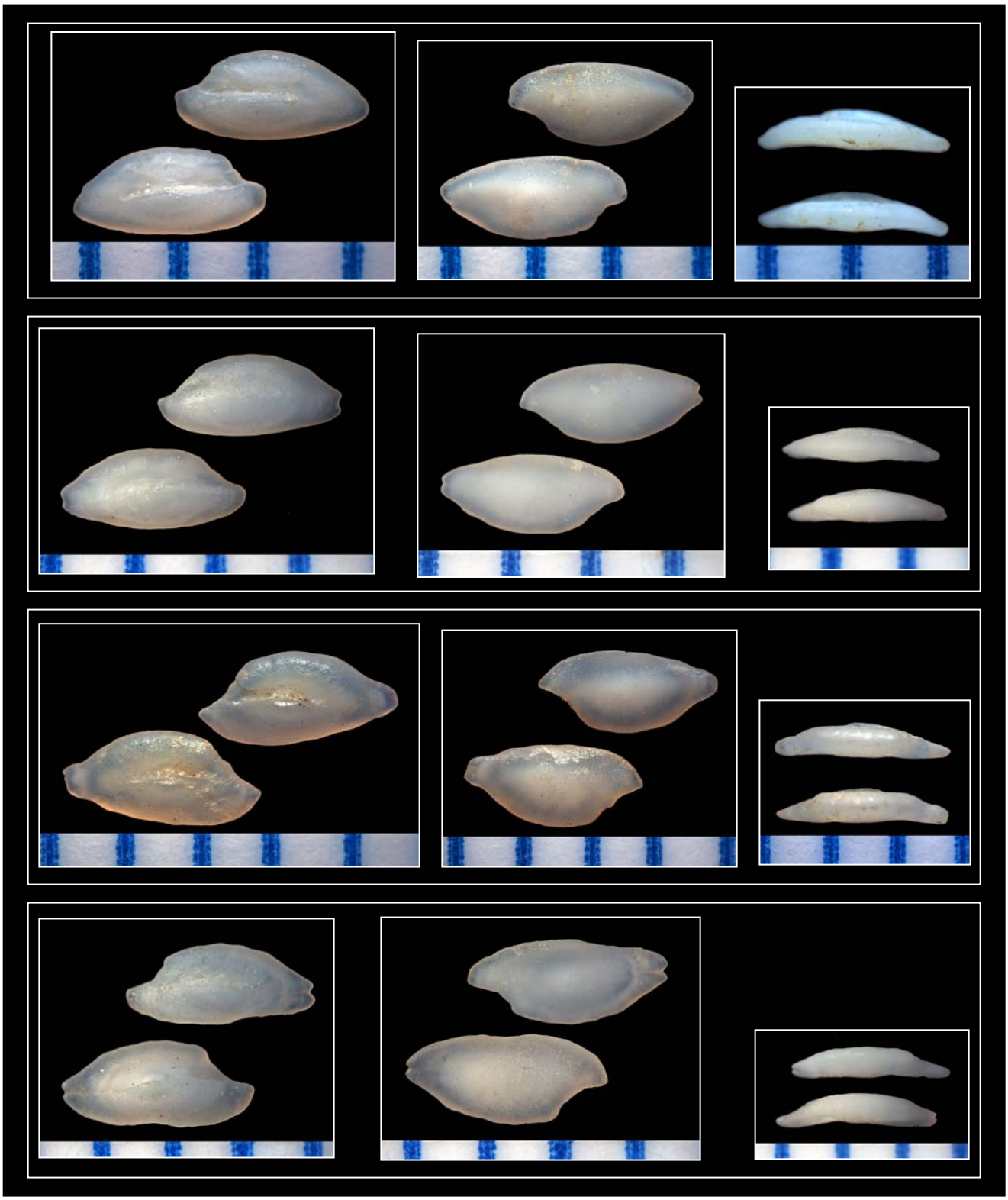
Cottidae

Leptocottus armatus, staghorn sculpin, LACM 56706-1



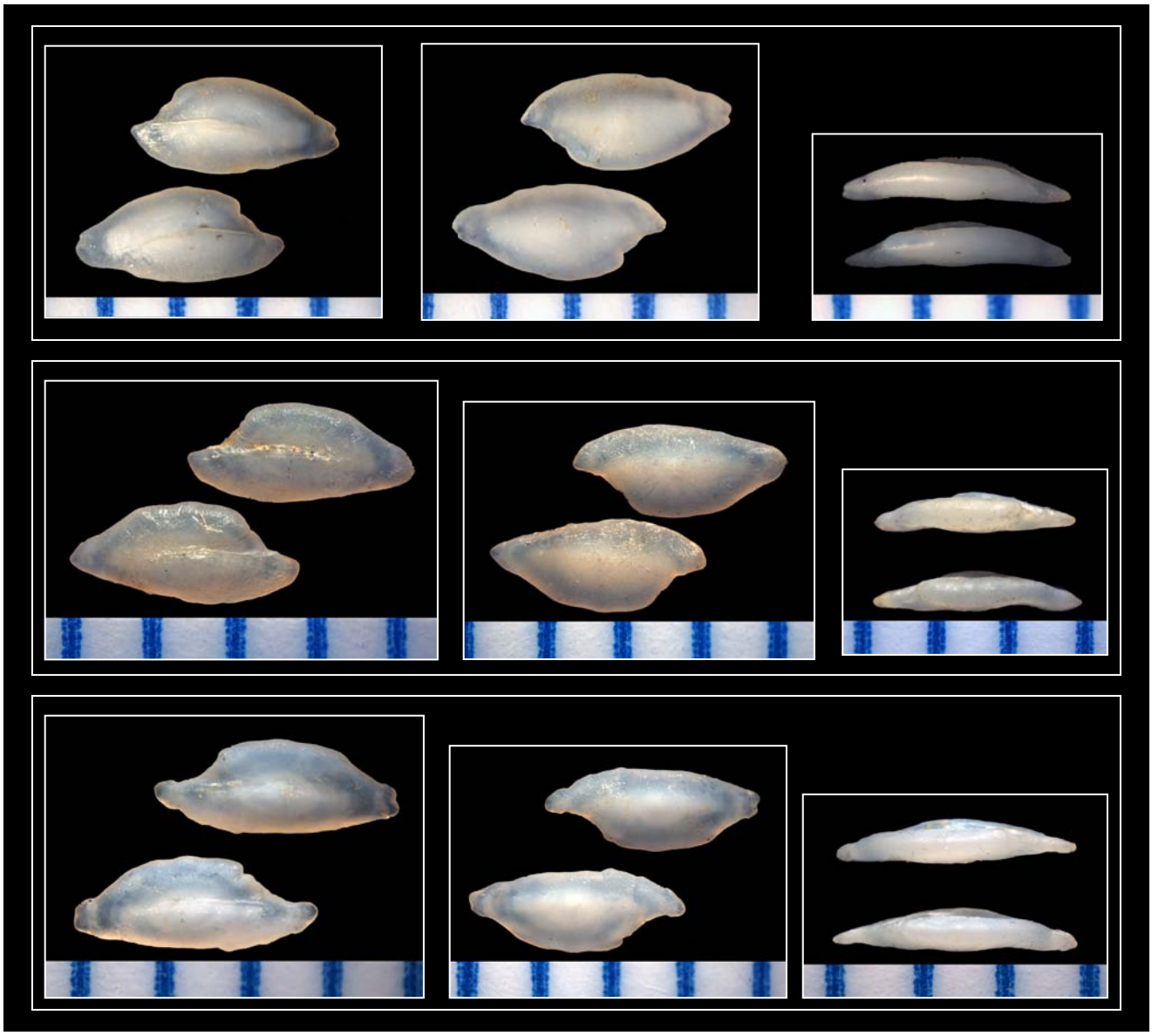
Cottidae

Orthonopias triacis, snubnose sculpin, LACM 56701-1



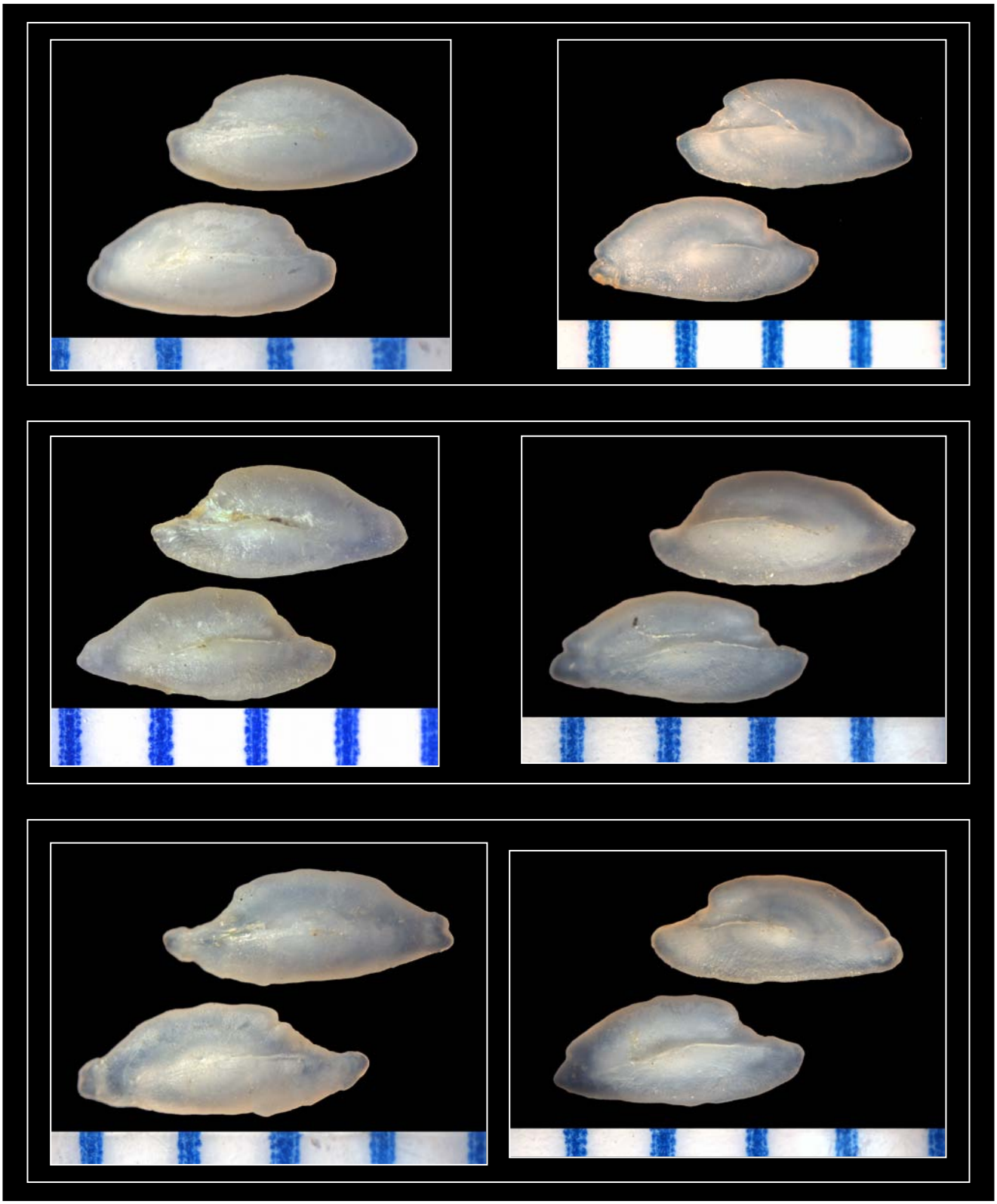
Cottidae

Orthonopias triacis, snubnose sculpin, LACM 56701-1



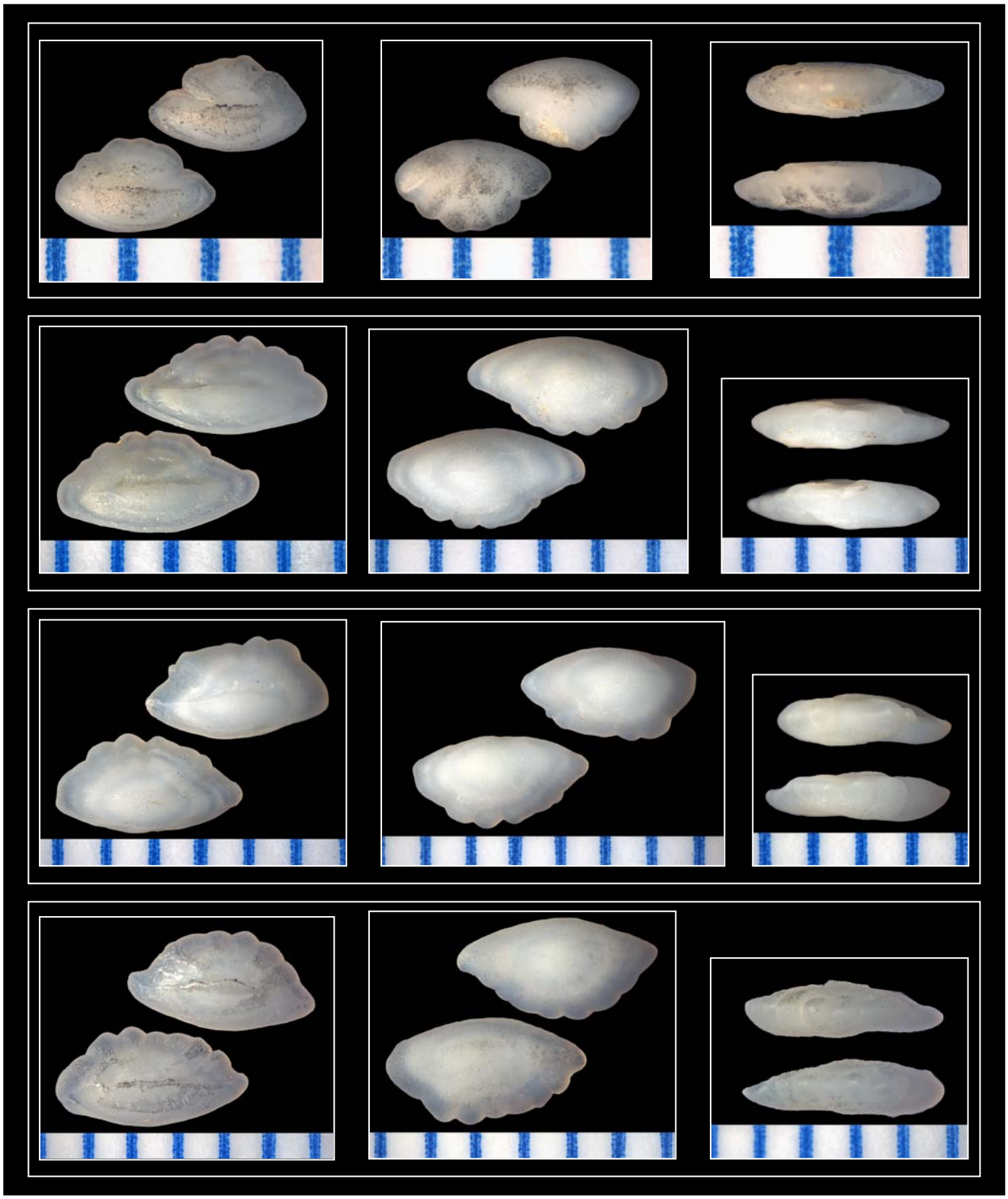
Cottidae

Orthonopias triacis, snubnose sculpin, LACM 56701-1

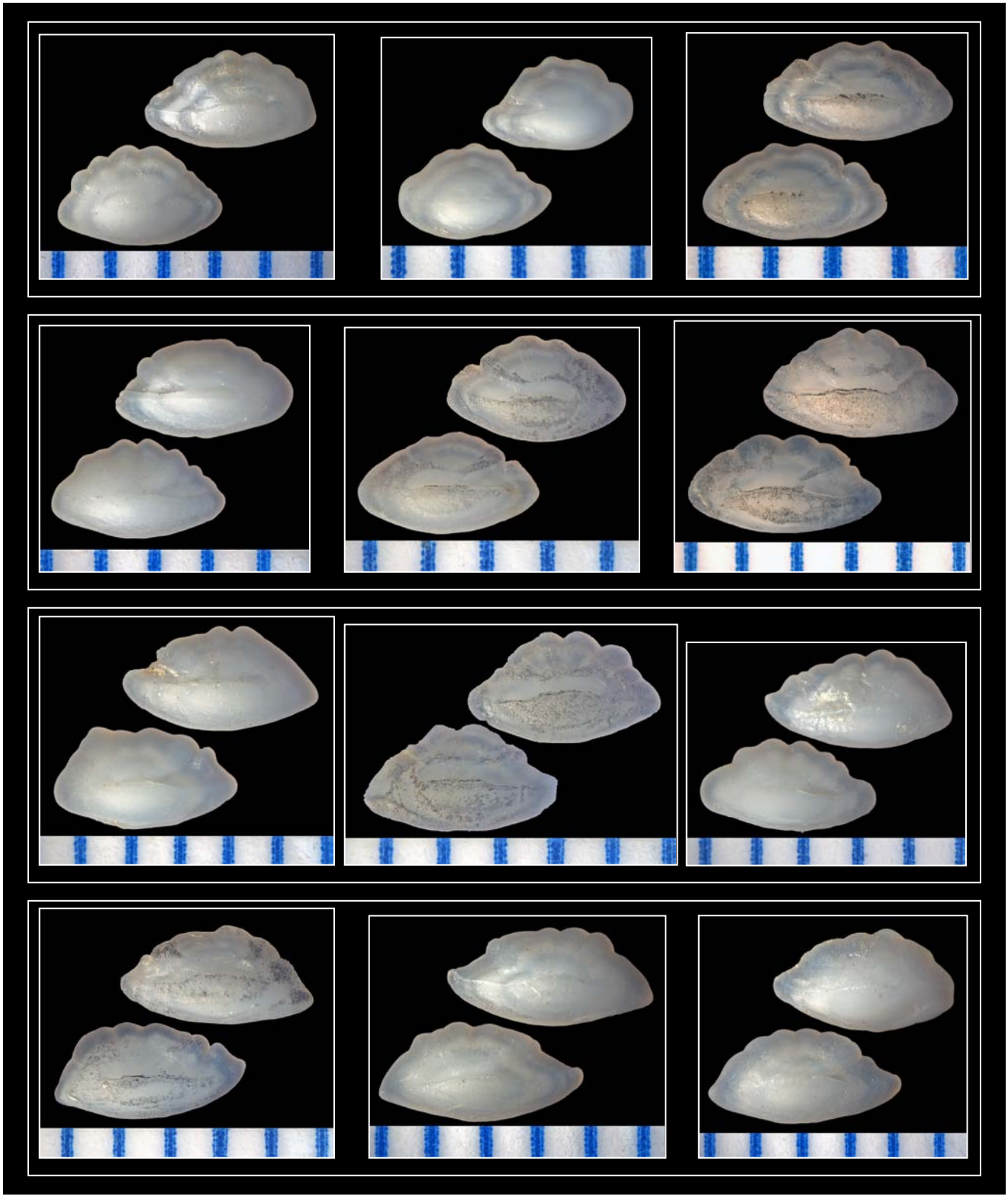


Cottidae

Radulinus asprellus, slim sculpin, LACM 56703-1

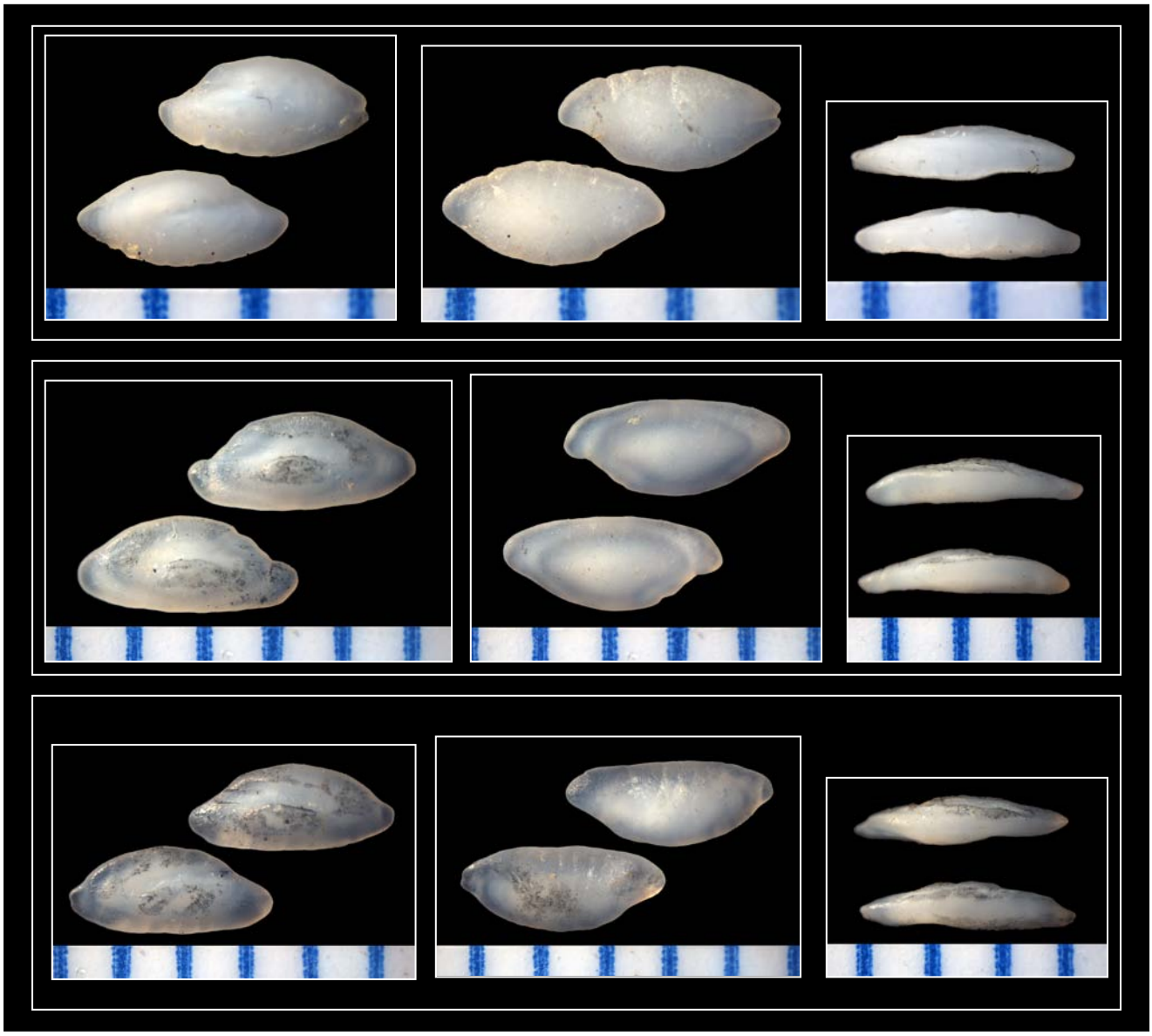


Cottidae
Radulinus asprellus, slim sculpin, LACM 56703-1

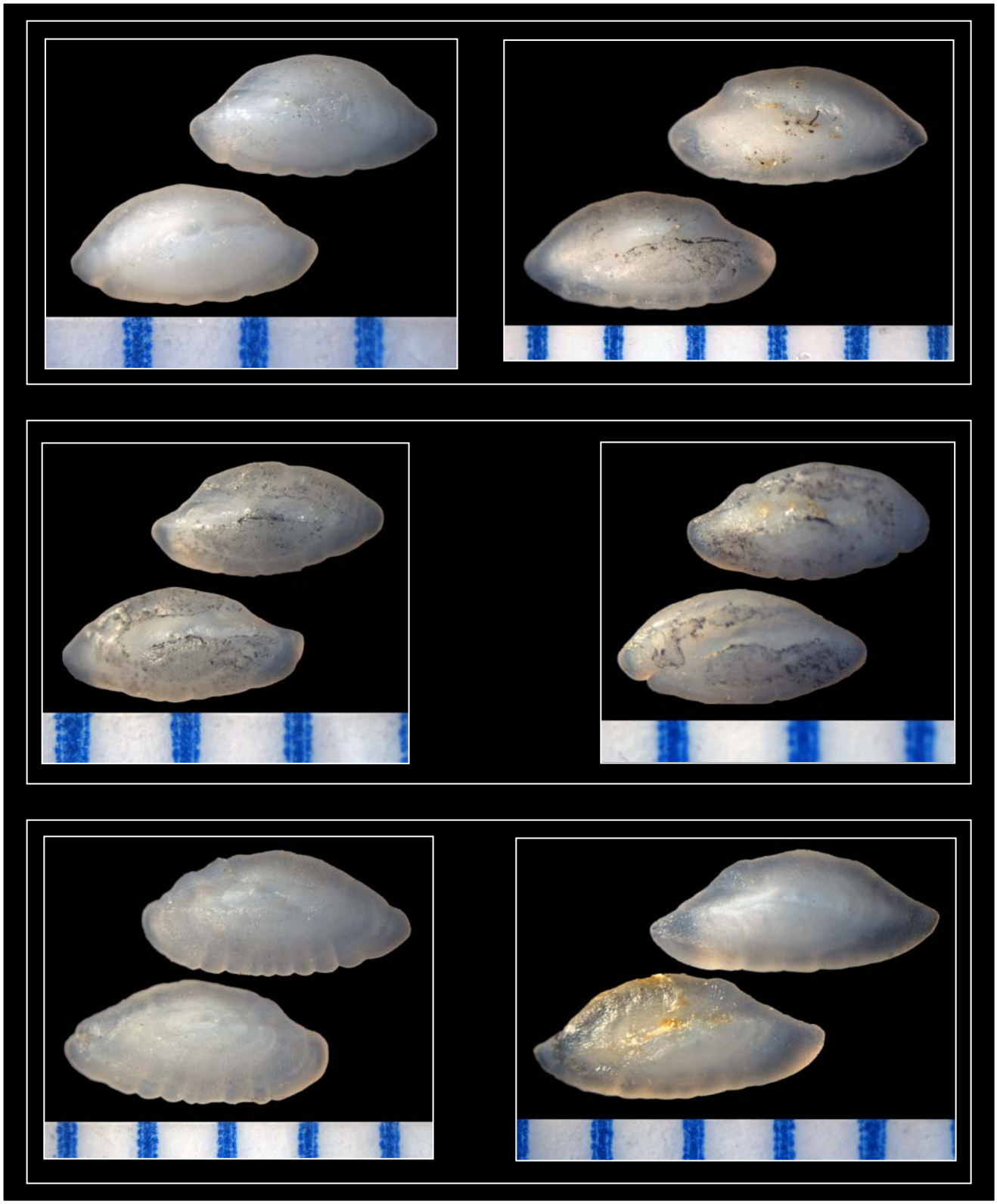


Cottidae

Ruscarius creaseri, roughcheek sculpin, LACM 56702-1



Cottidae
Ruscarius creaseri, roughcheek sculpin, LACM 56702-1



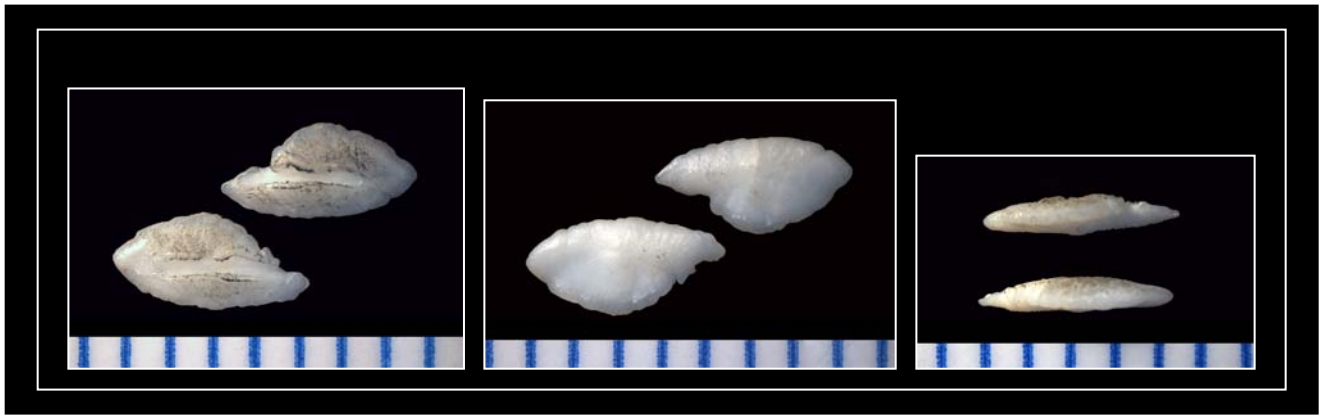
Agonidae
Xeneretmus ritteri, stripefin poacher, LACM 56682-1

Agonidae
Xeneretmus ritteri, stripefin poacher, LACM 56682-1

Agonidae

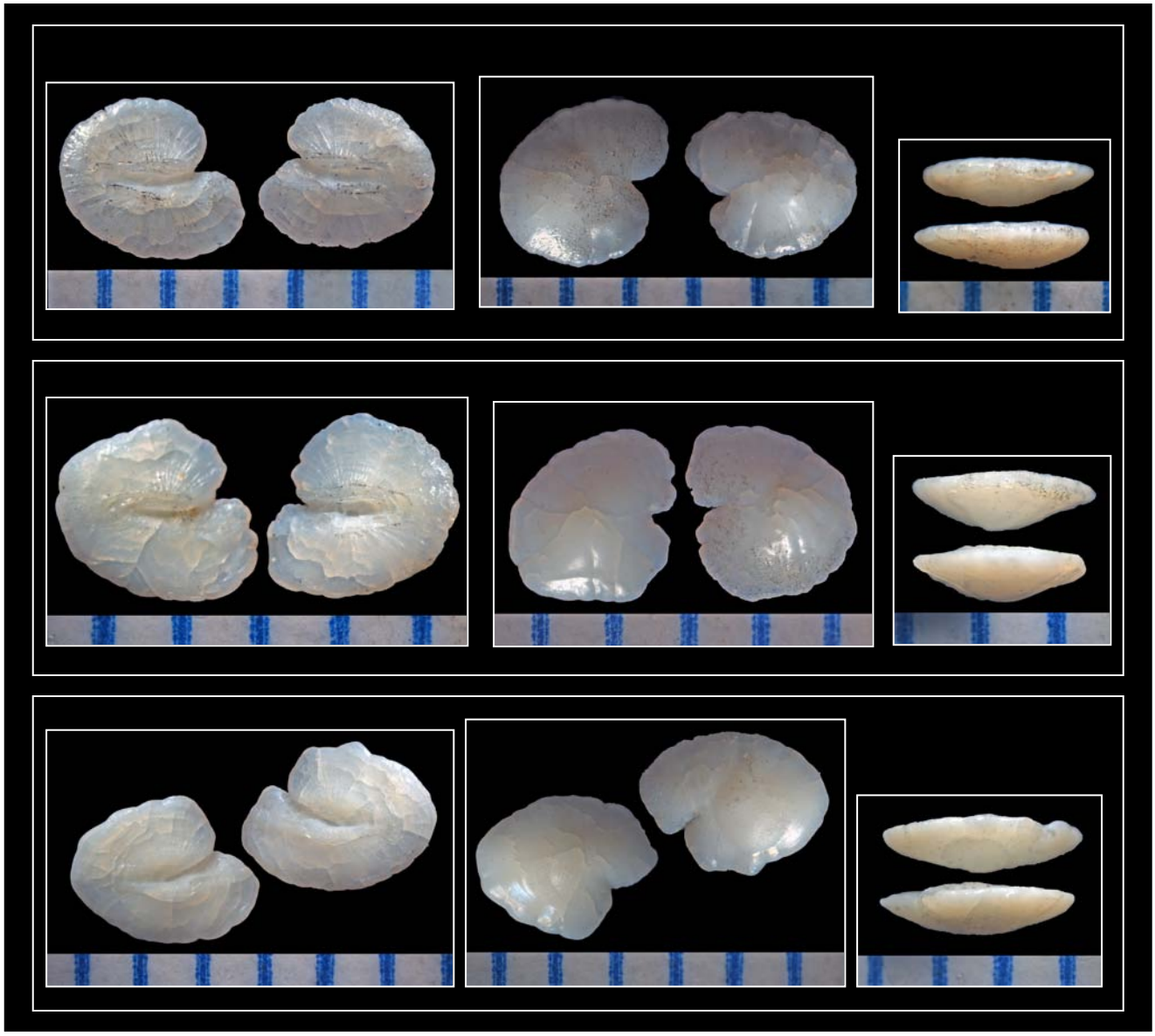
Xeneretmus triacanthus, bluespotted poacher, LACM 56679-1

Agonidae
Xeneretmus triacanthus, bluespotted poacher, LACM 56679-1



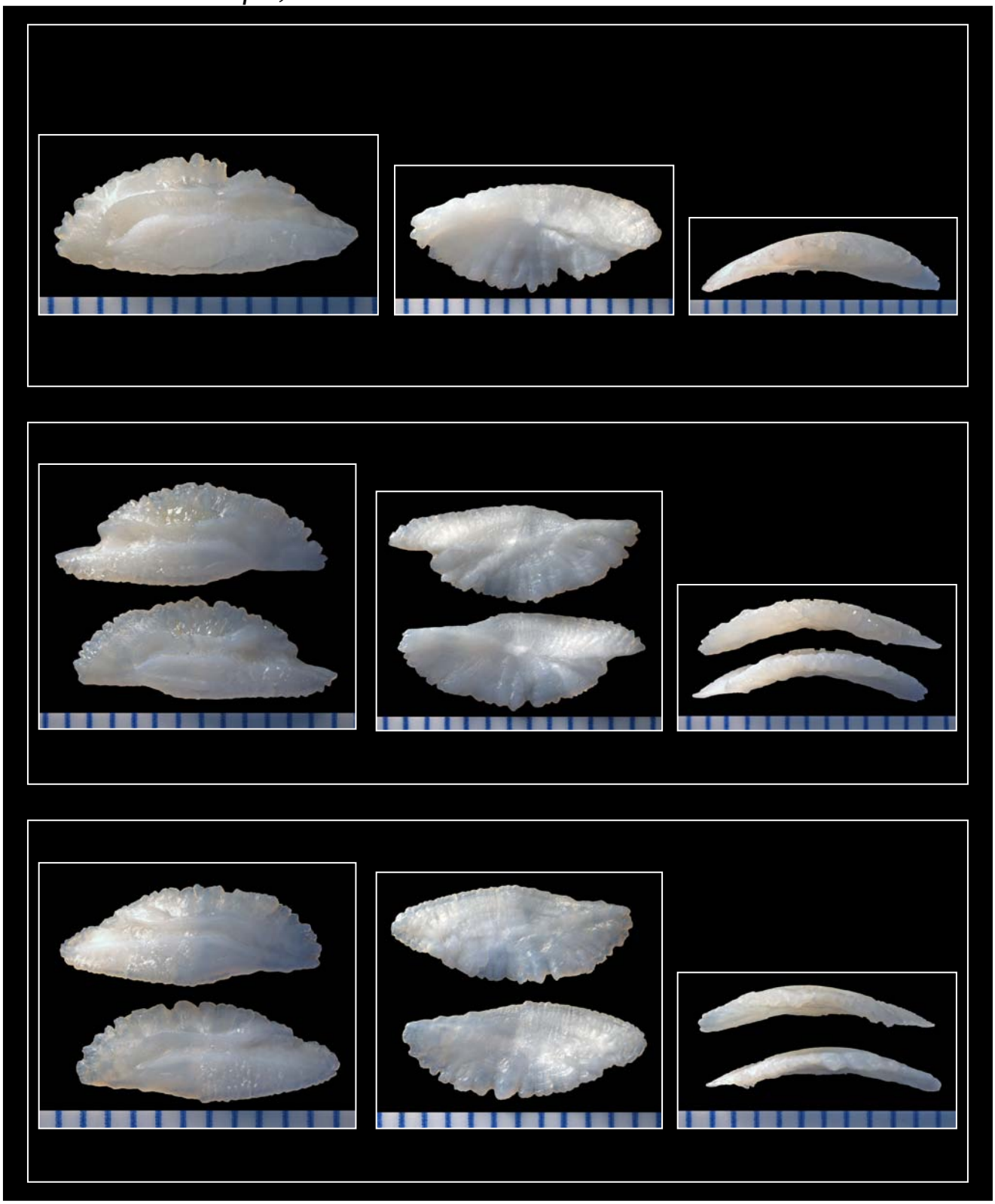
Agonidae
Xeneretmus triacanthus, bluespotted poacher, LACM 56679-1

Liparidae
Careproctus melanurus, blacktail snailfish, LACM 56719-1

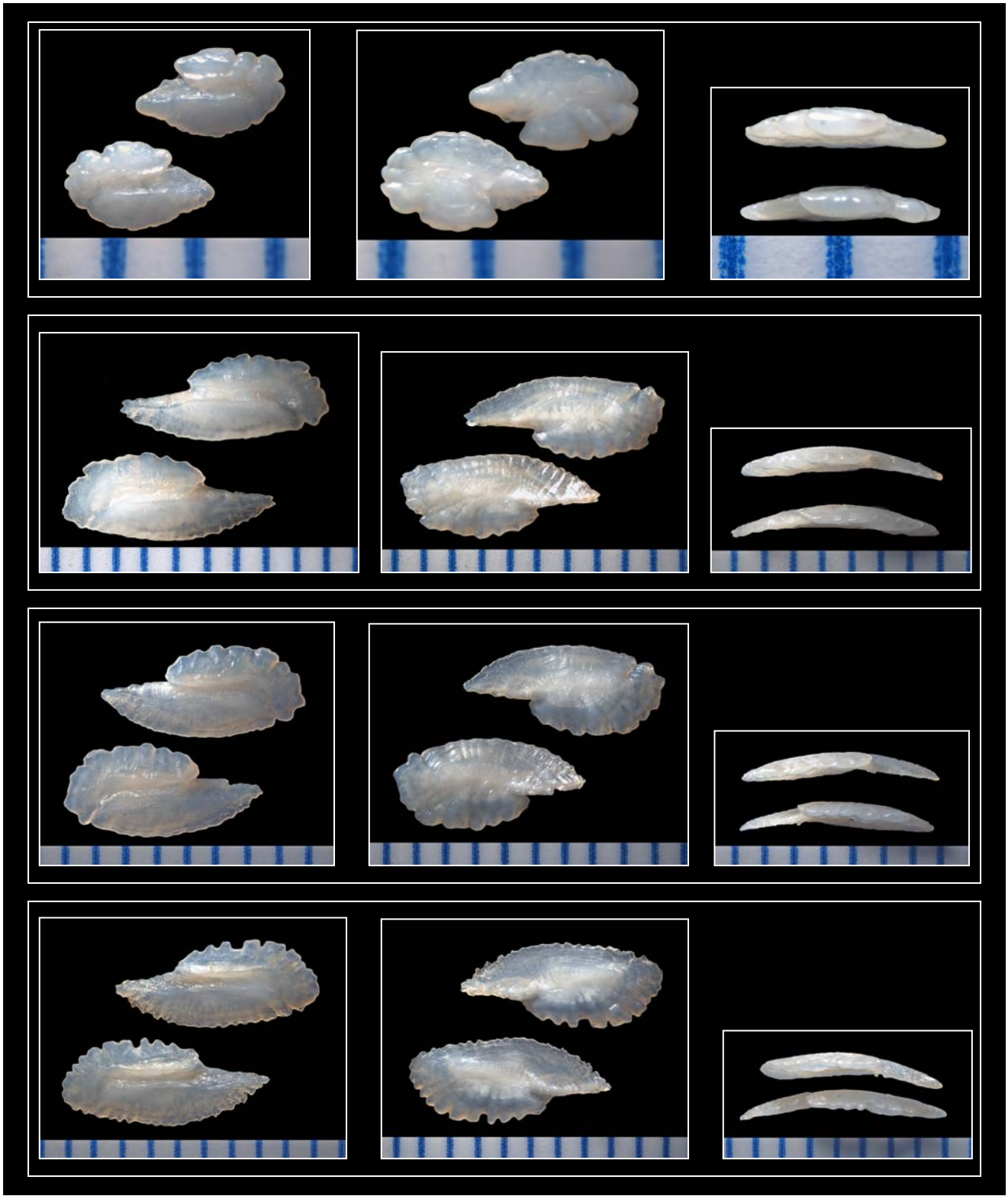


Serranidae
Paralabrax clathratus, kelp bass

Serranidae
Paralabrax nebulifer, barred sand bass



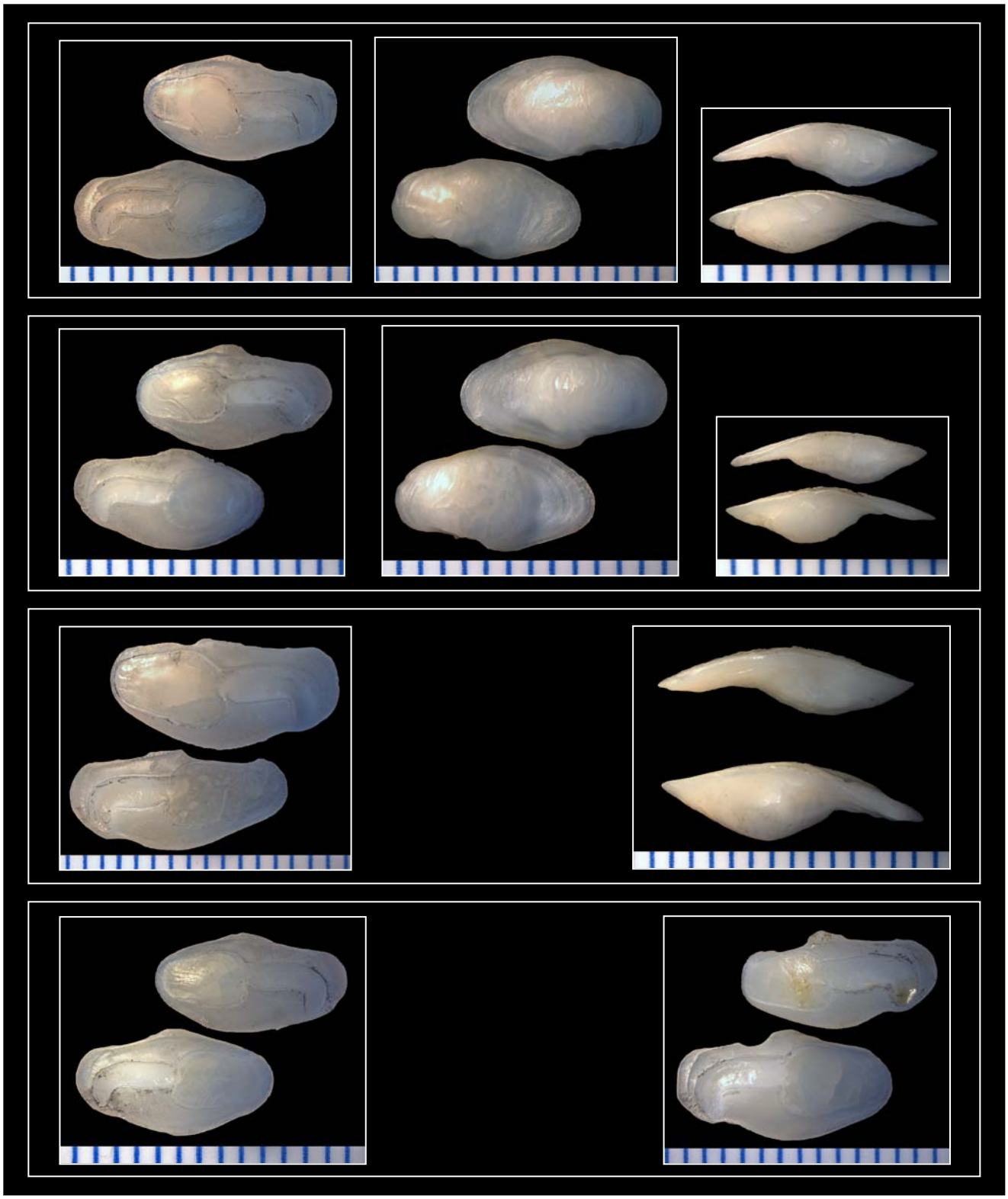
Carangidae
Trachurus symmetricus, jack mackerel, LACM 56598-1



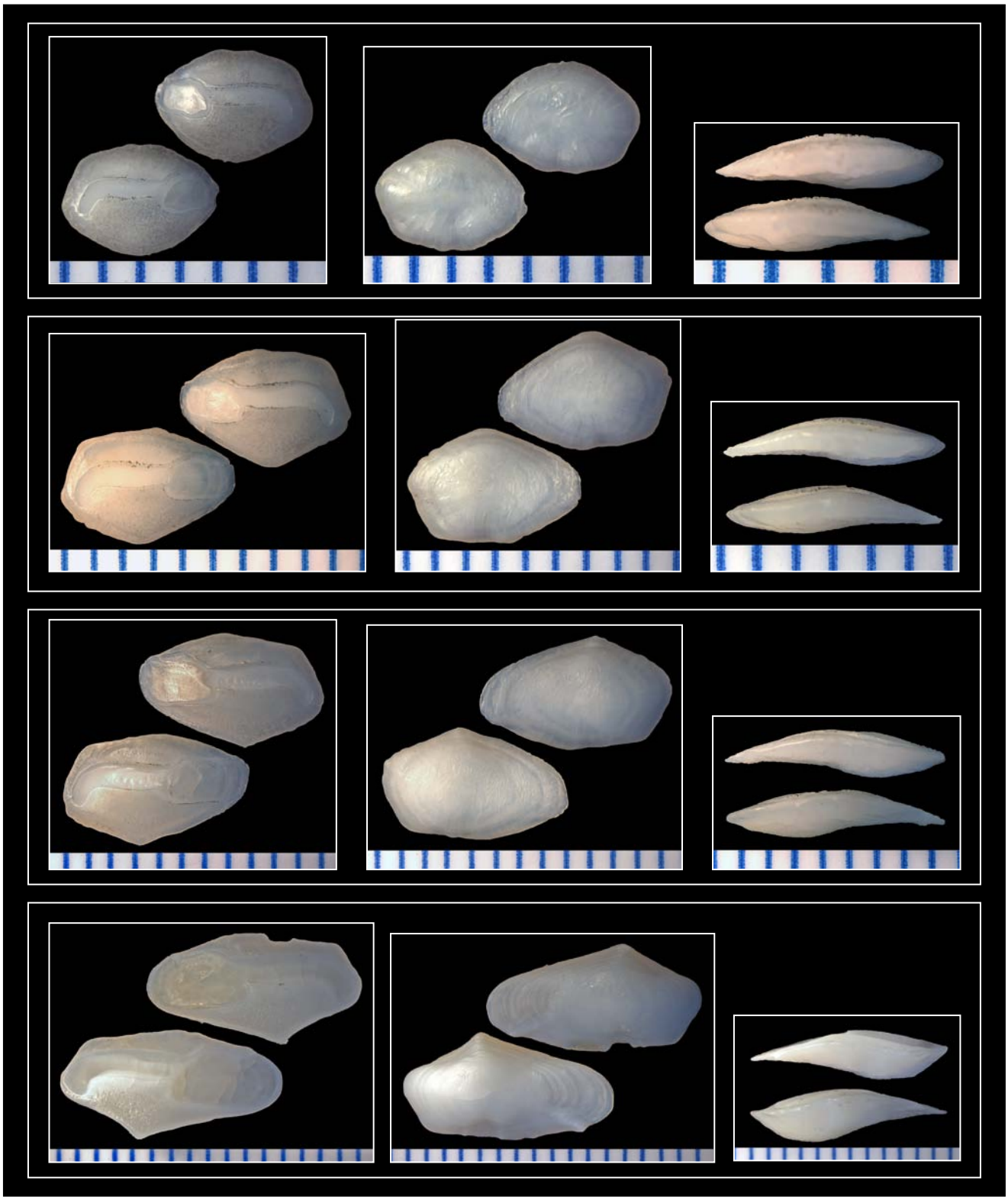
Carangidae
Trachurus symmetricus, jack mackerel, LACM 56598-1

Sciaenidae

Genyonemus lineatus, white croaker, LACM 56673-1



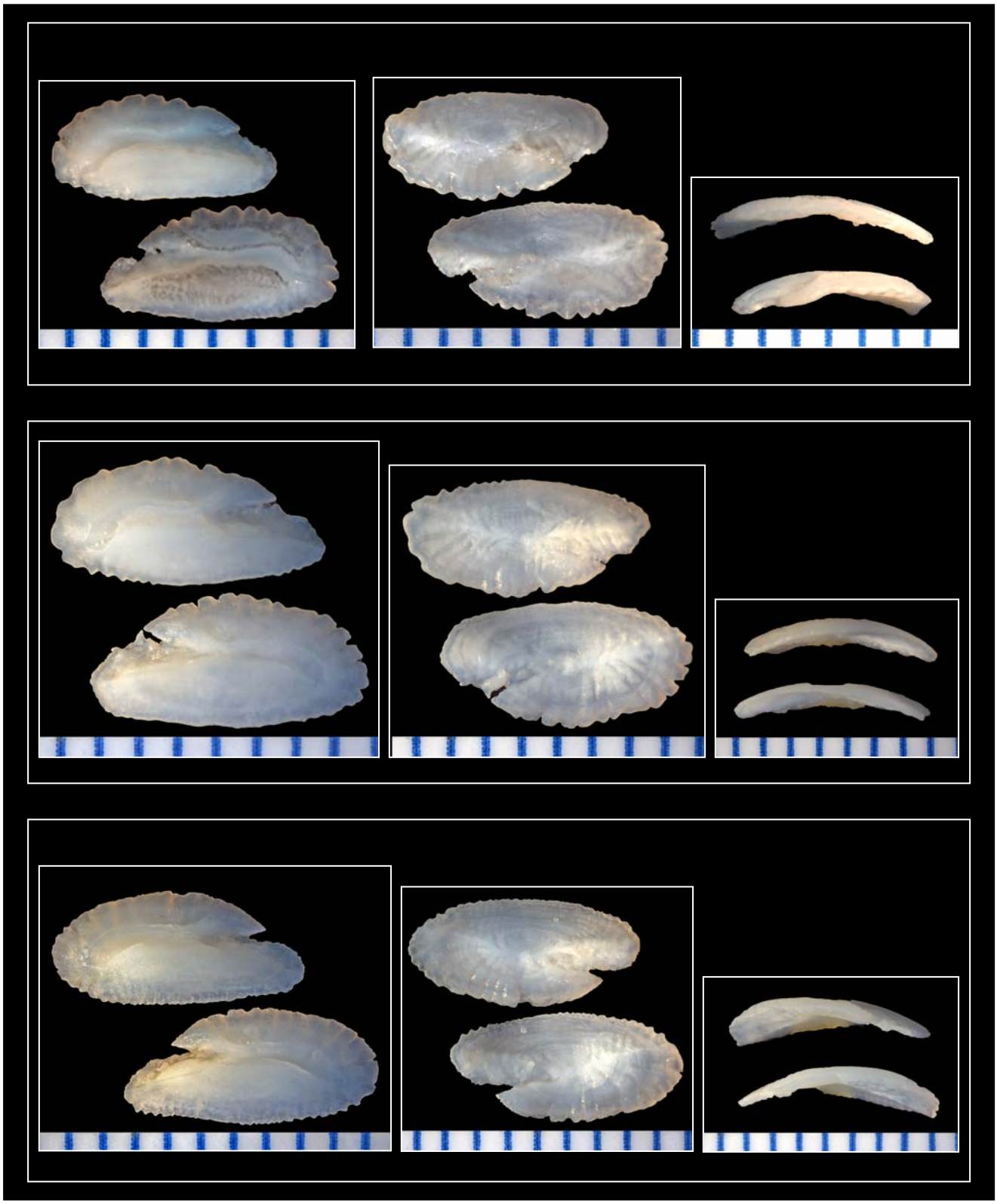
Sciaenidae
Seriphus politus, queenfish, LACM 56696-1



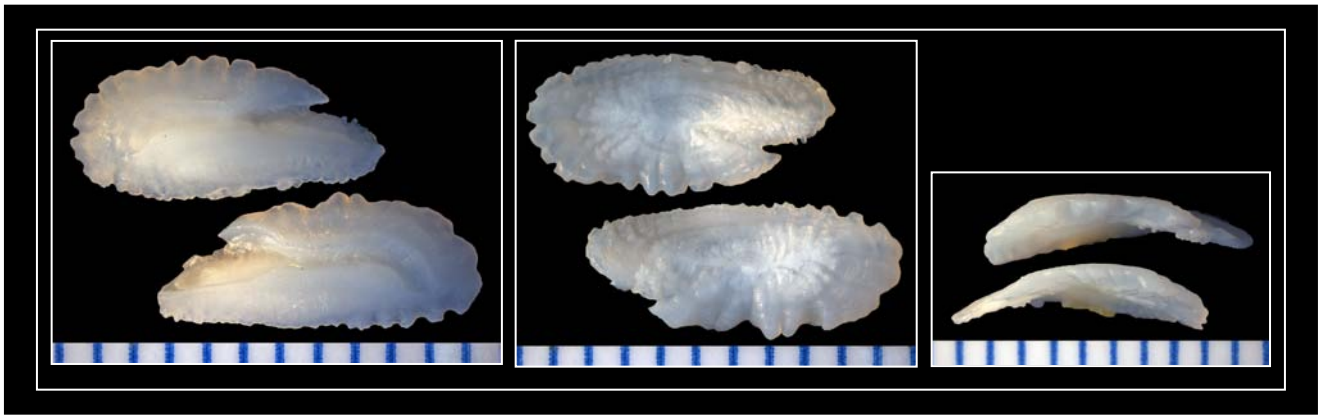
Kyphosidae
Girella nigricans, opaleye, LACM 56686-1

Kyphosidae
Girella nigricans, opaleye, LACM 56686-1

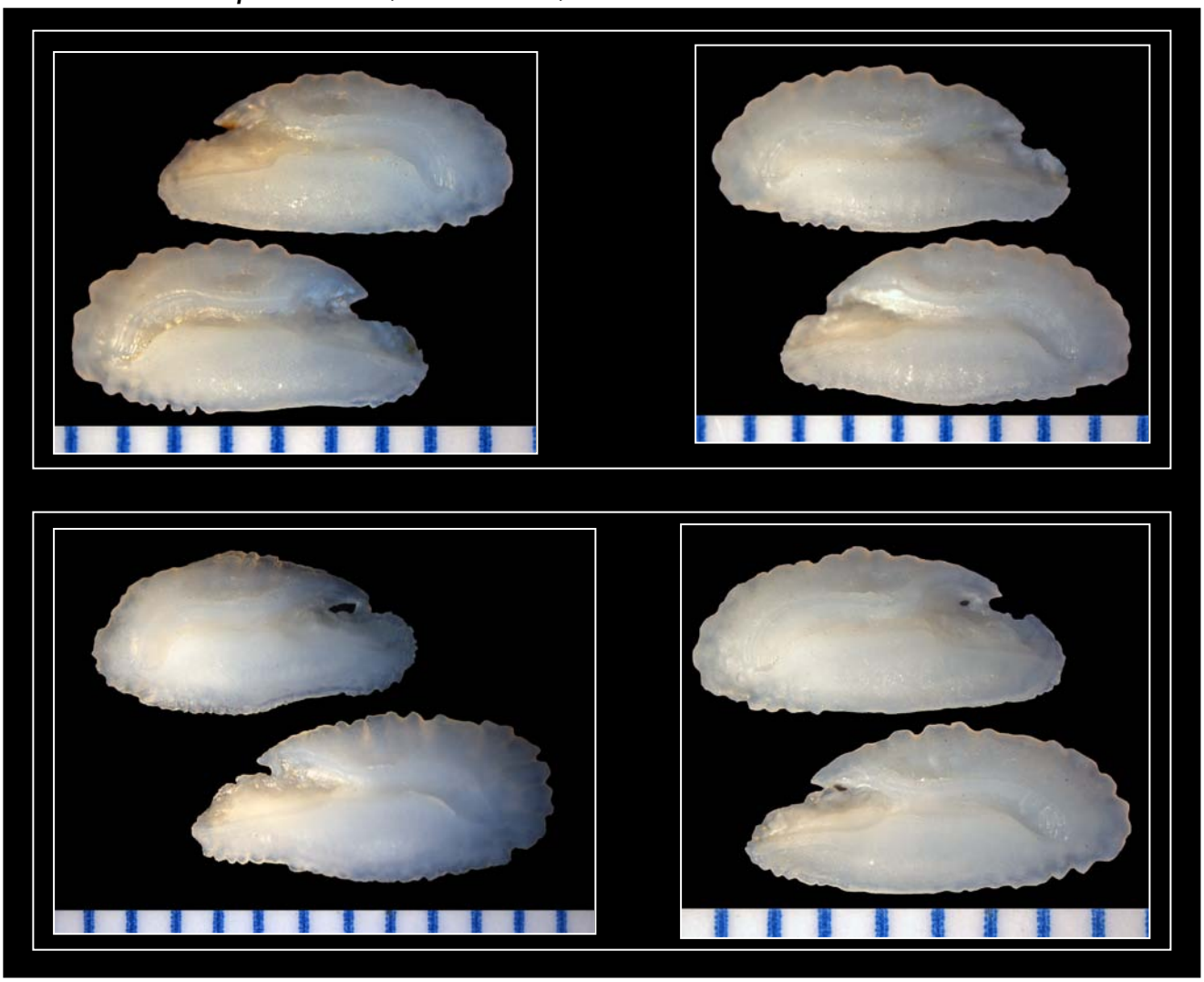
Kyphosidae
Medialuna californiensis, halfmoon, LACM 56660-1



Kyphosidae
Medialuna californiensis, halfmoon, LACM 56660-1



Kyphosidae
Medialuna californiensis, halfmoon, LACM 56660-1

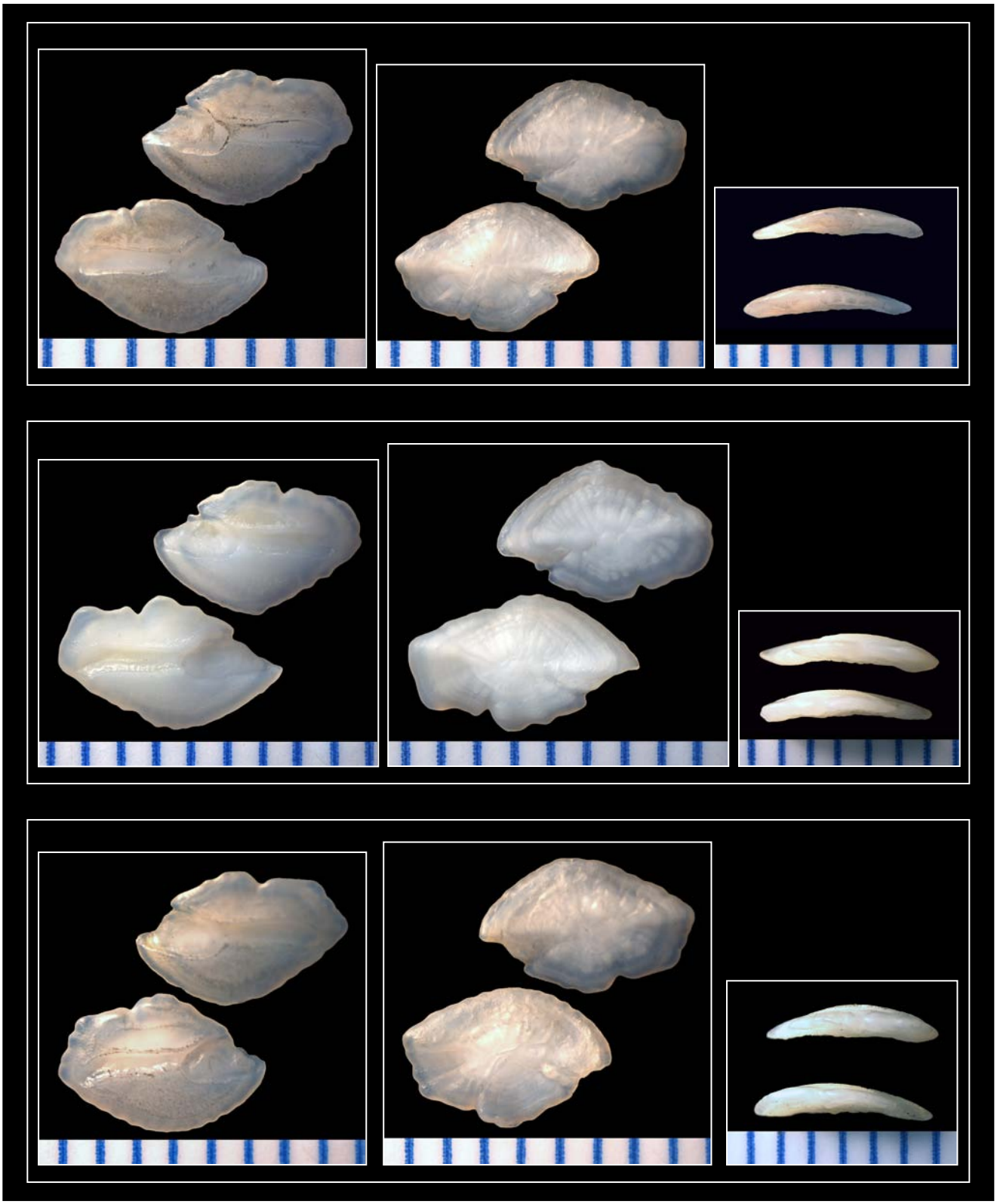


Embiotocidae
Cymatogaster aggregata, shiner surfperch, LACM 56662-1

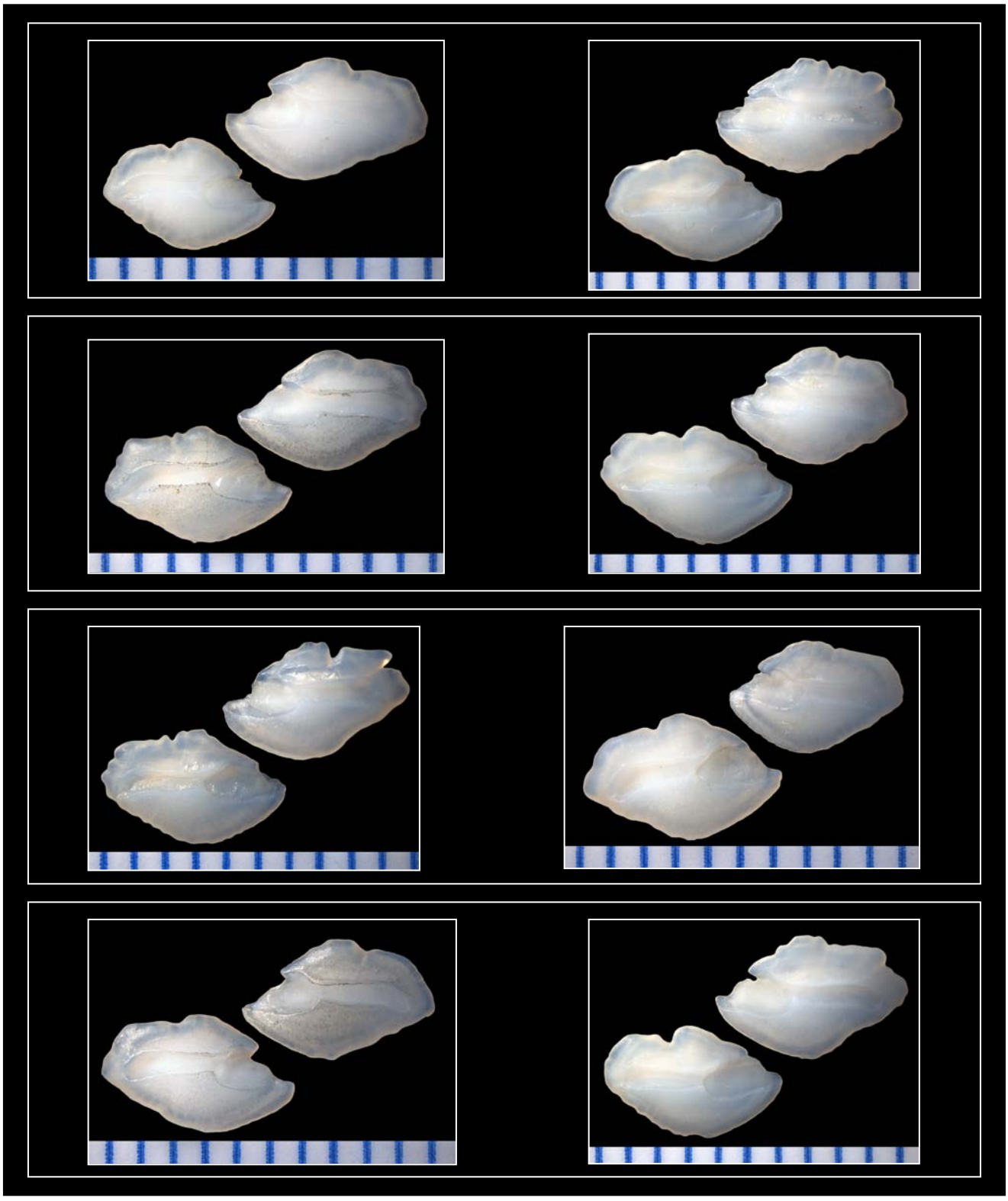
Embiotocidae
Cymatogaster aggregata, shiner surfperch, LACM 56662-1

Embiotocidae

Cymatogaster aggregata gracilis, island surfperch, LACM 56663-1

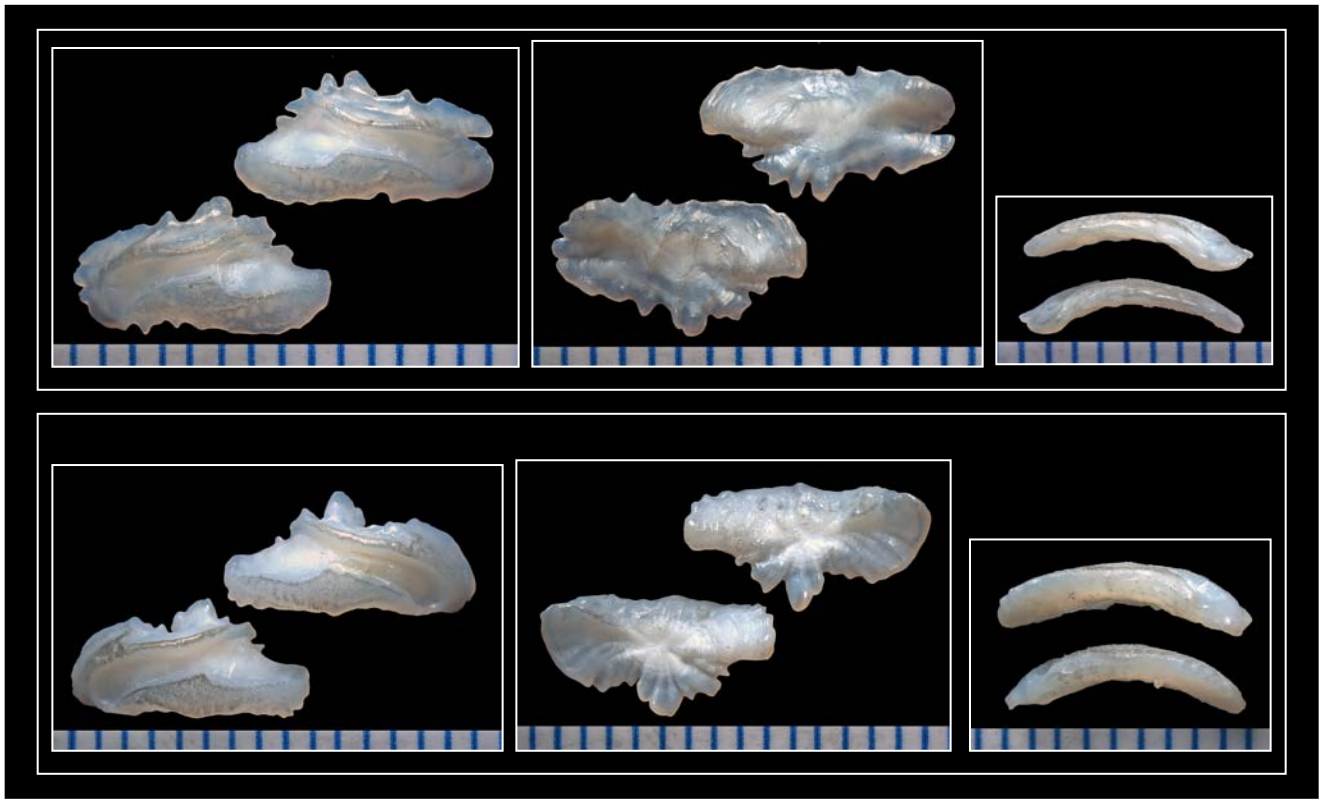


Embiotocidae
Cymatogaster aggregata gracilis, island surfperch, LACM 56663-1

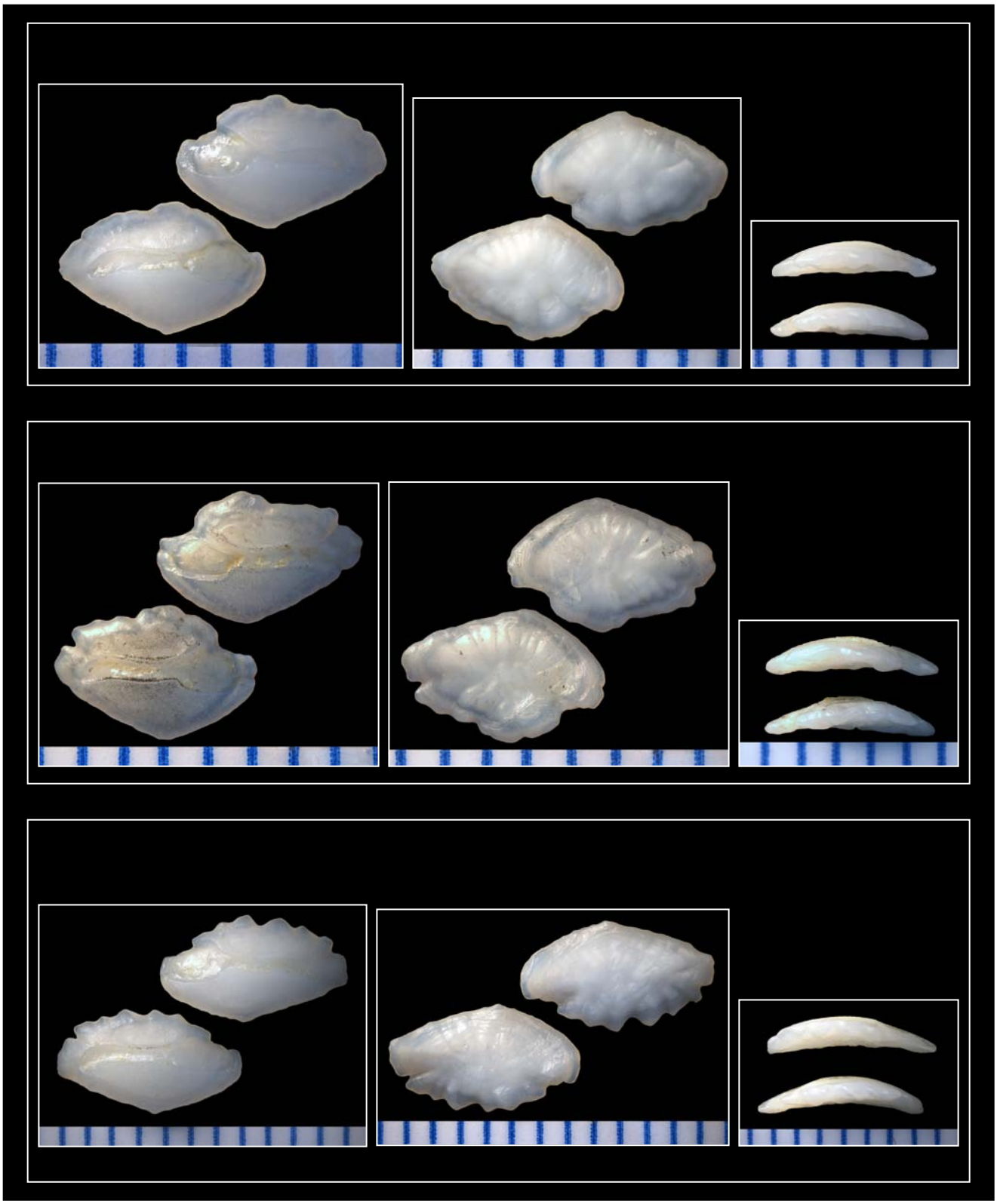


Embiotocidae
Embiotoca jacksoni, black surfperch, LACM 56721-1

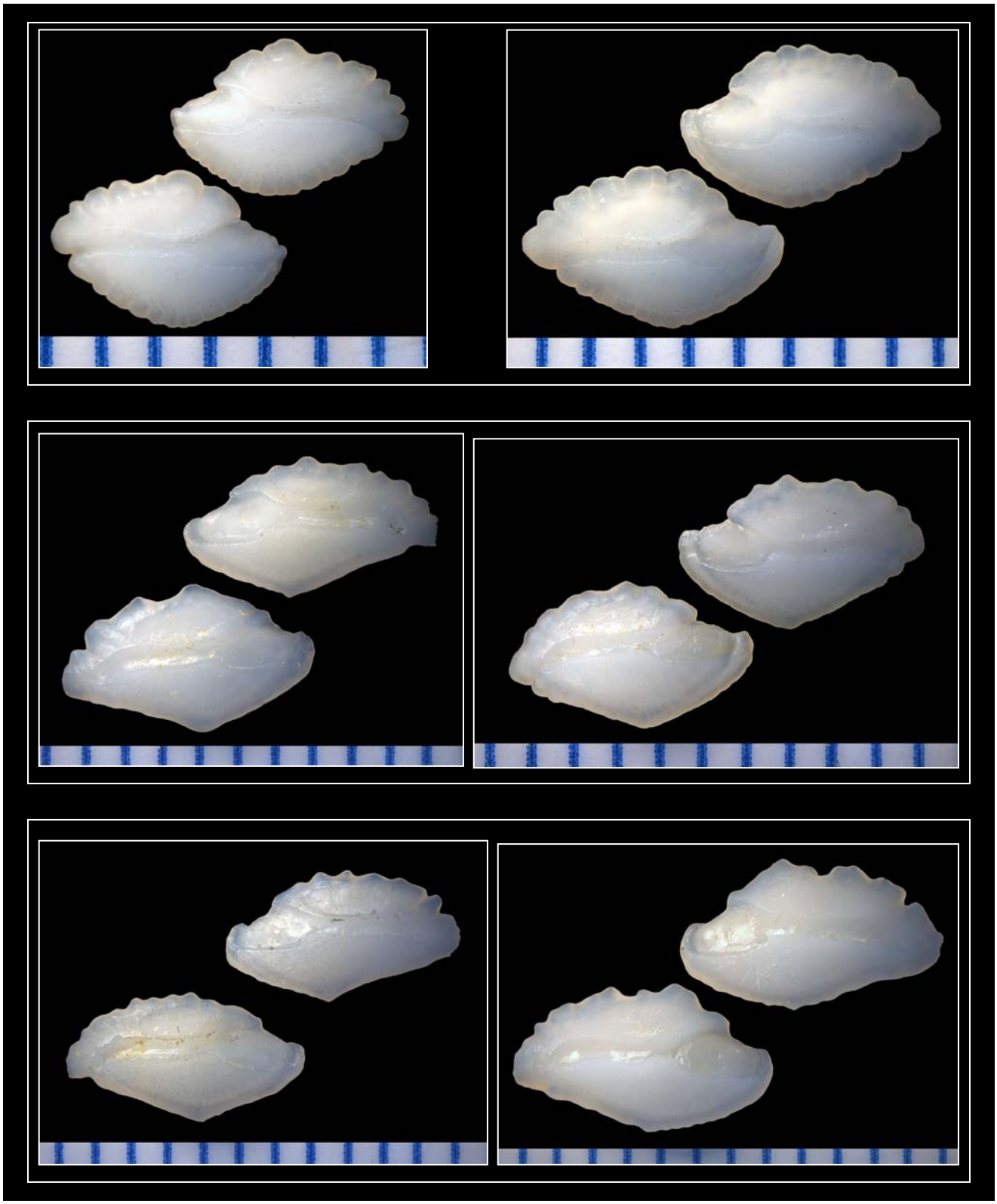
Embiotocidae
Embiotoca jacksoni, black surfperch, LACM 56721-1



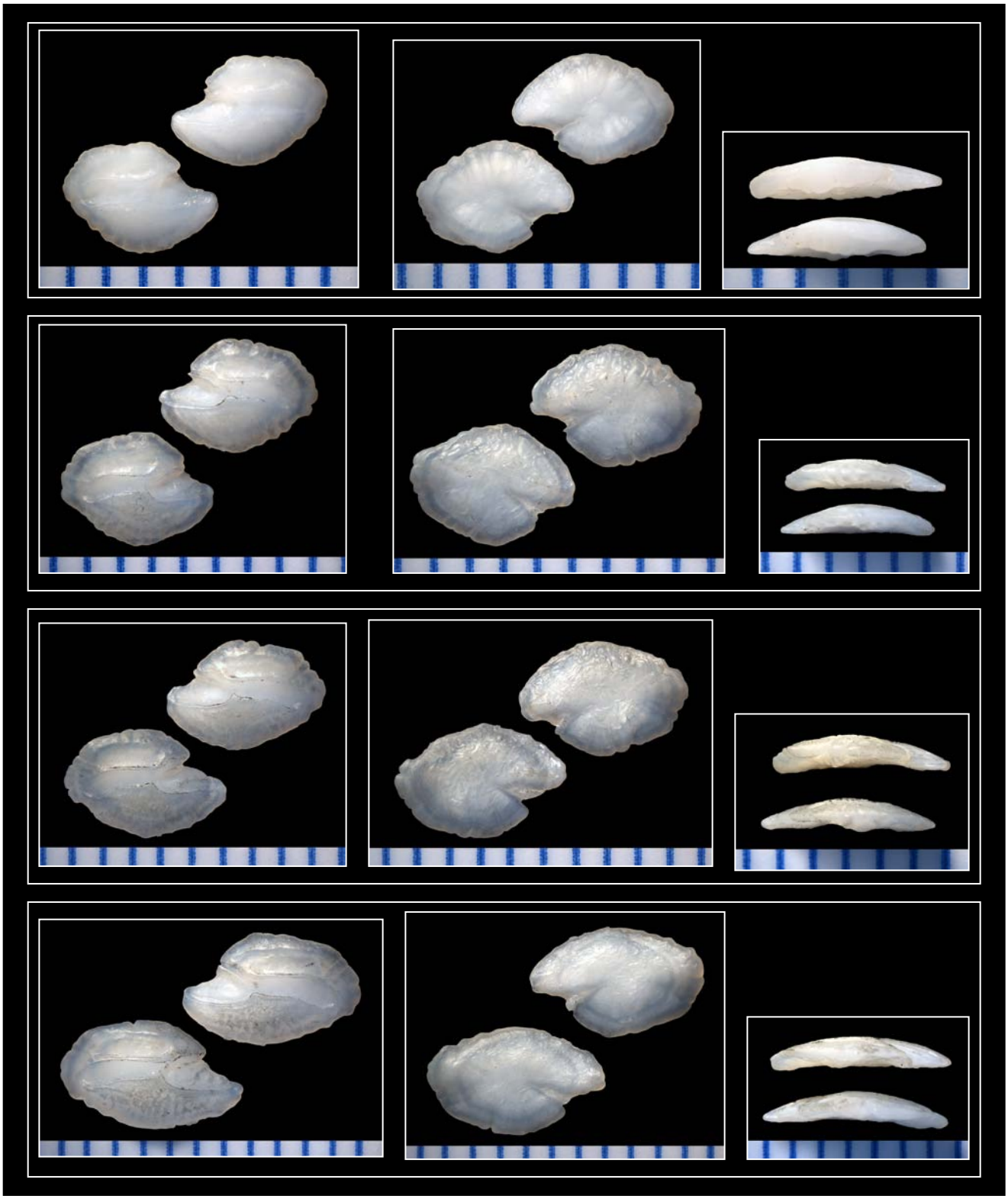
Embiotocidae
Hyperprosopon anale, spotfin surfperch, LACM 56664-1



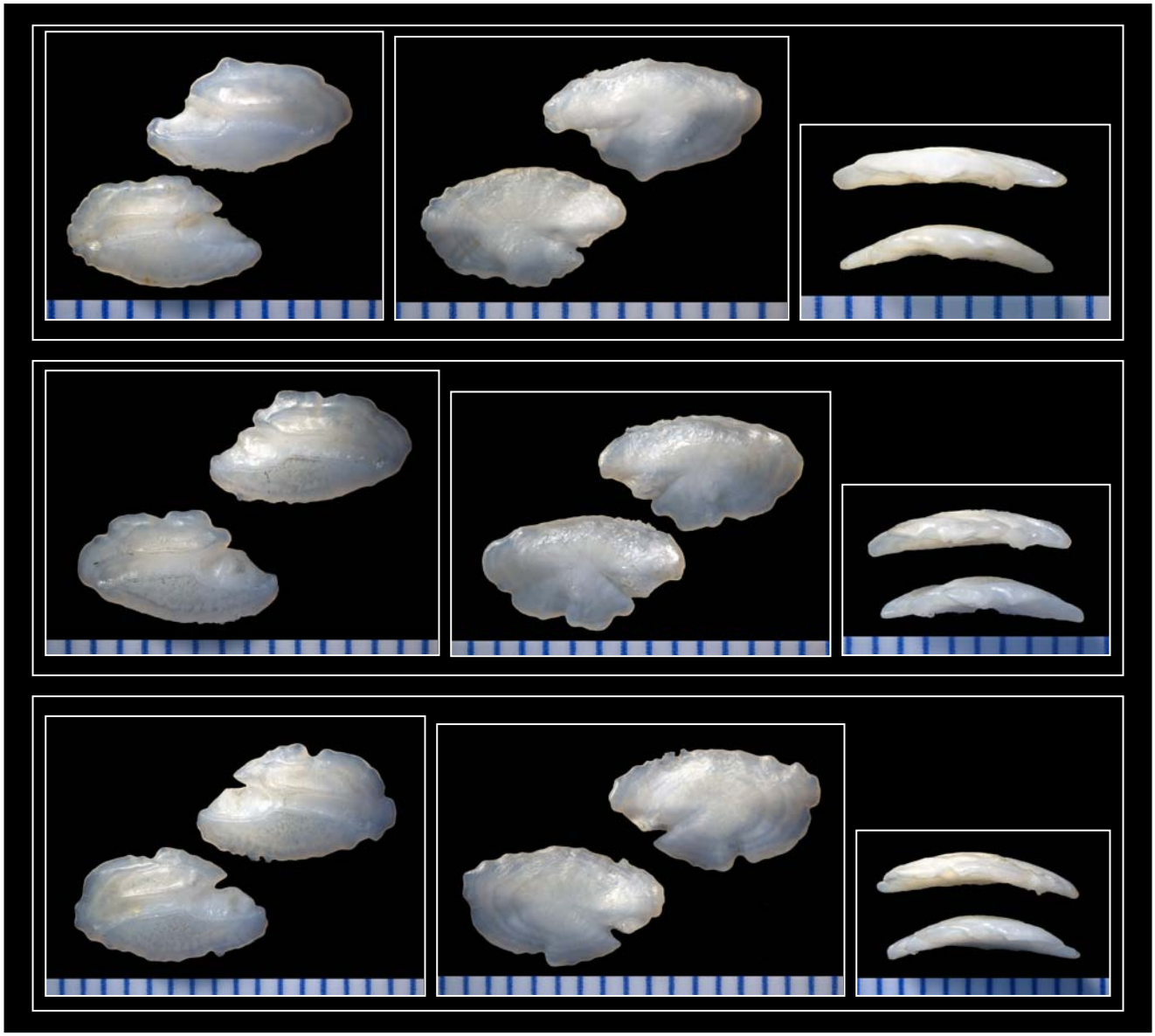
Embiotocidae
Hyperprosopon anale, spotfin surfperch, LACM 56664-1



Embiotocidae
Phanerodon furcatus, white surfperch, LACM 56694-1



Embiotocidae
Phanerodon furcatus, white surfperch, LACM 56694-1

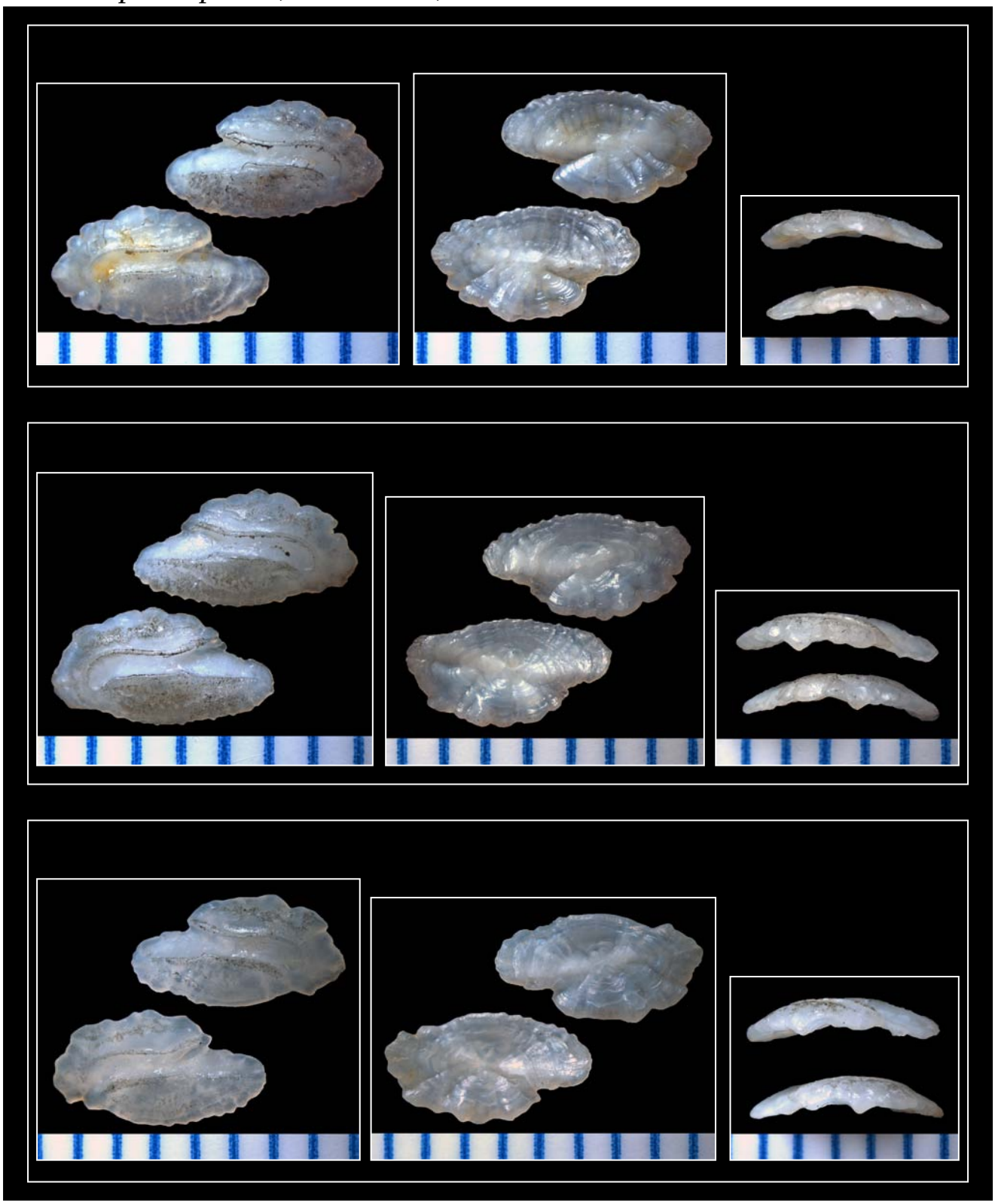


Embiotocidae
Phanerodon furcatus, white surfperch, LACM 56694-1

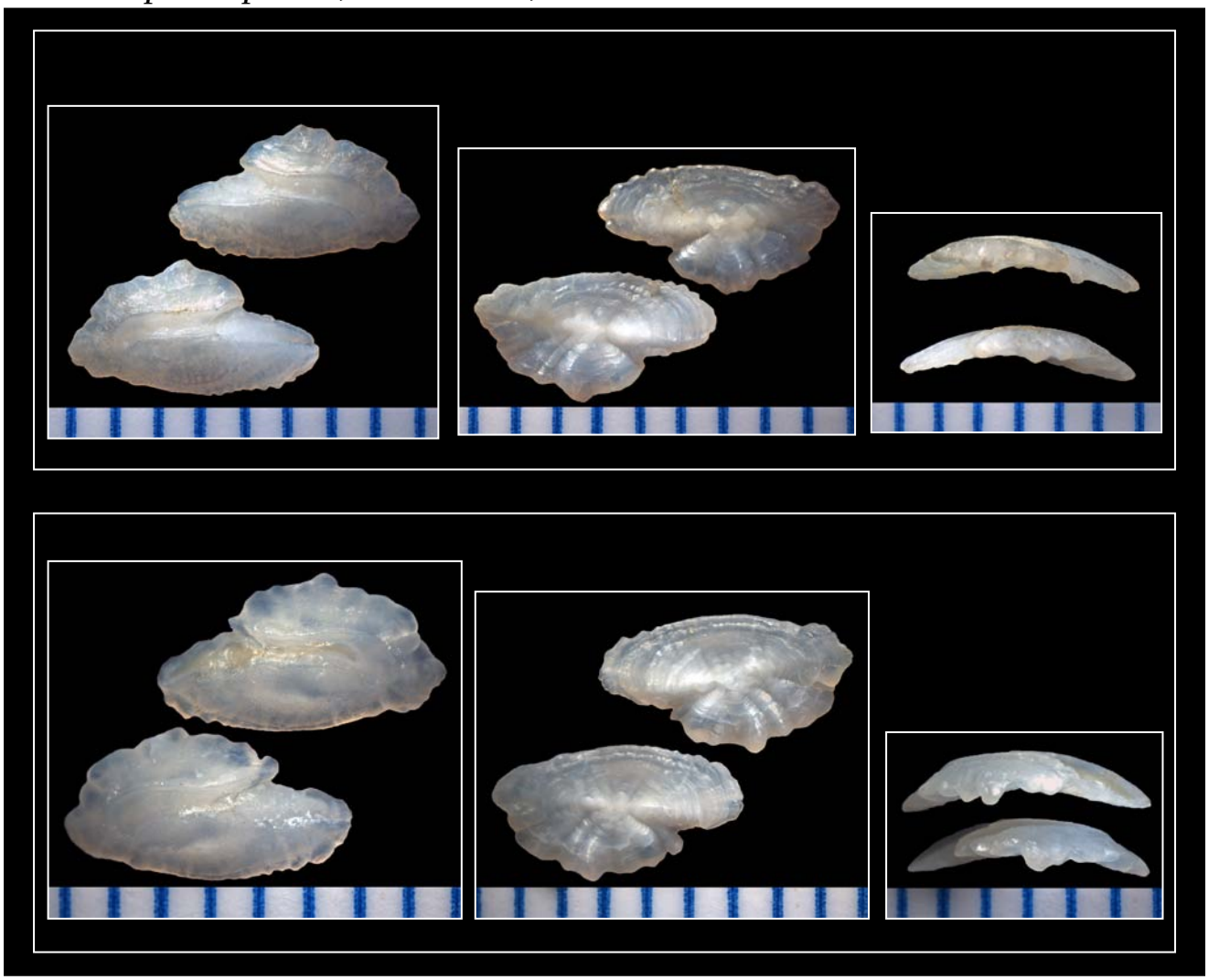
Embiotocidae
Zalembius rosaceus, pink surfperch, LACM 56661-1

Embiotocidae
Zalembius rosaceus, pink surfperch, LACM 56661-1

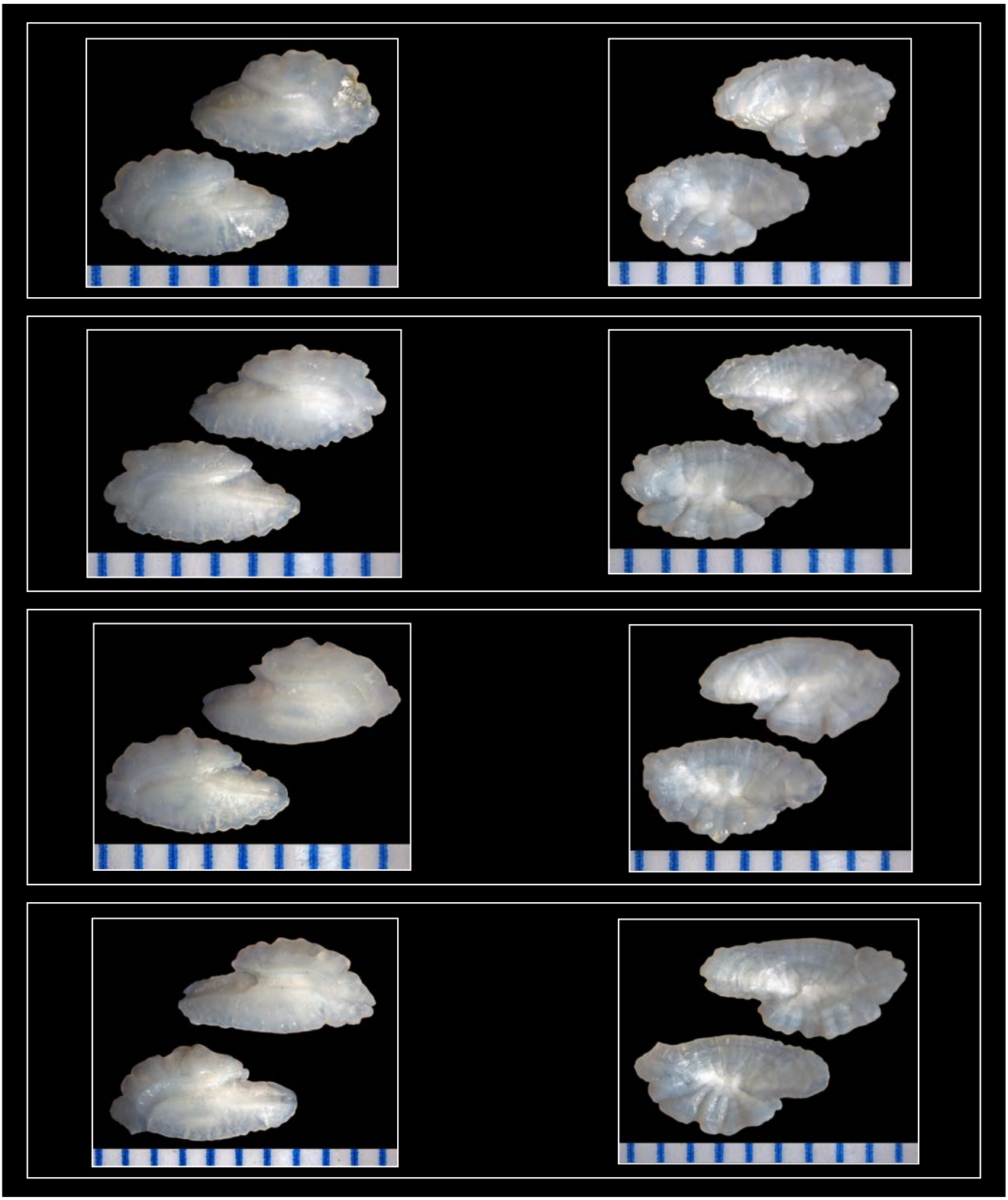
Pomacentridae
Chromis punctipinnis, blacksmith, LACM 56610-1



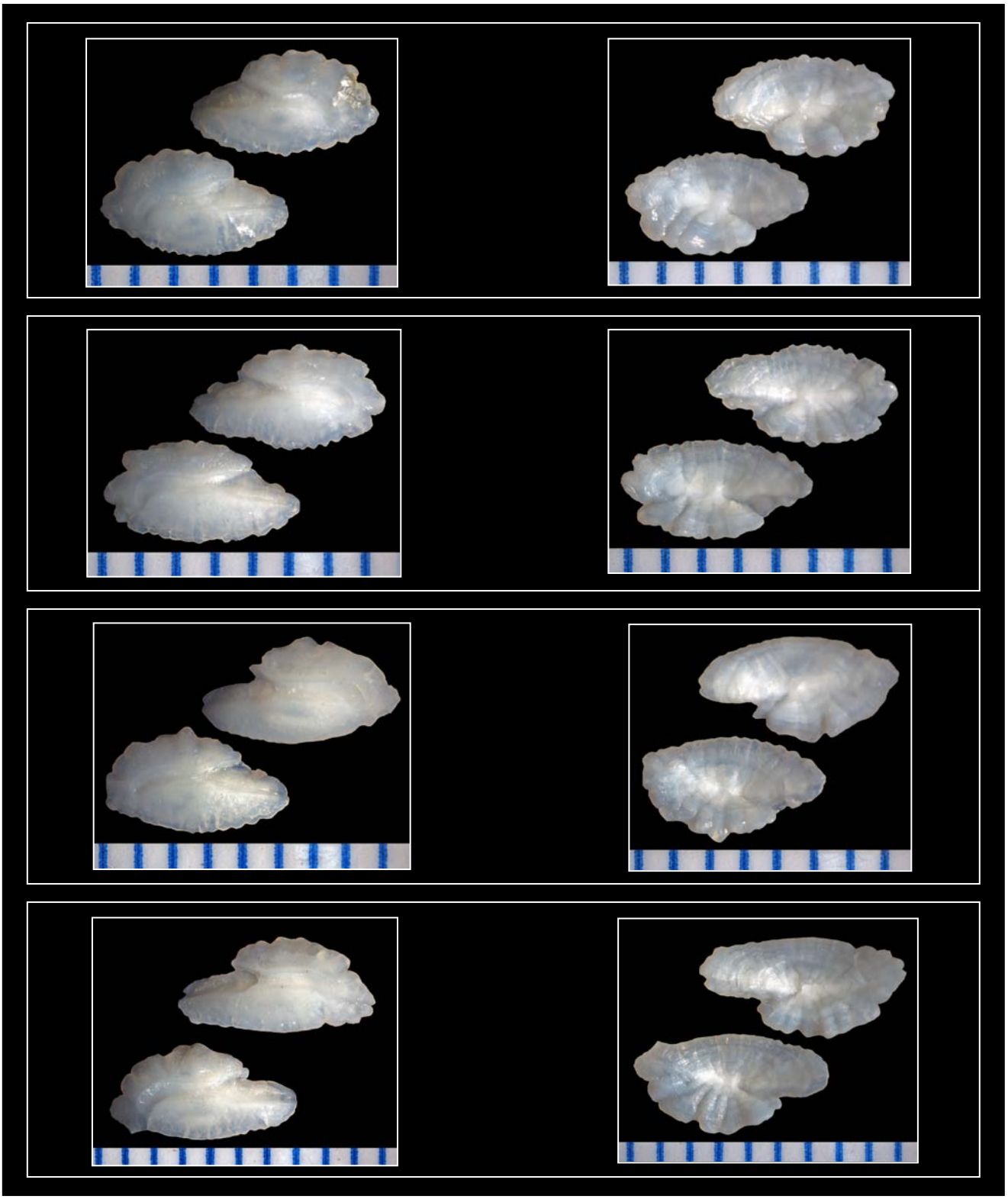
Pomacentridae
Chromis punctipinnis, blacksmith, LACM 56610-1



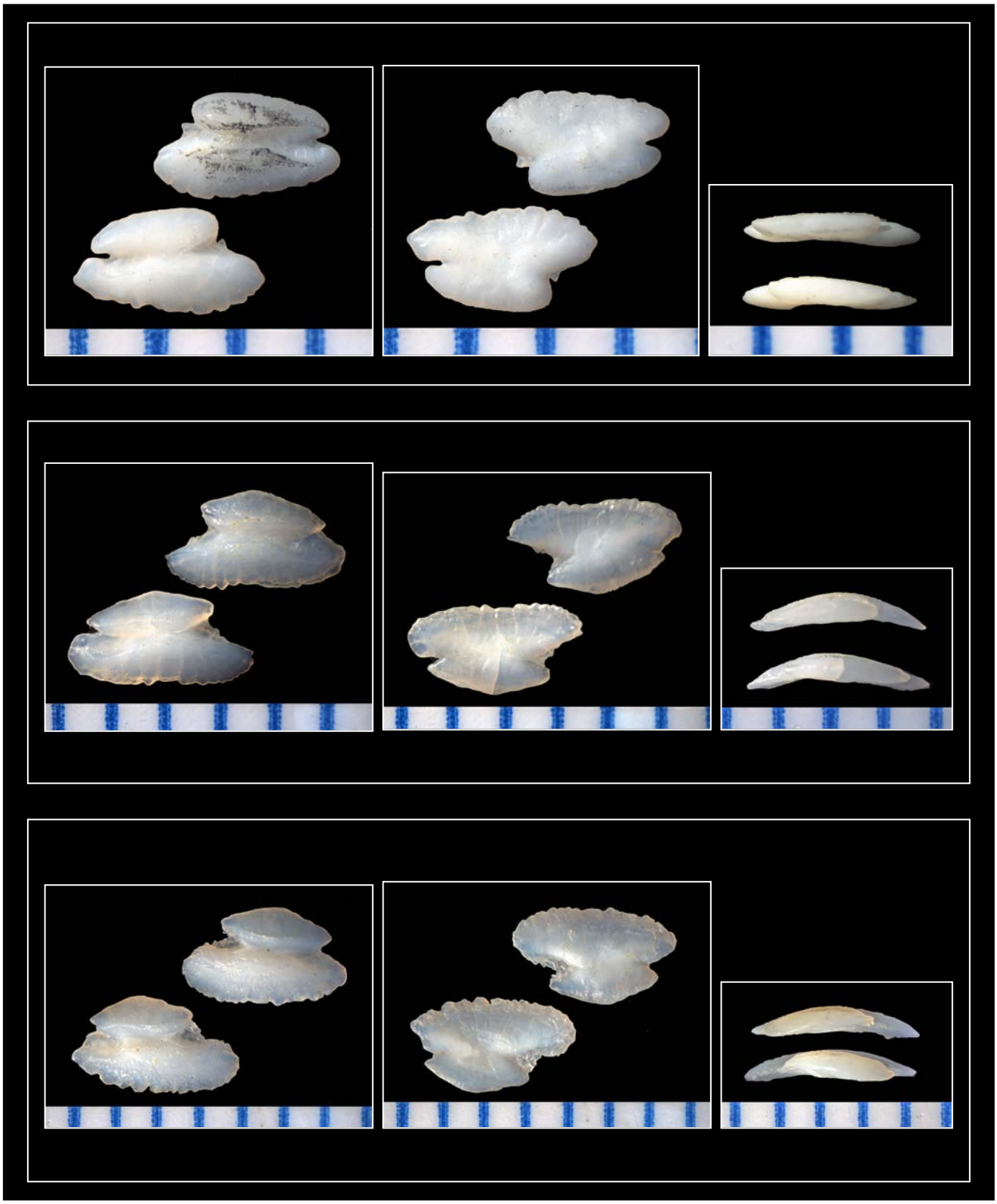
Pomacentridae
Chromis punctipinnis, blacksmith, LACM 56610-1



Pomacentridae
Chromis punctipinnis, blacksmith, LACM 56610-1



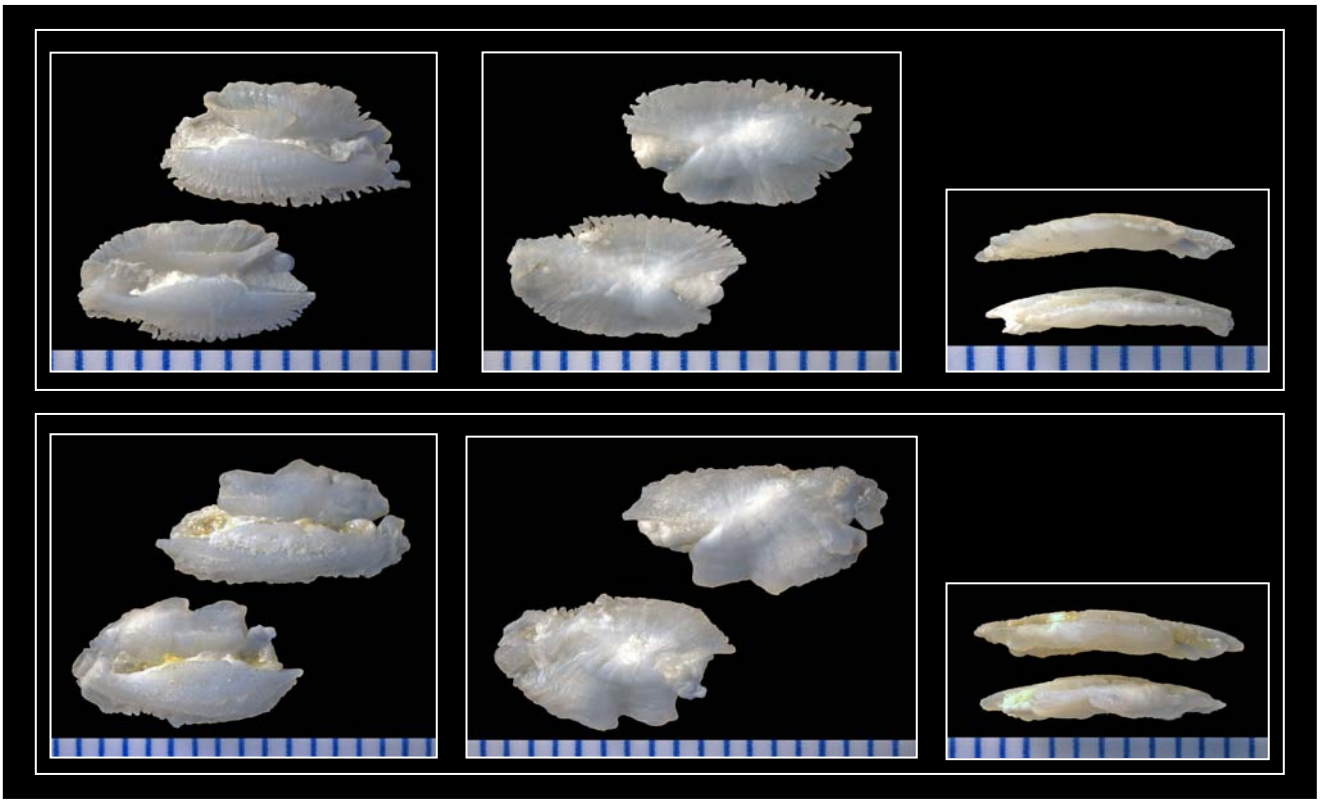
Labridae
Oxyjulis californica, señorita, LACM 56611-1



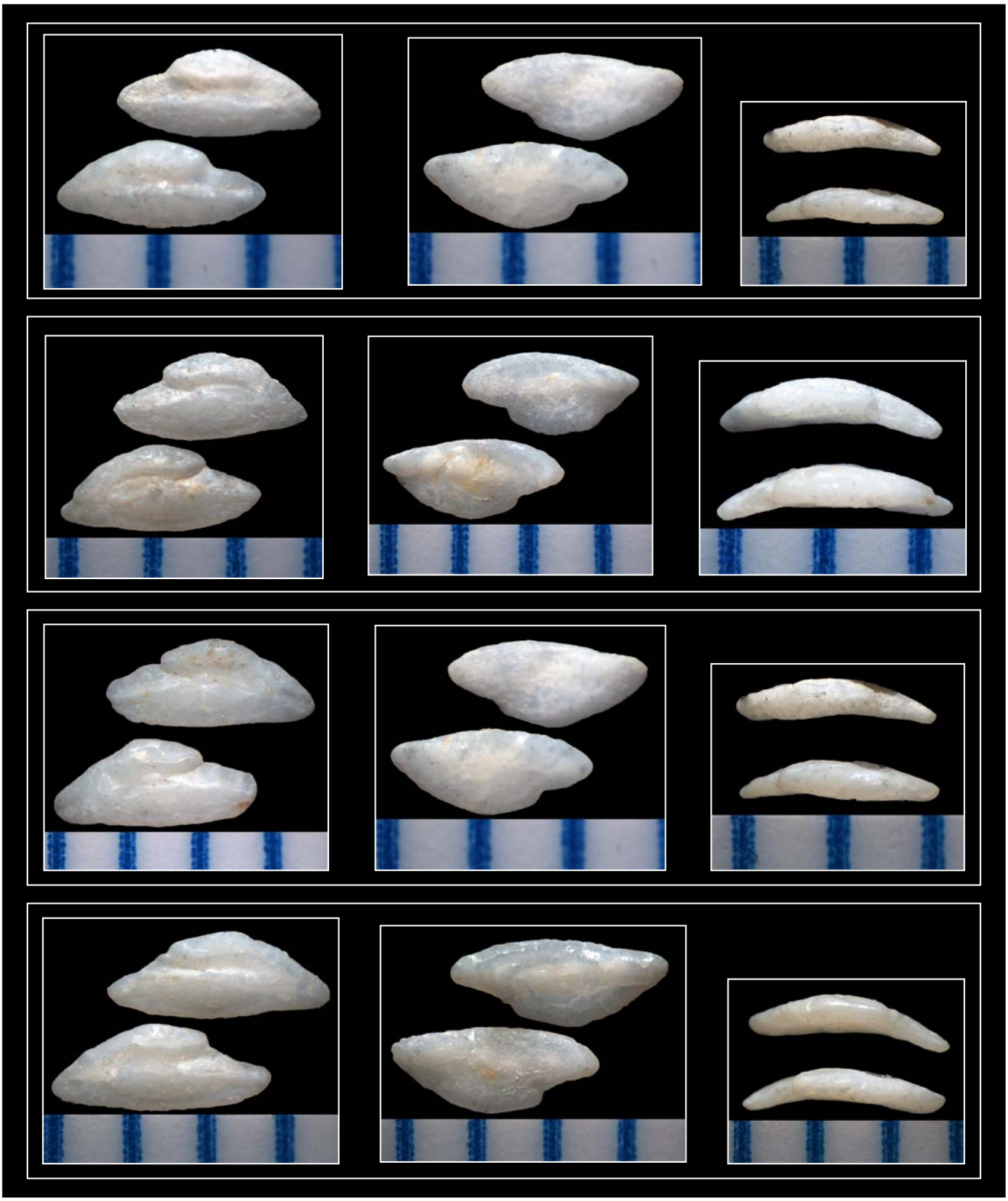
Labridae
Oxyjulis californica, señorita, LACM 56611-1

Labridae
Semicossyphus pulcher, California sheephead, LACM 56695-1

Labridae
Semicossyphus pulcher, California sheephead, LACM 56695-1

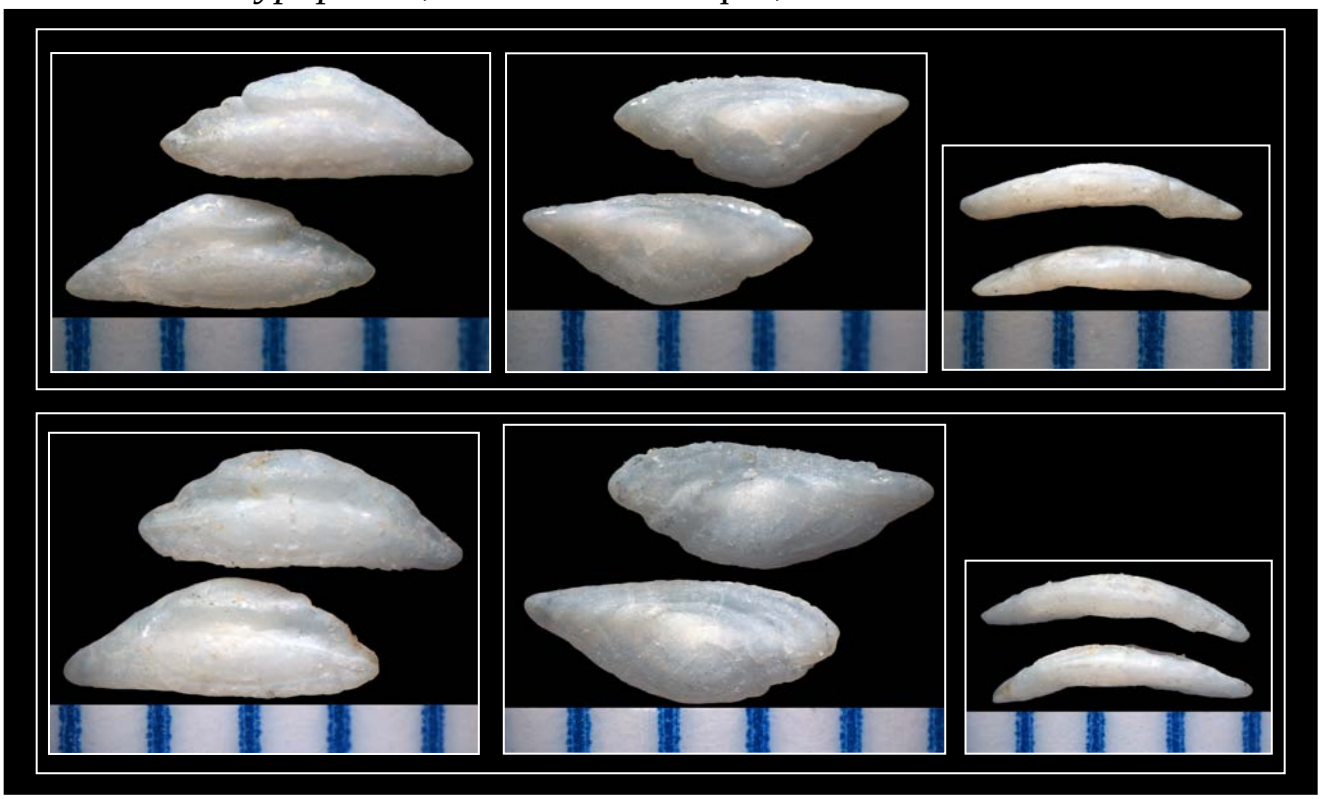


Bathymasteridae
Rathbunella hypoplecta, bluebanded ronquil, LACM 57267-1



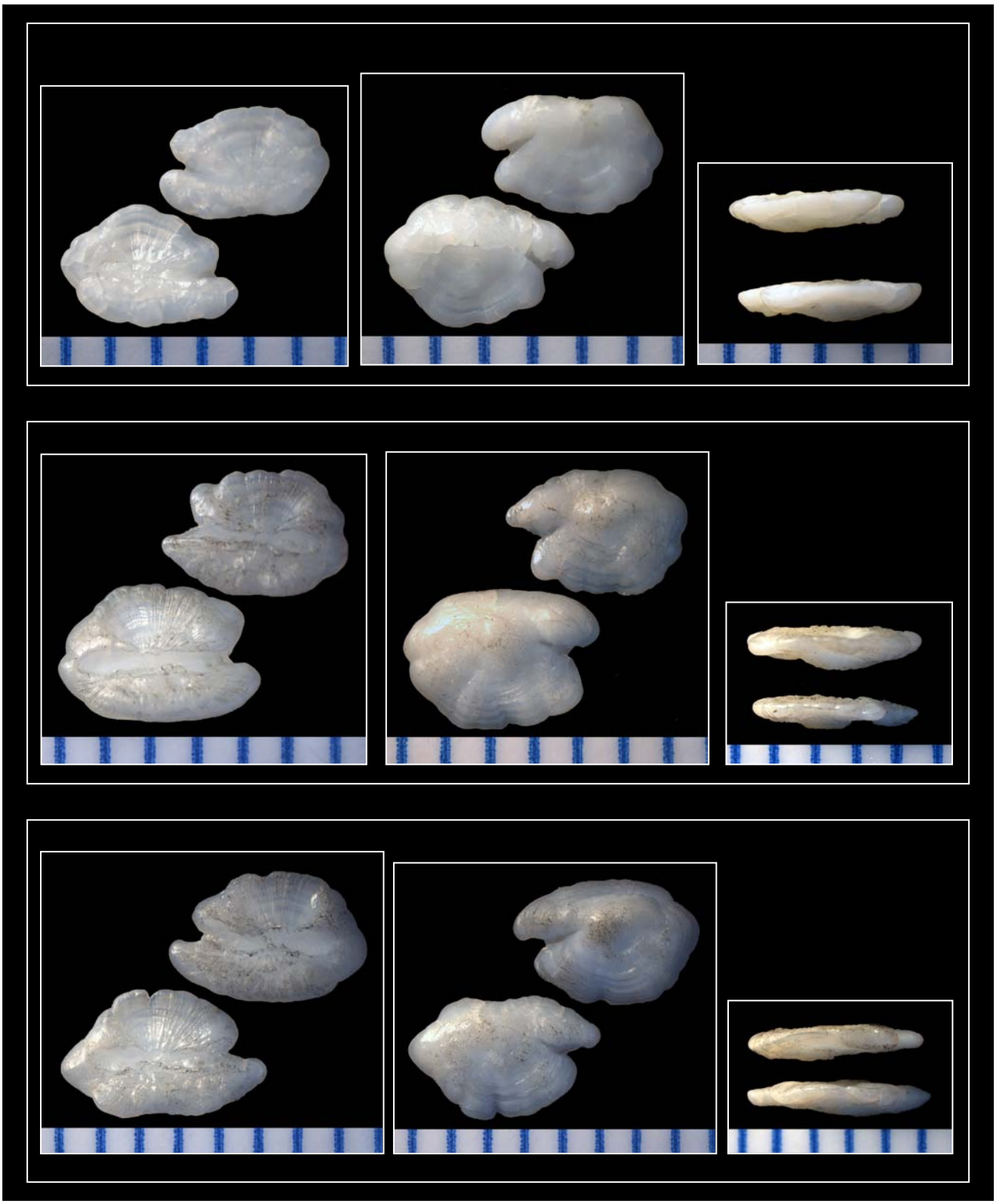
Bathymasteridae
Rathbunella hypoplecta, bluebanded ronquil, LACM 57267-1

Bathymasteridae
Rathbunella hypoplecta, bluebanded ronquil, LACM 57267-1

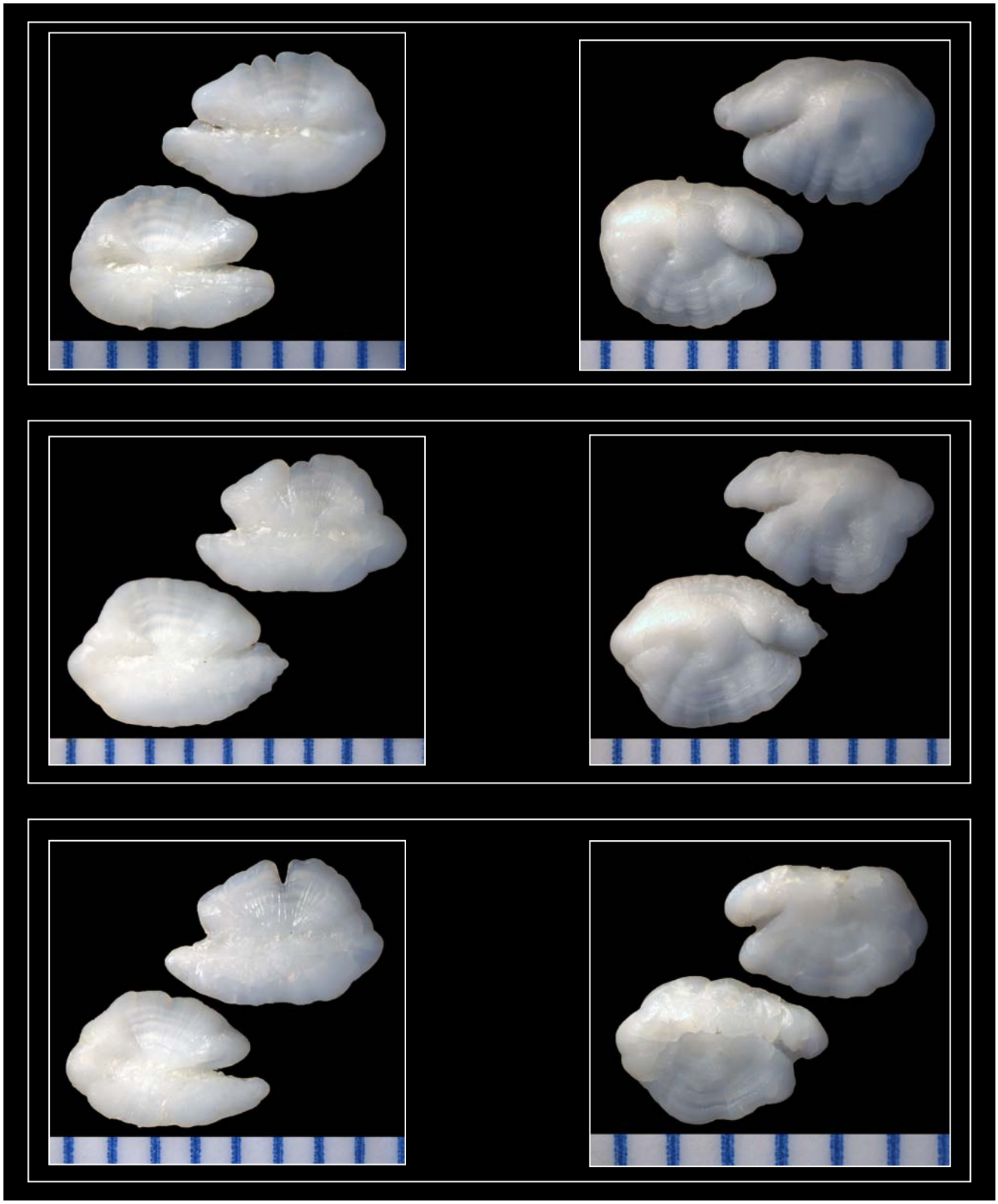


Zoarcidae

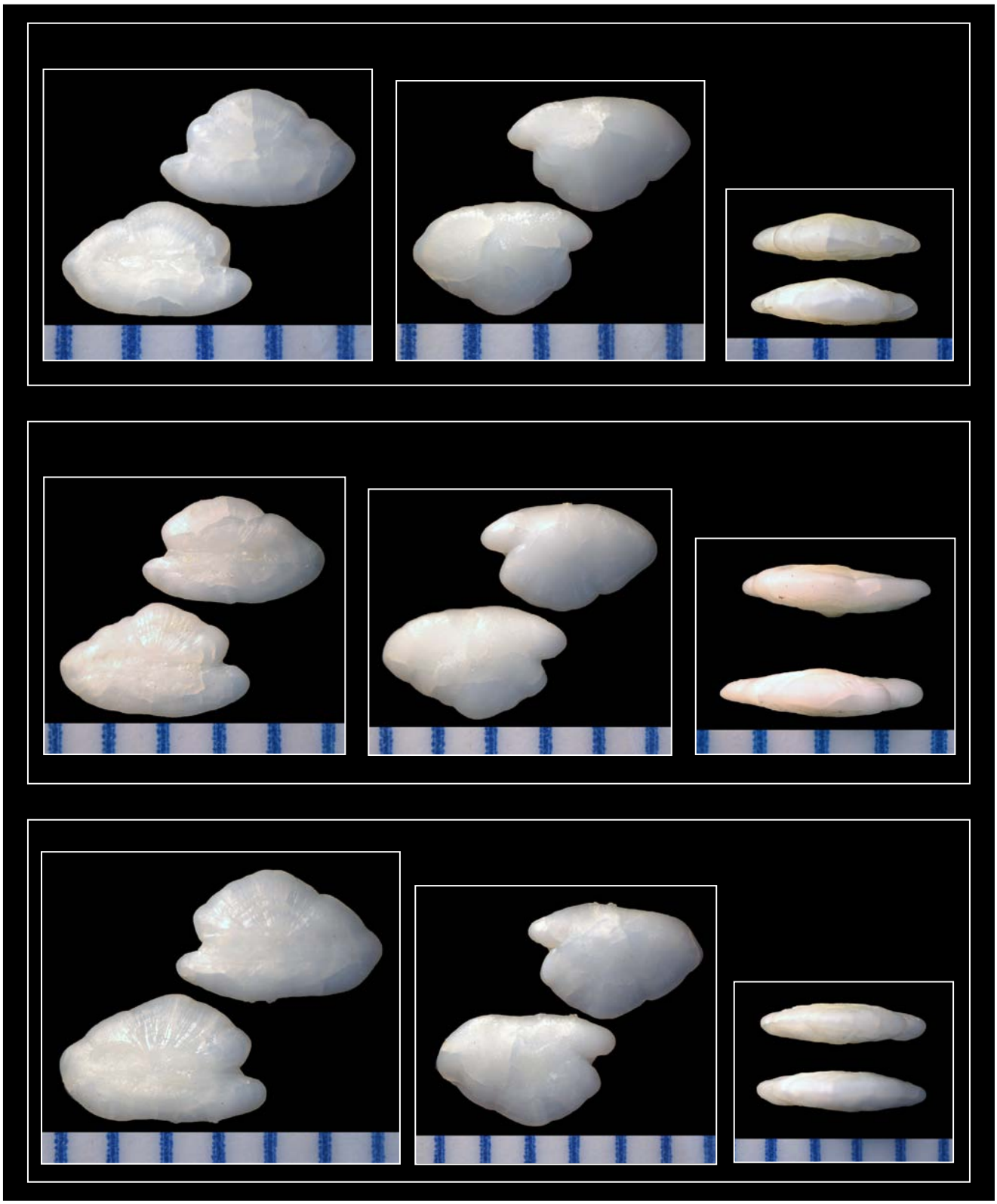
Lycodes cortezianus, Bigfin eelpout, LACM 56665-1



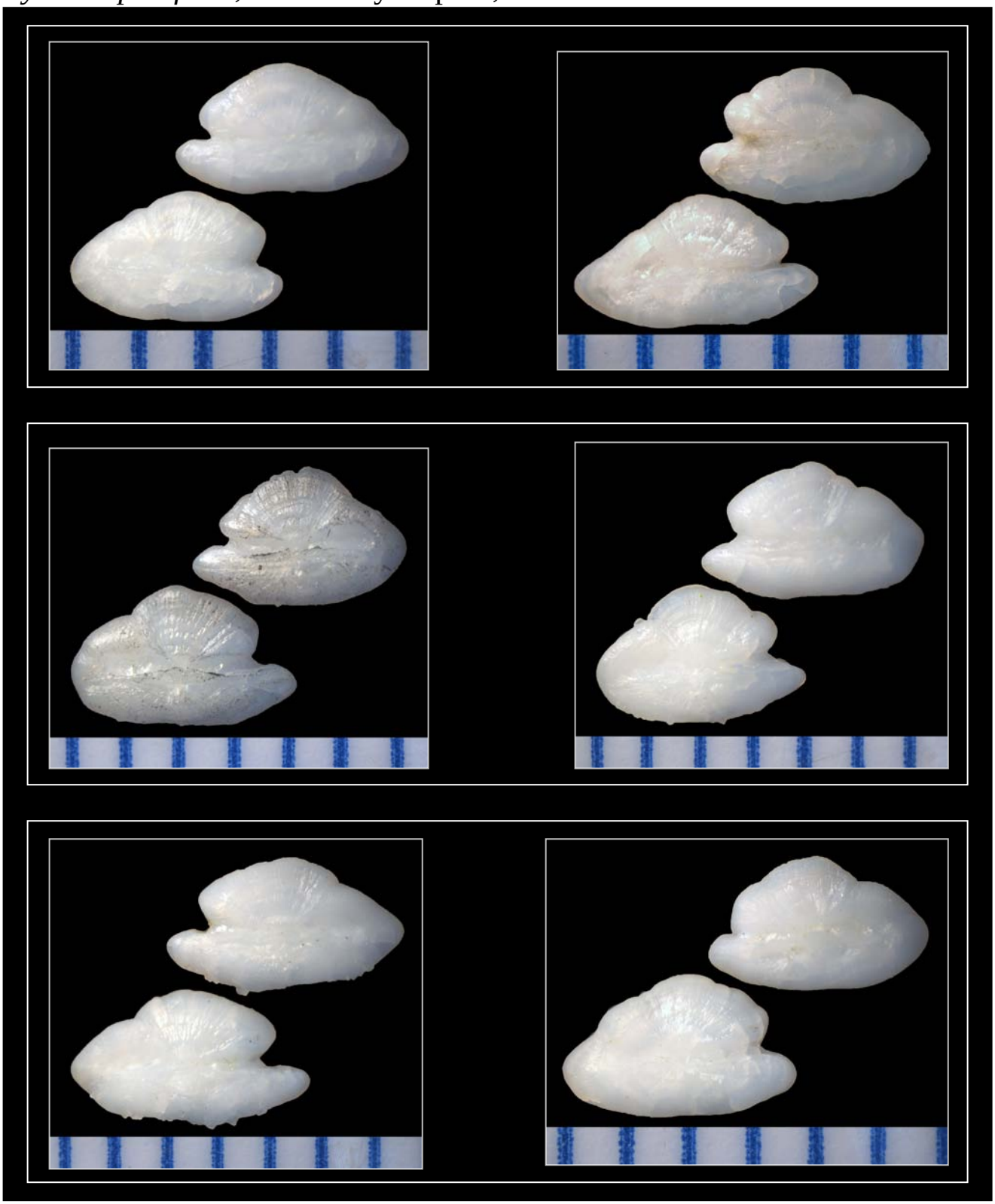
Zoarcidae
Lycodes cortezianus, Bigfin eelpout, LACM 56665-1



Zoarcidae
Lycodes pacificus, Blackbelly eelpout, LACM 56665-1



Zoarcidae
Lycodes pacificus, Blackbelly eelpout, LACM 56665-1



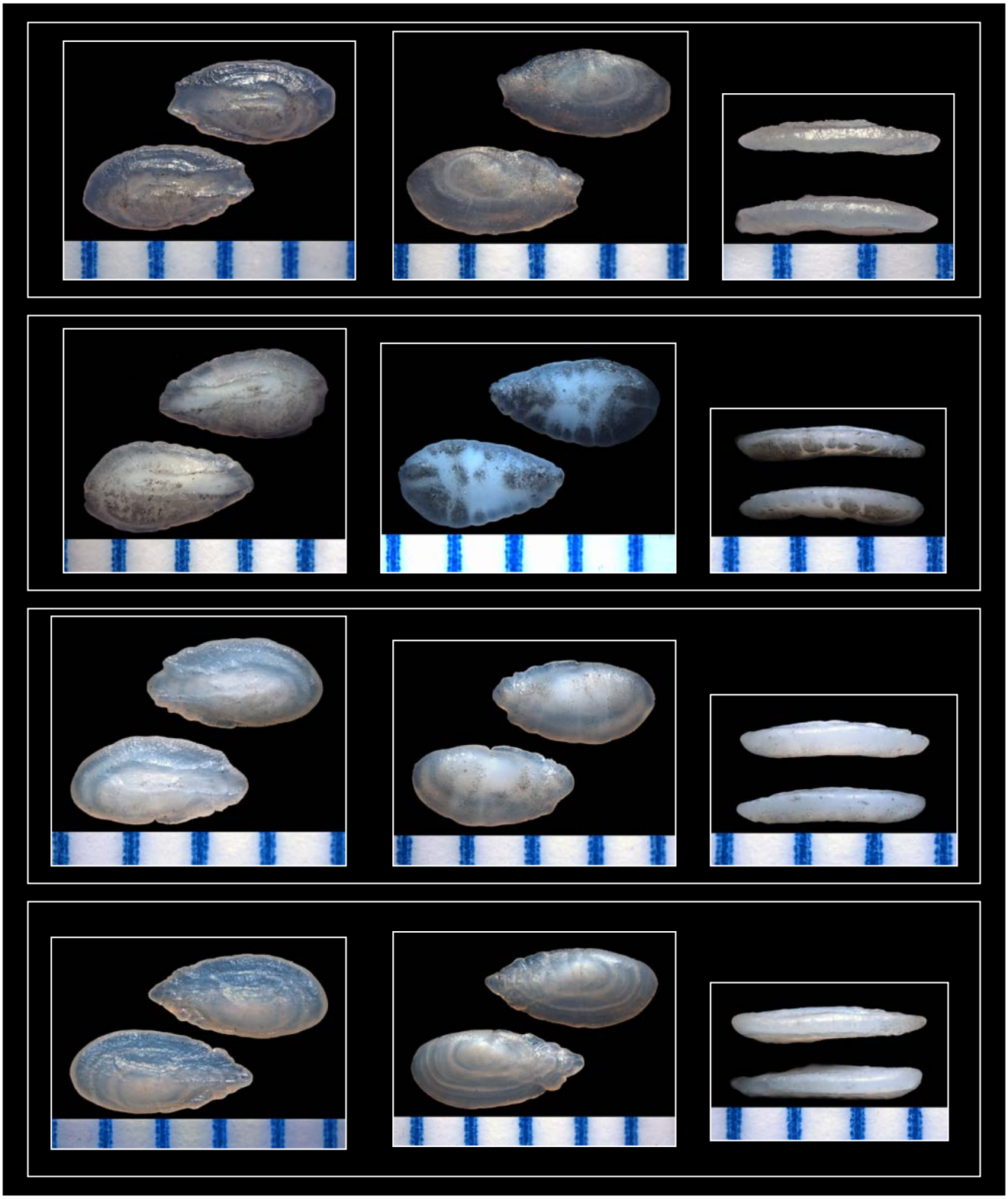
Zoarcidae

Lyconema barbatum, bearded eelpout, LACM 57265-1

Zoarcidae

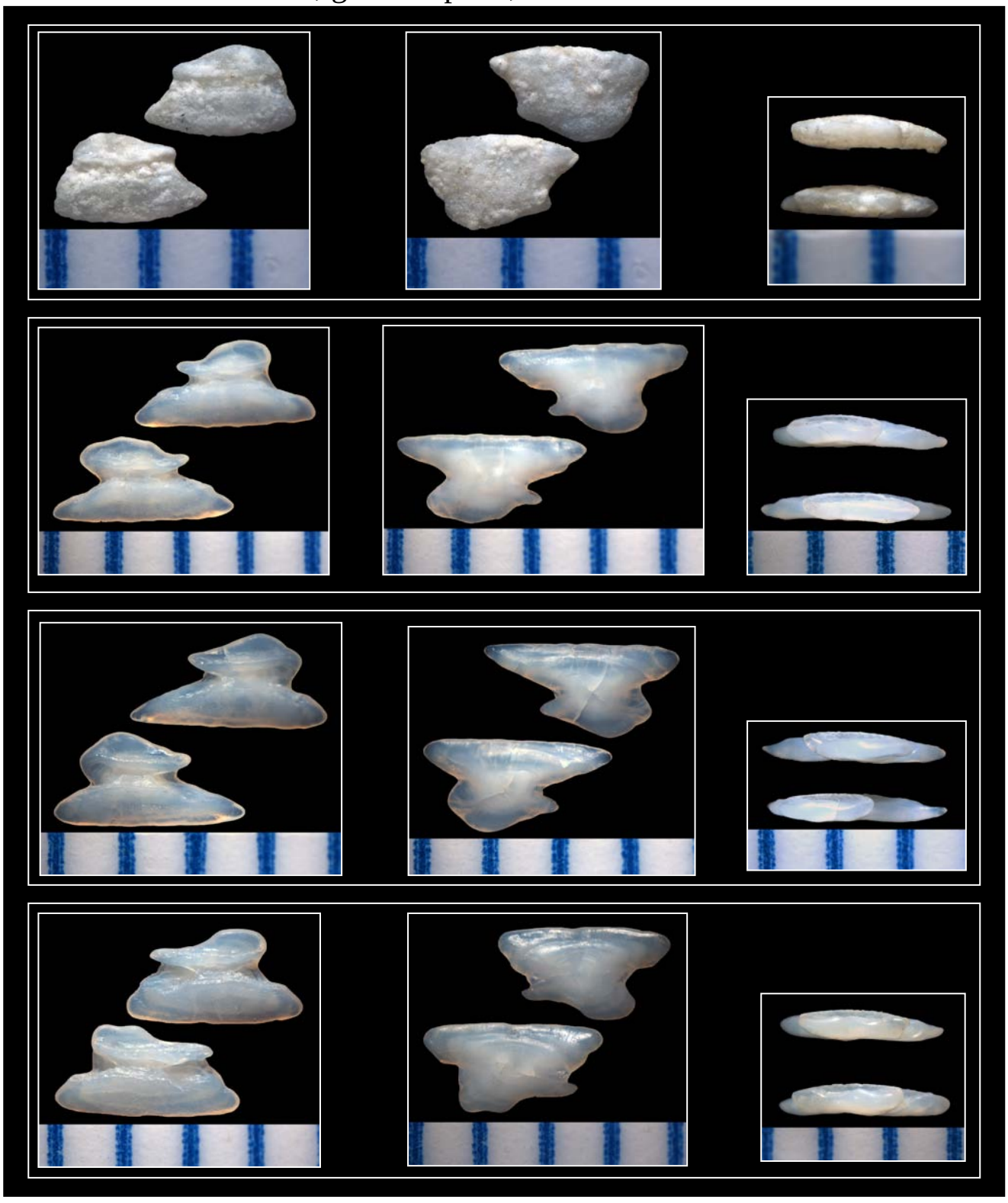
Lyconema barbatum, bearded eelpout, LACM 57265-1

Ammodytidae
Ammodytes hexapterus, Pacific sandlance, LACM 56930-1



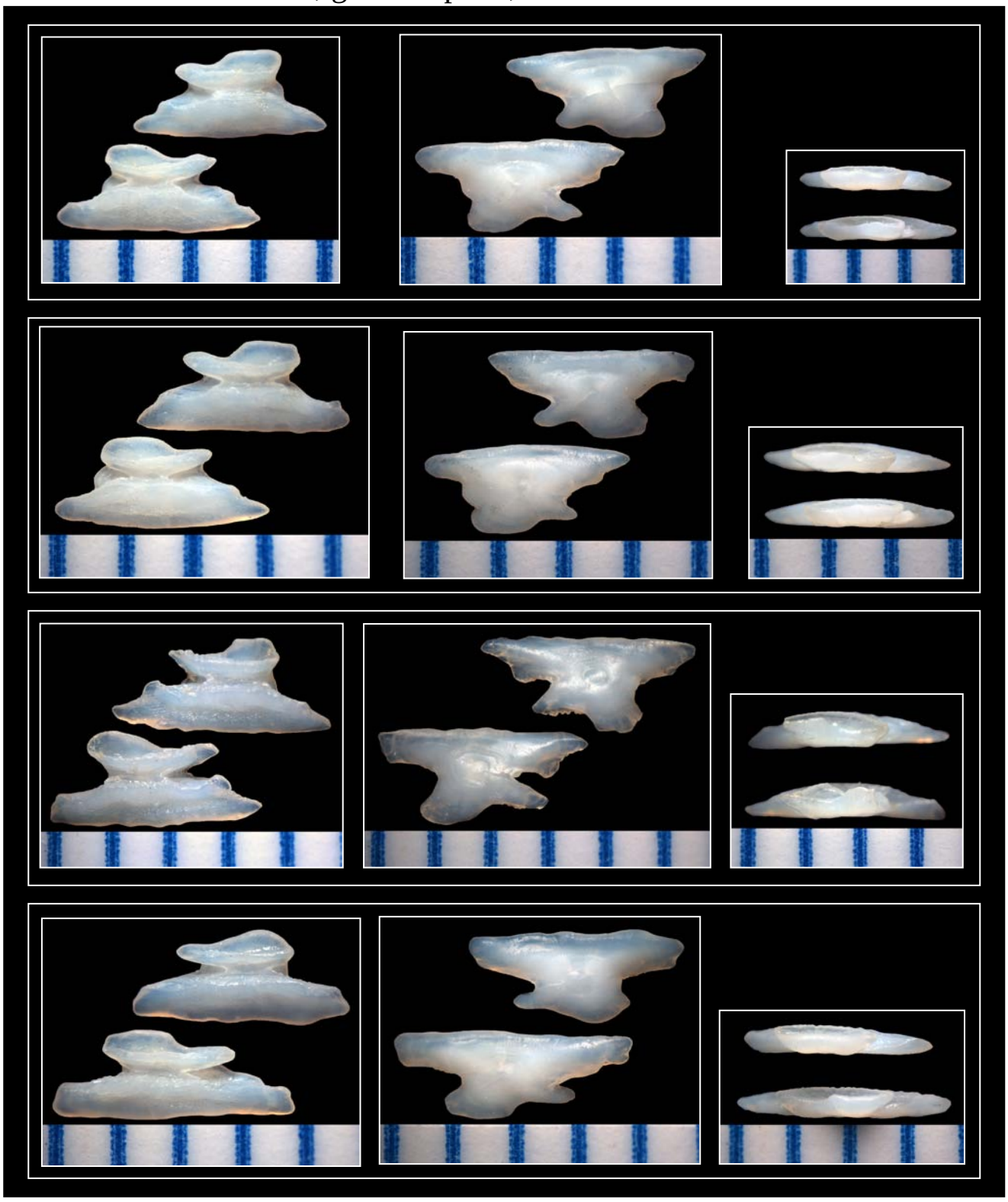
Clinidae

Heterostichus rostratus, giant kelpfish, LACM 57266-1

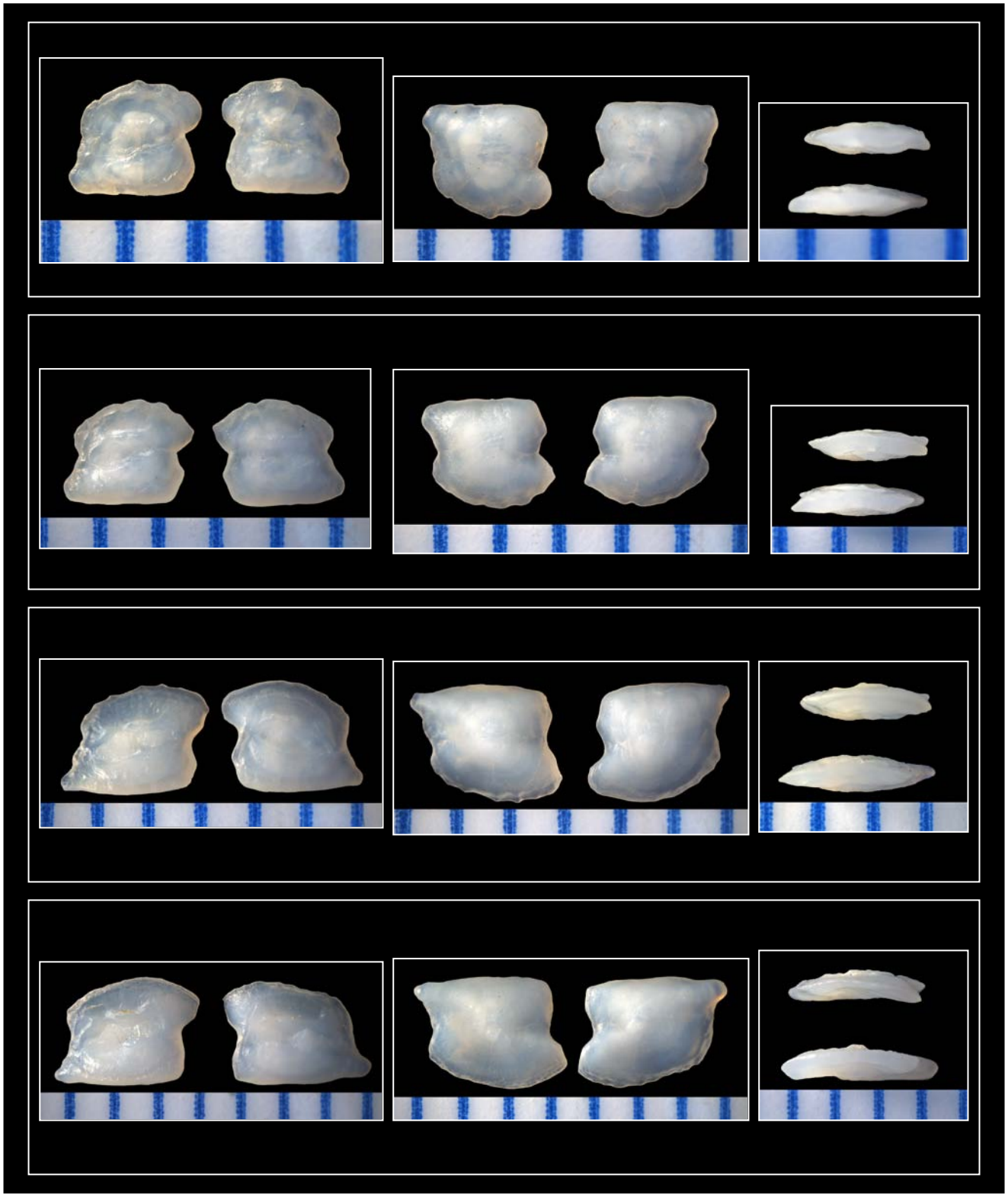


Clinidae

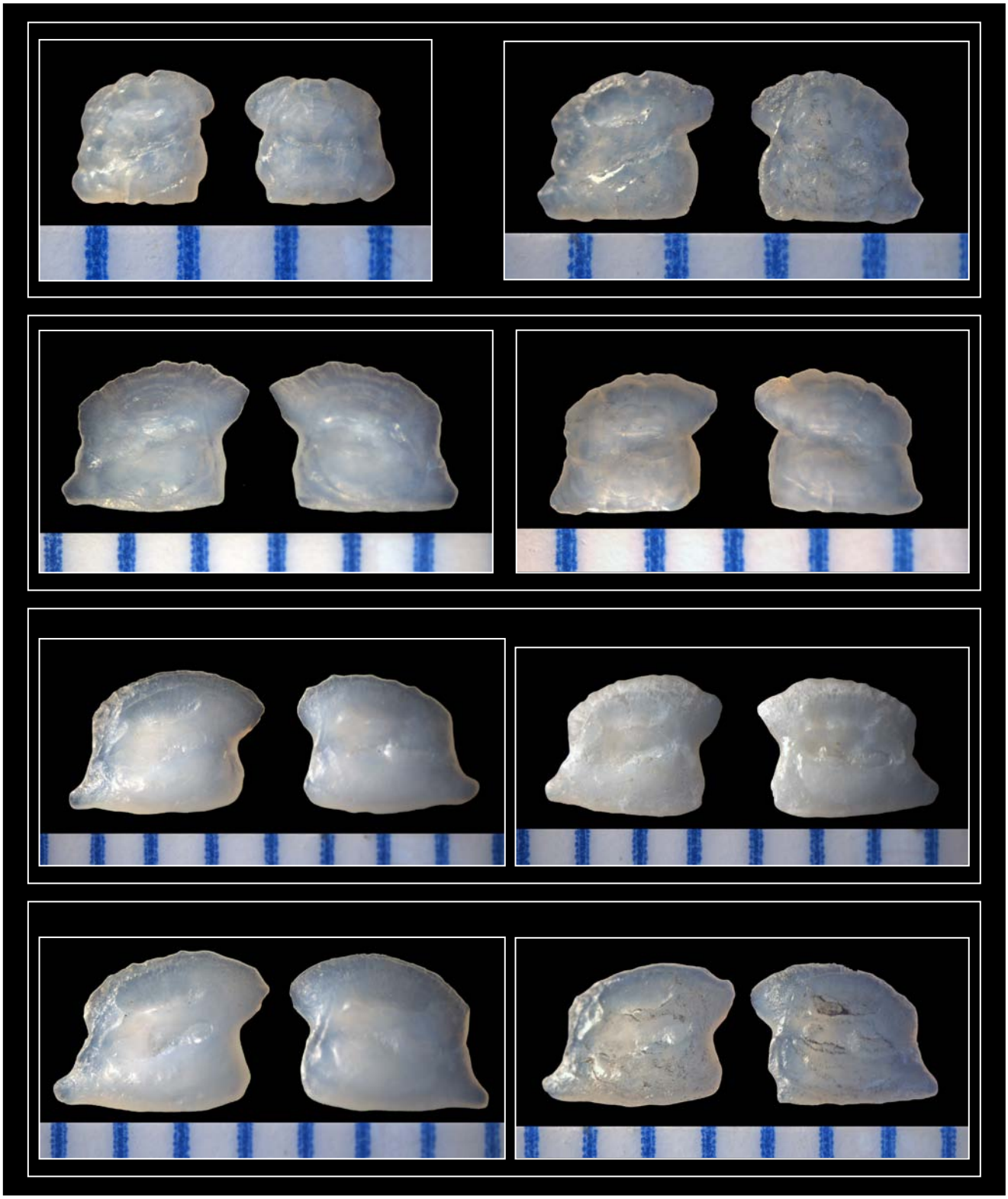
Heterostichus rostratus, giant kelpfish, LACM 57266-1



Gobiidae
Rhinogobiops nicholsii, blackeye goby, LACM 56681-1

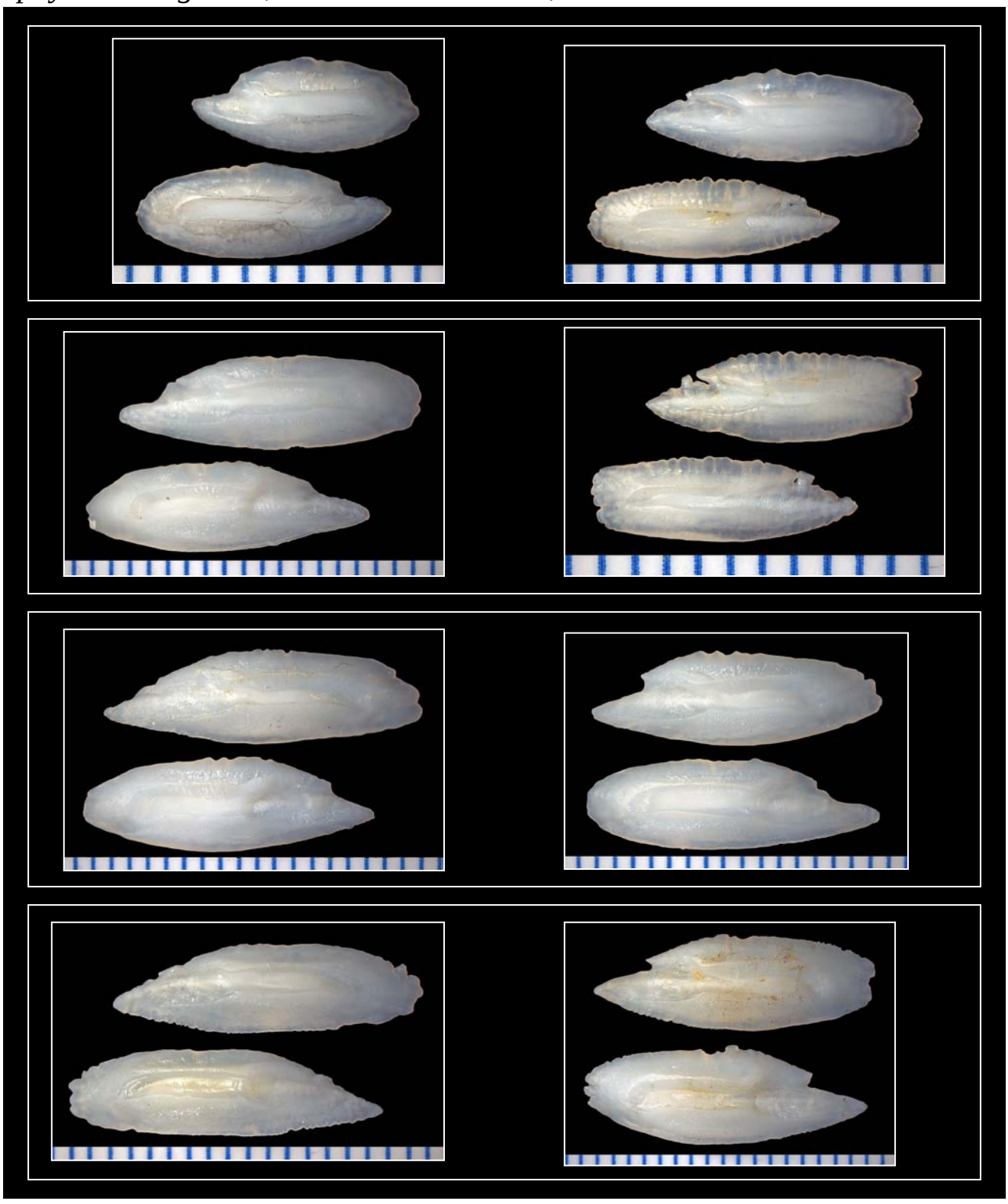


Gobiidae
Rhinogobiops nicholsii, blackeye goby, LACM 56681-1

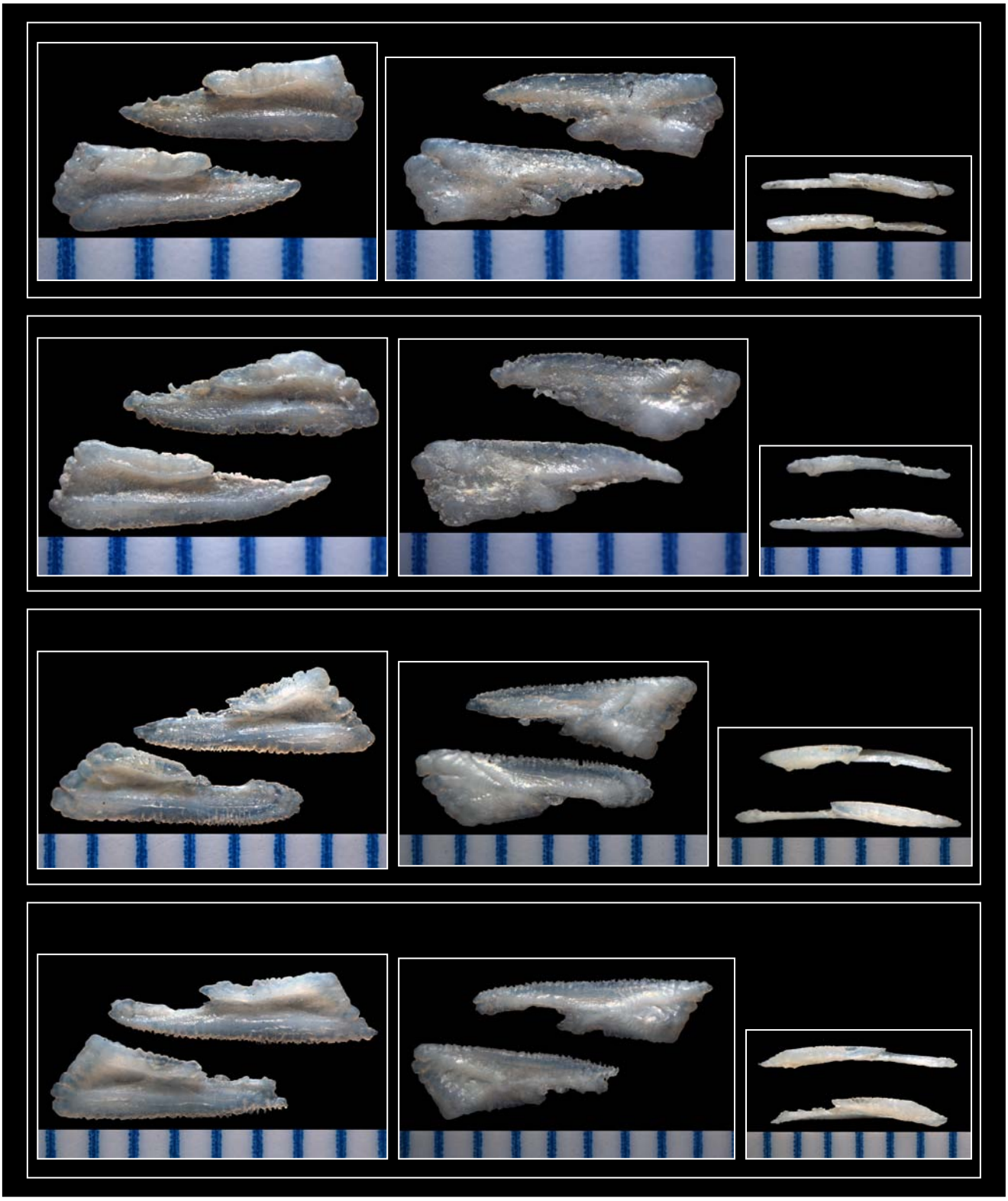


Sphyraenidae
Sphyraena argentea, California barracuda, LACM 56687-1

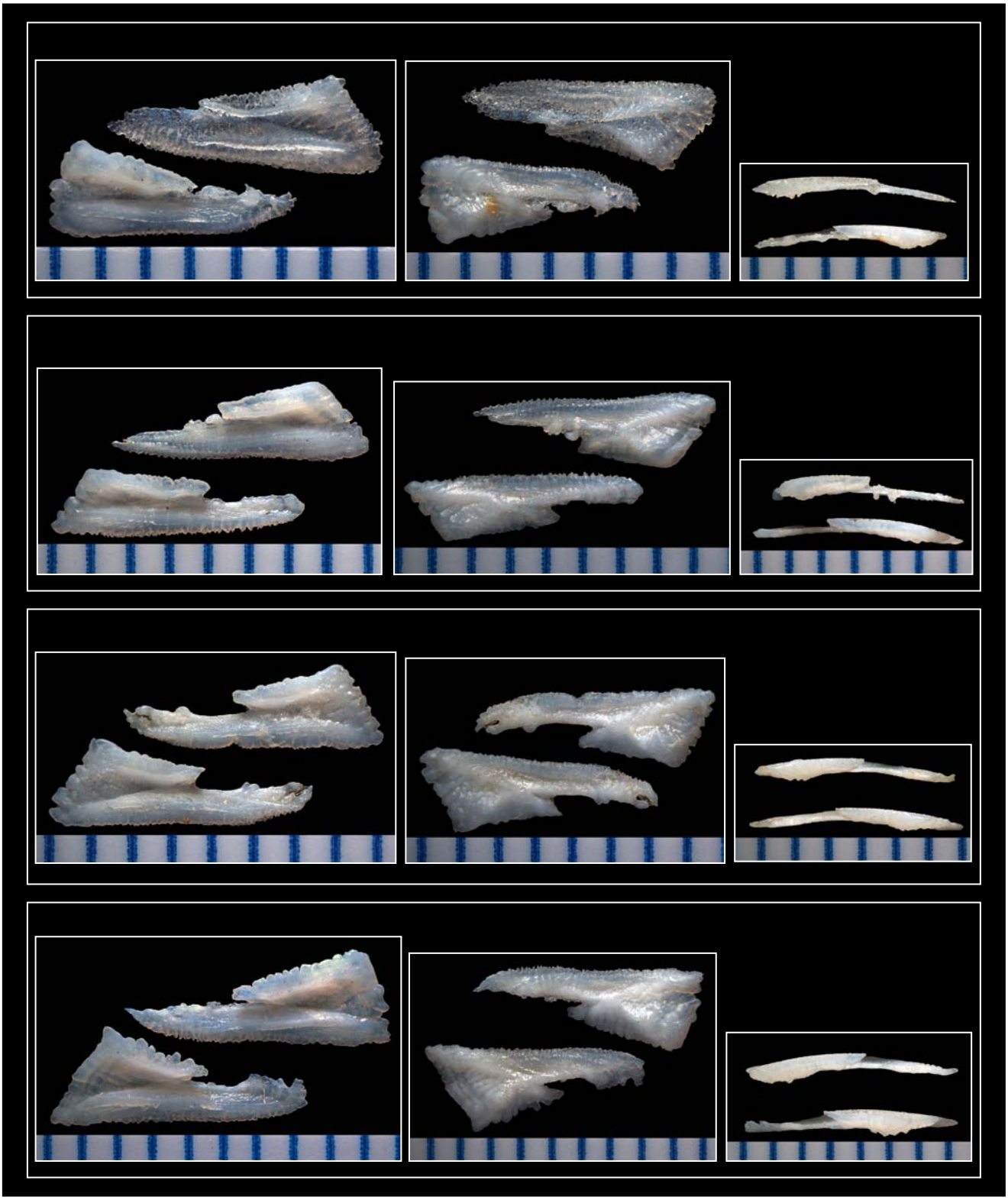
Sphyraenidae
Sphyraena argentea, California barracuda, LACM 56687-1



Scombridae
Sarda chiliensis, Pacific bonito, LACM 57268-1



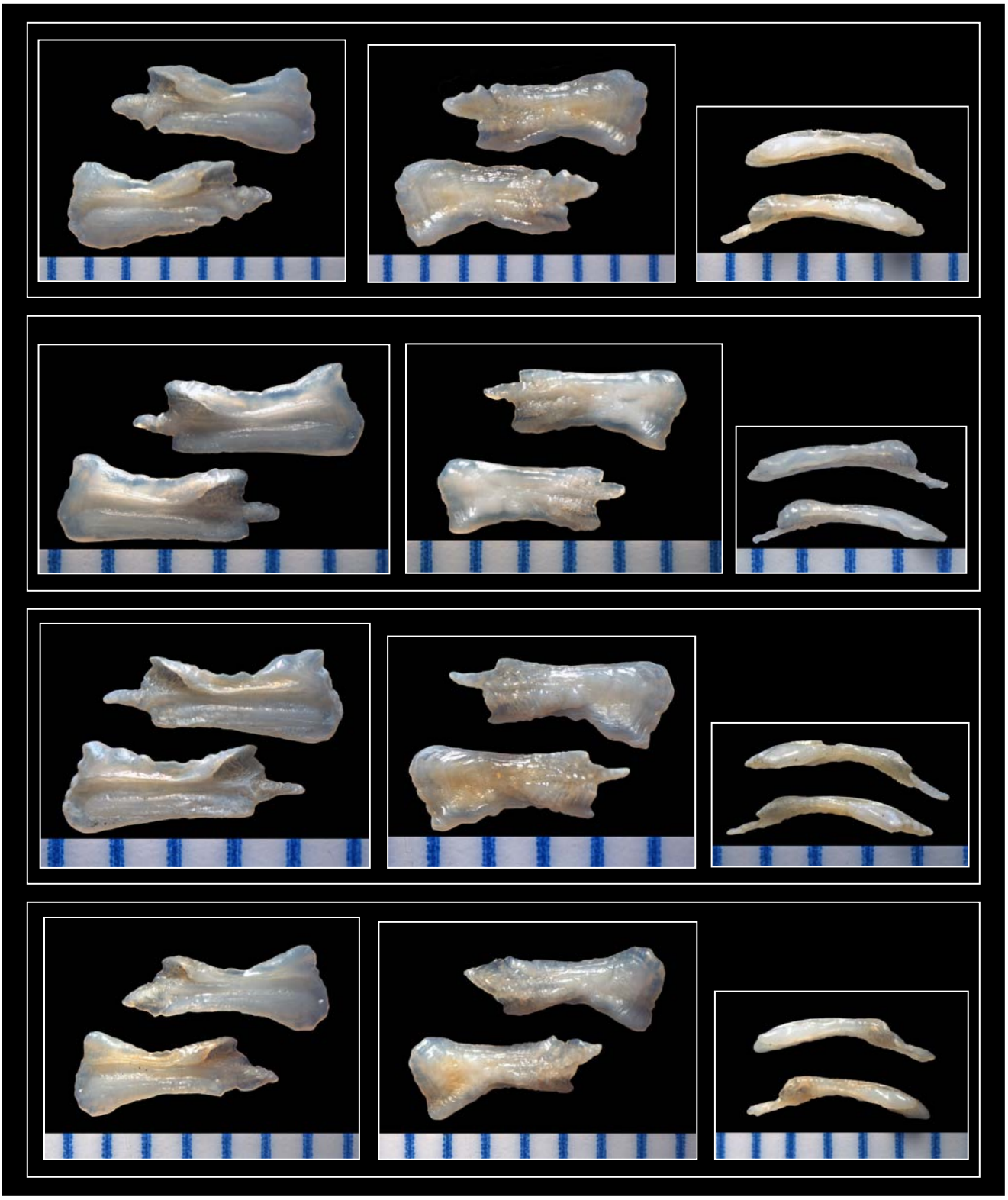
Scombridae
Sarda chiliensis, Pacific bonito, LACM 57268-1



Scombridae
Sarda chiliensis, Pacific bonito, LACM 57268-1

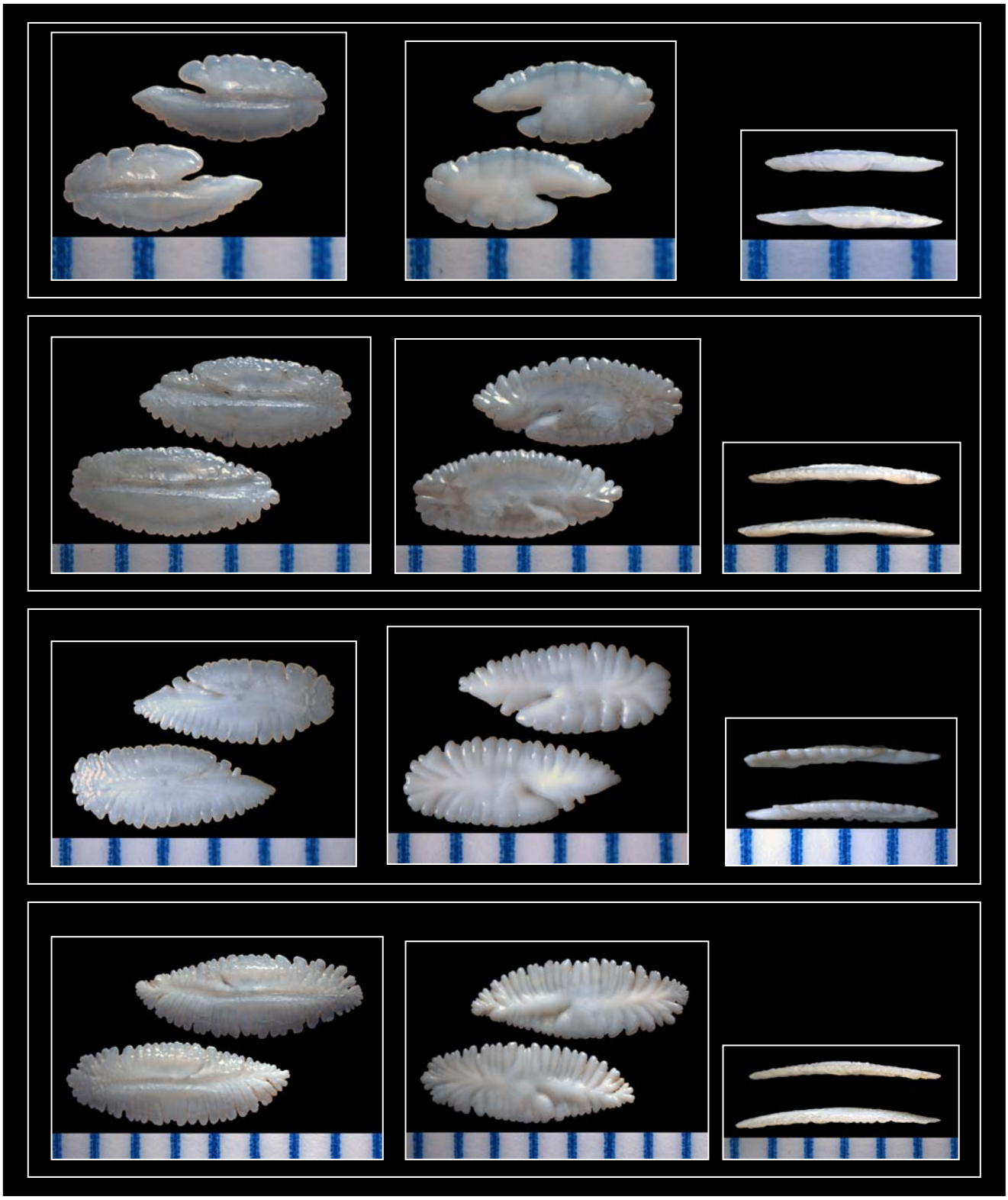
Scombridae
Scomber japonicus, Pacific mackerel, LACM 56604-1

Scombridae
Scomber japonicus, Pacific mackerel, LACM 56604-1

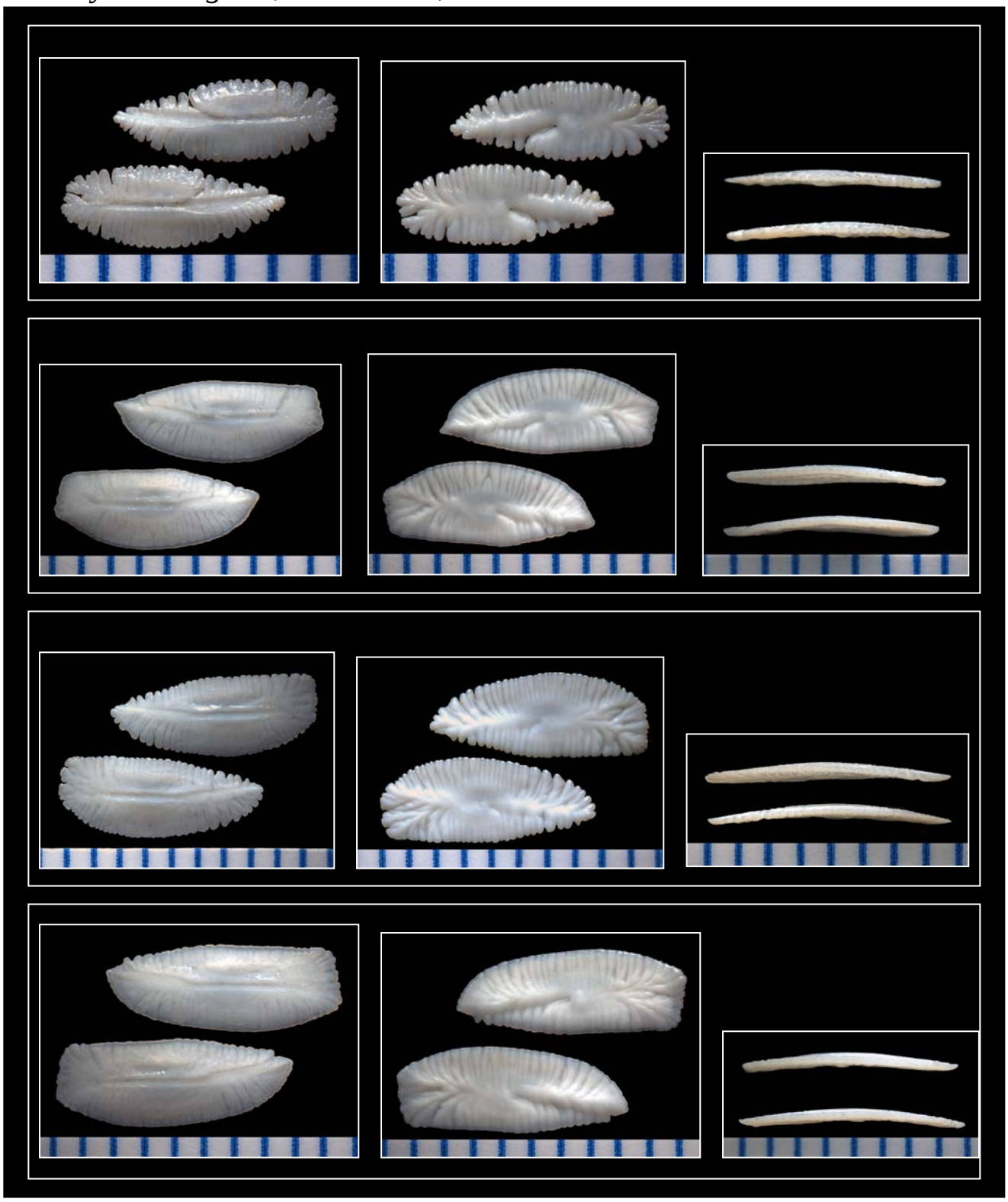


Scombridae
Scomber japonicus, Pacific mackerel, LACM 56604-1

Centrolophidae
Icichthys lockingtoni, medusafish, LACM 56602-1

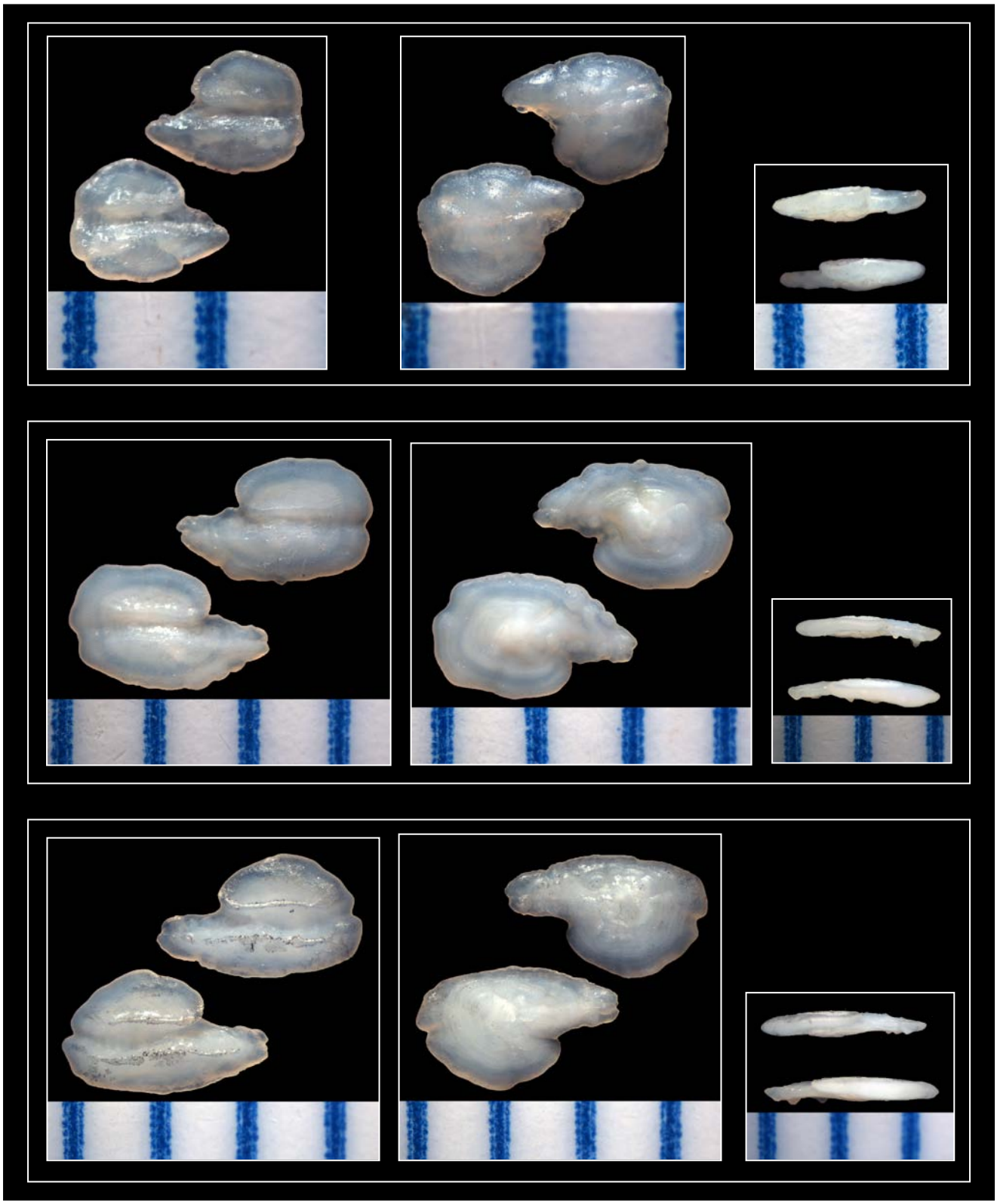


Centrolophidae
Icichthys lockingtoni, medusafish, LACM 56602-1

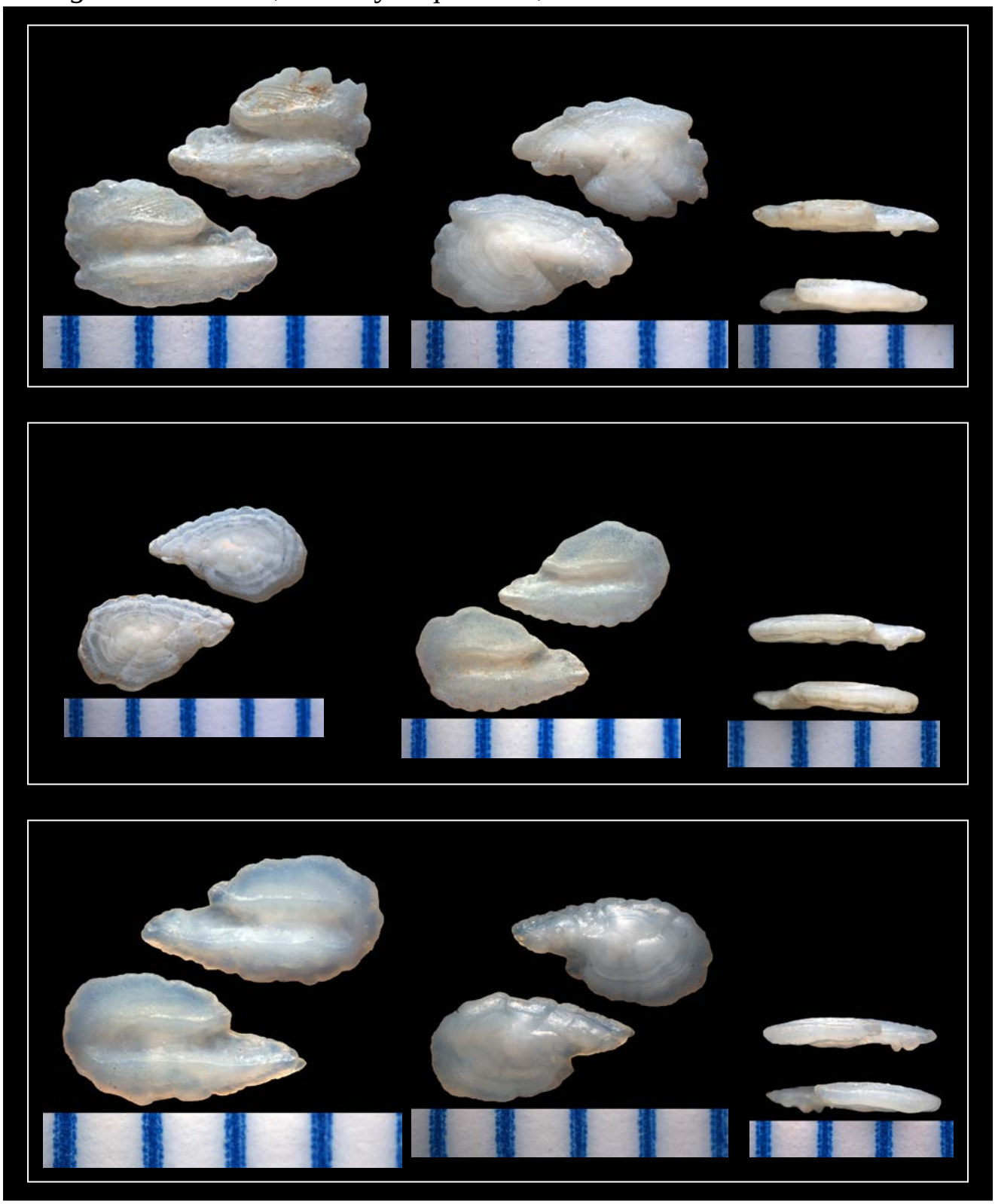


Centrolophidae
Icichthys lockingtoni, medusafish, LACM 56602-1

Tetragonuridae
Tetragonurus cuvieri, smalleye squaretail, LACM 57269-1

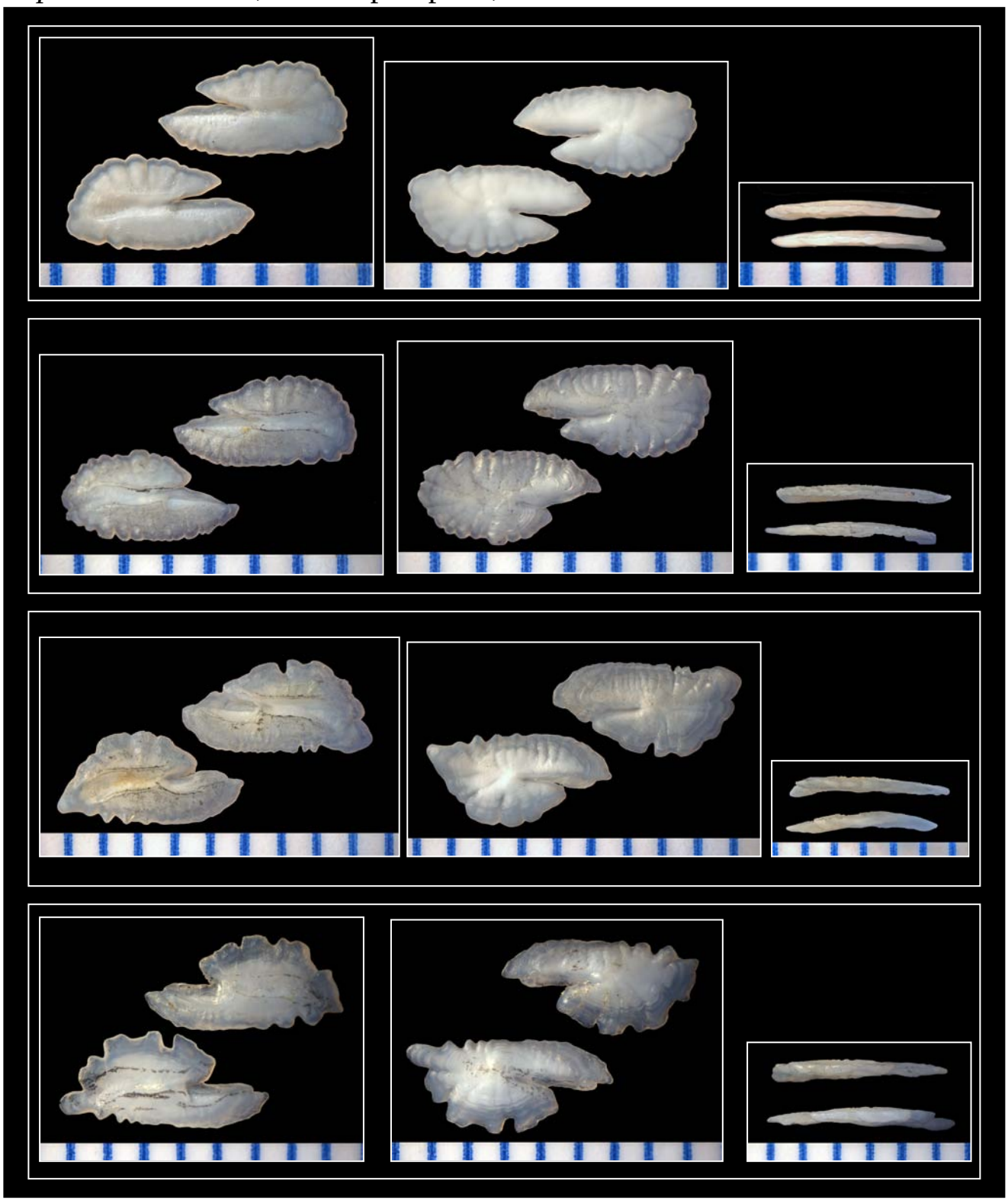


Tetragonuridae
Tetragonurus cuvieri, smalleye squaretail, LACM 57269-1

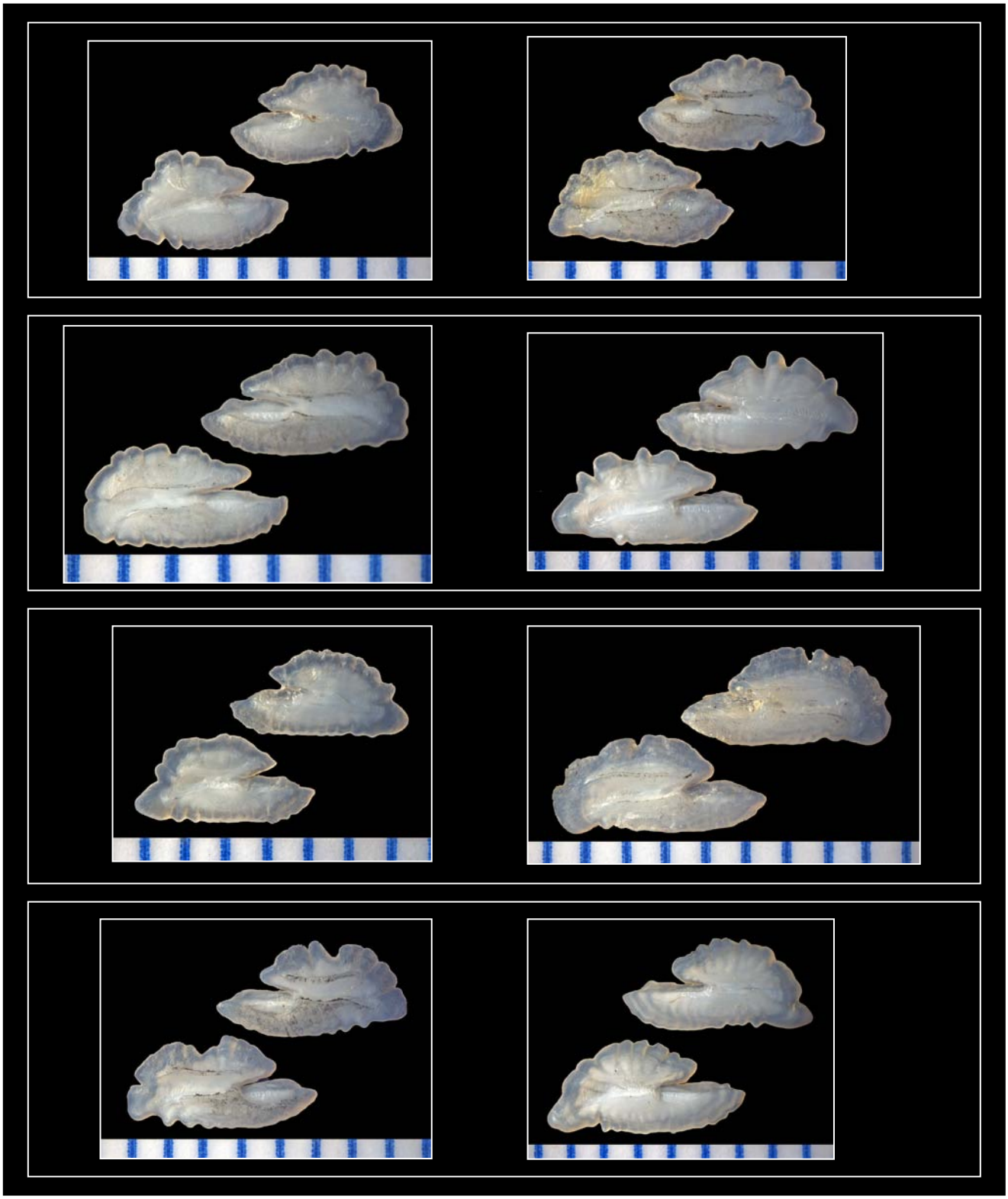


Tetragonuridae
Tetragonurus cuvieri, smalleye squaretail, LACM 57269-1

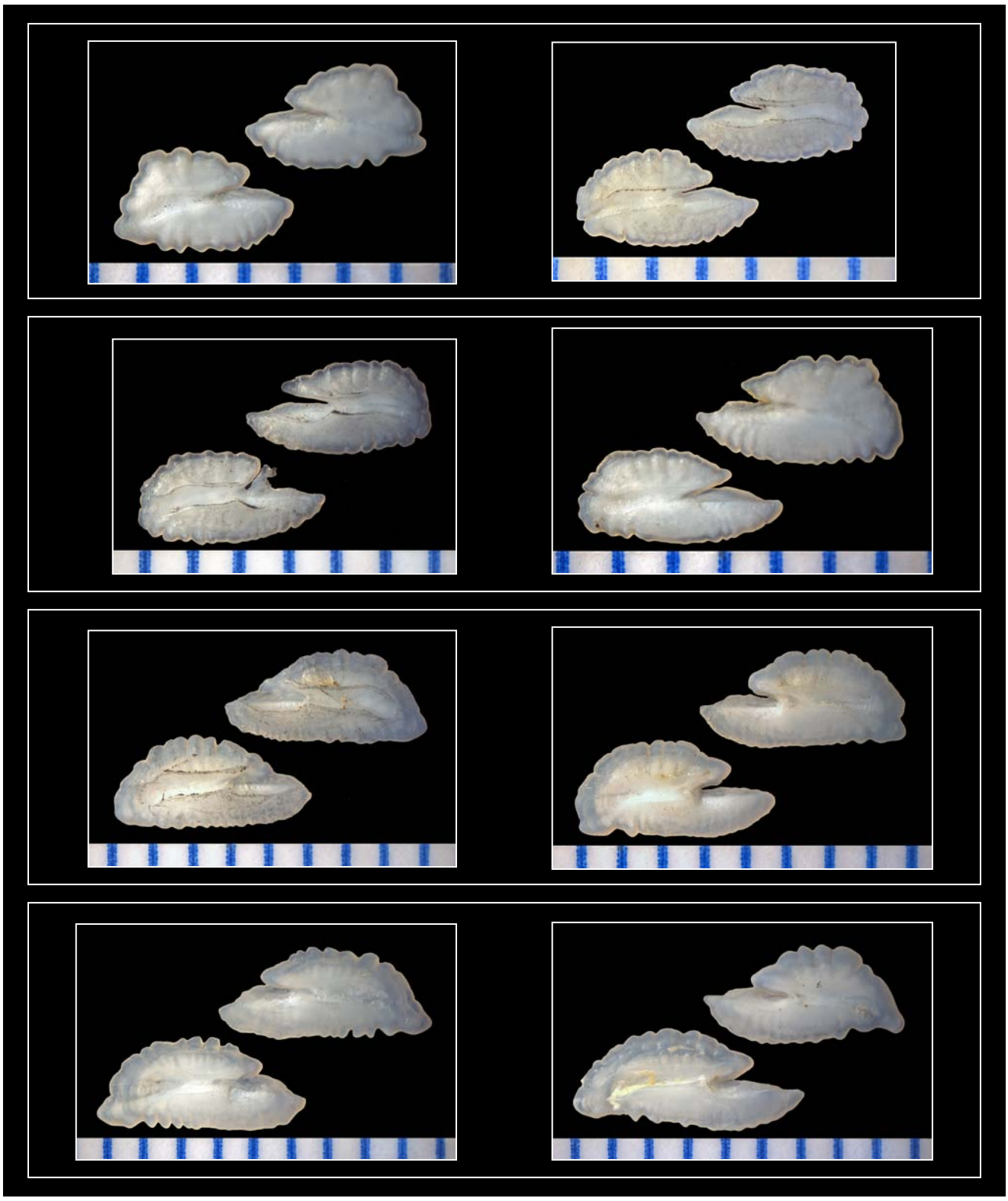
Stromateidae
Peprilus simillimus, Pacific pompano, LACM 56689-1



Stromateidae
Peprilus simillimus, Pacific pompano, LACM 56689-1

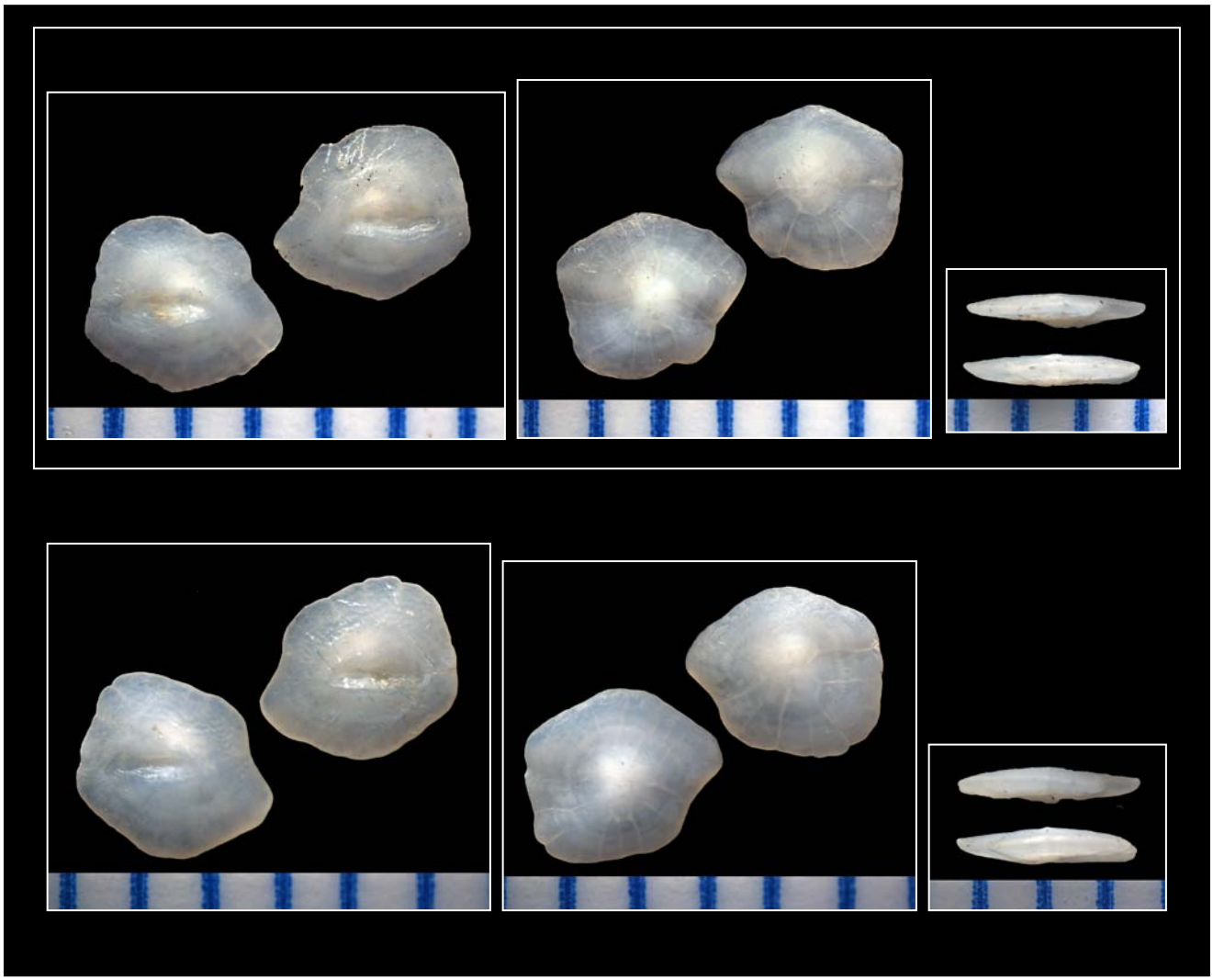


Stromateidae
Peprilus simillimus, Pacific pompano, LACM 56689-1

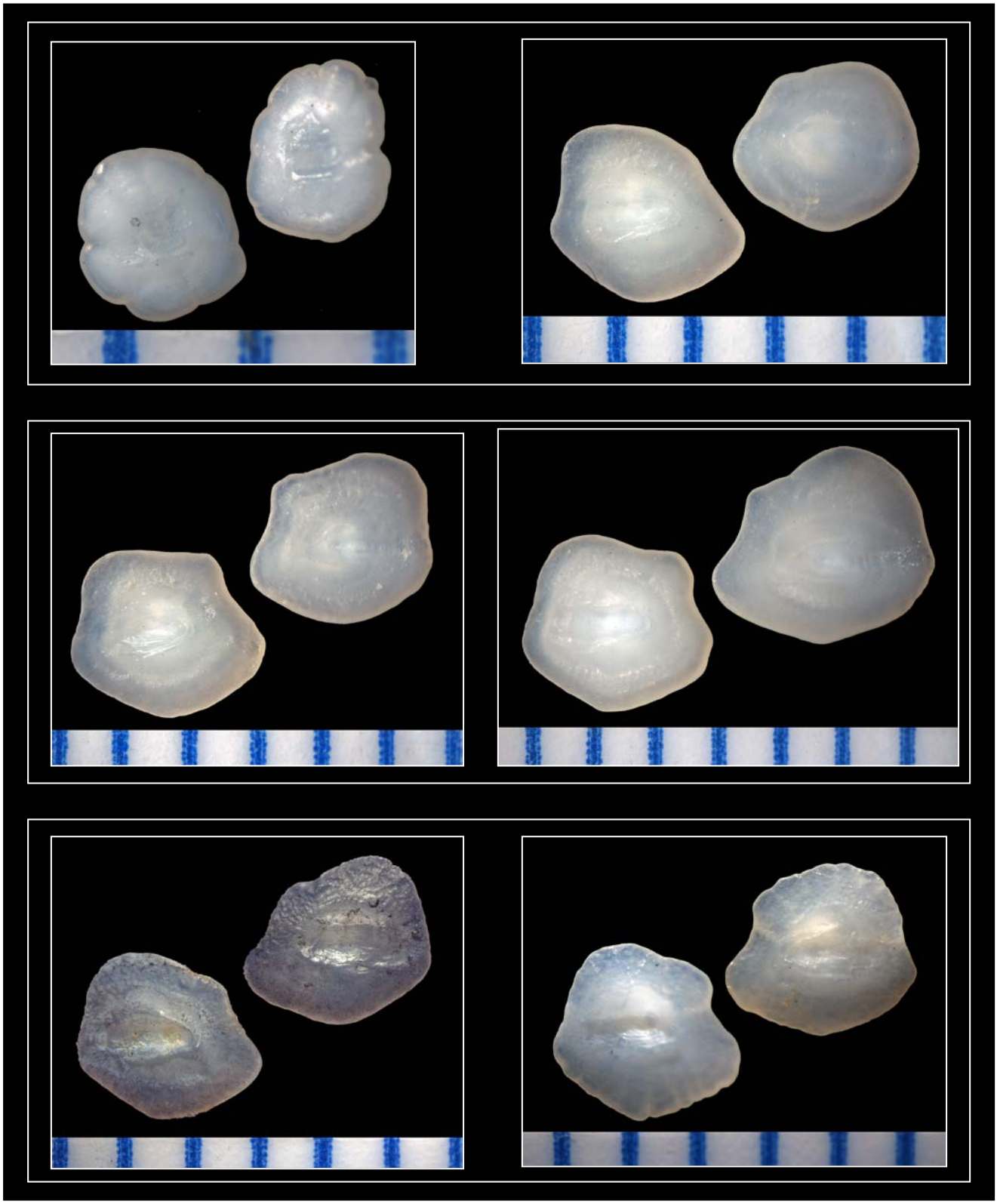


Paralichthyidae
Citharichthys sordidus, Pacific sanddab, LACM 56637-1

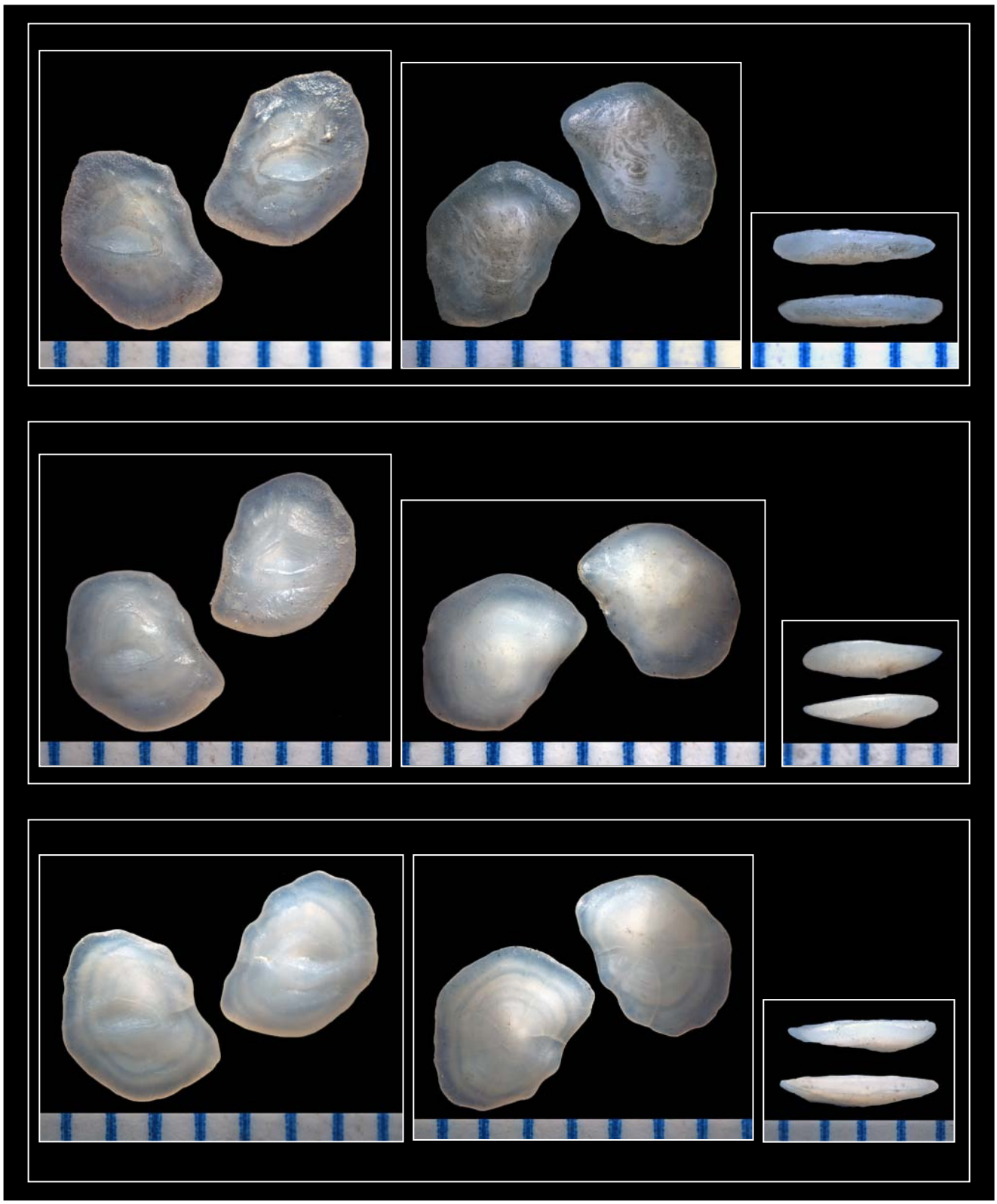
Paralichthyidae
Citharichthys stigmaeus, speckled sanddab, LACM 56638-1



Paralichthyidae
Citharichthys stigmaeus, speckled sanddab, LACM 56638-1



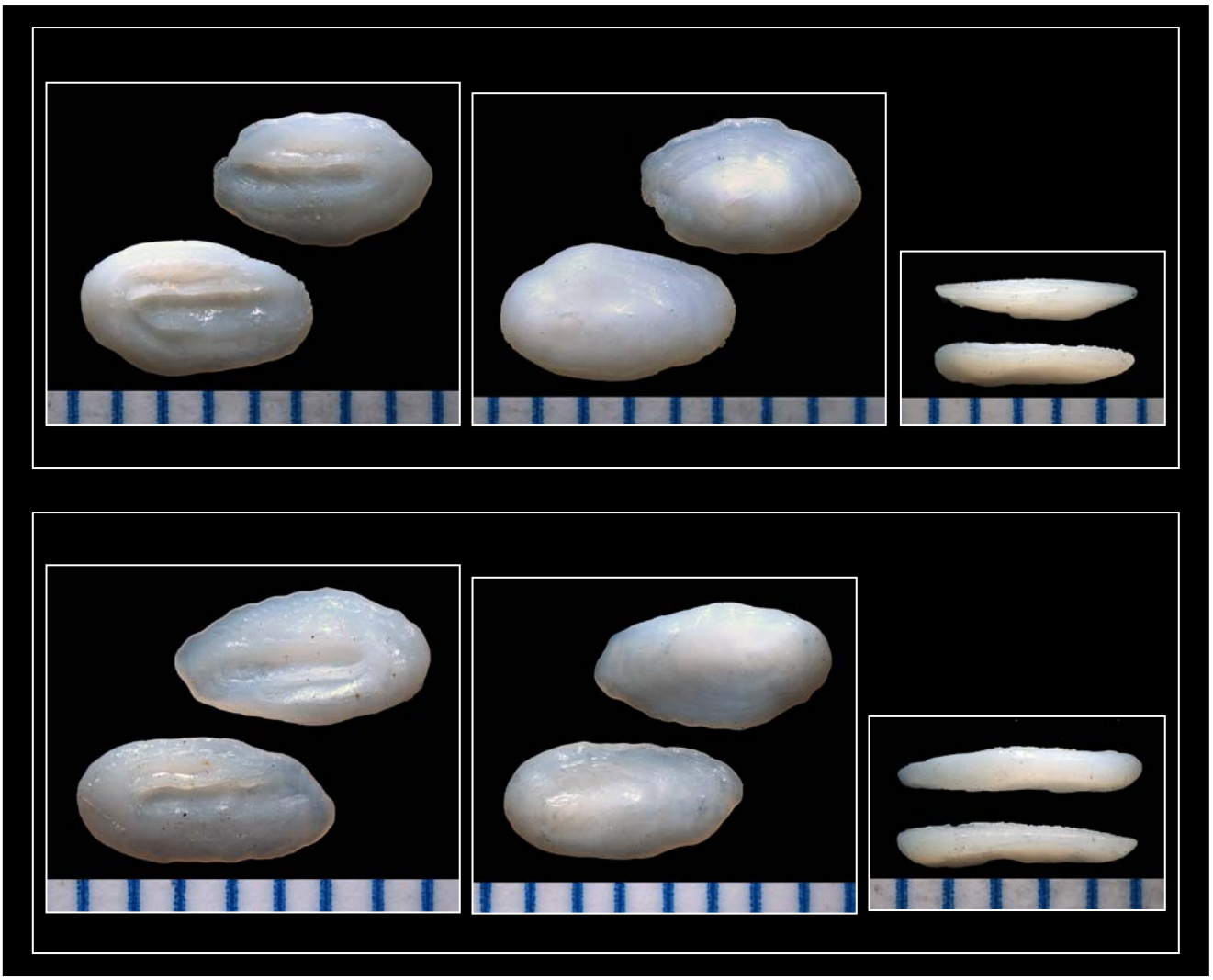
Paralichthyidae
Citharichthys xanthostigma, longfin sanddab, LACM 56718-1



Paralichthyidae
Citharichthys xanthostigma, longfin sanddab, LACM 56718-1

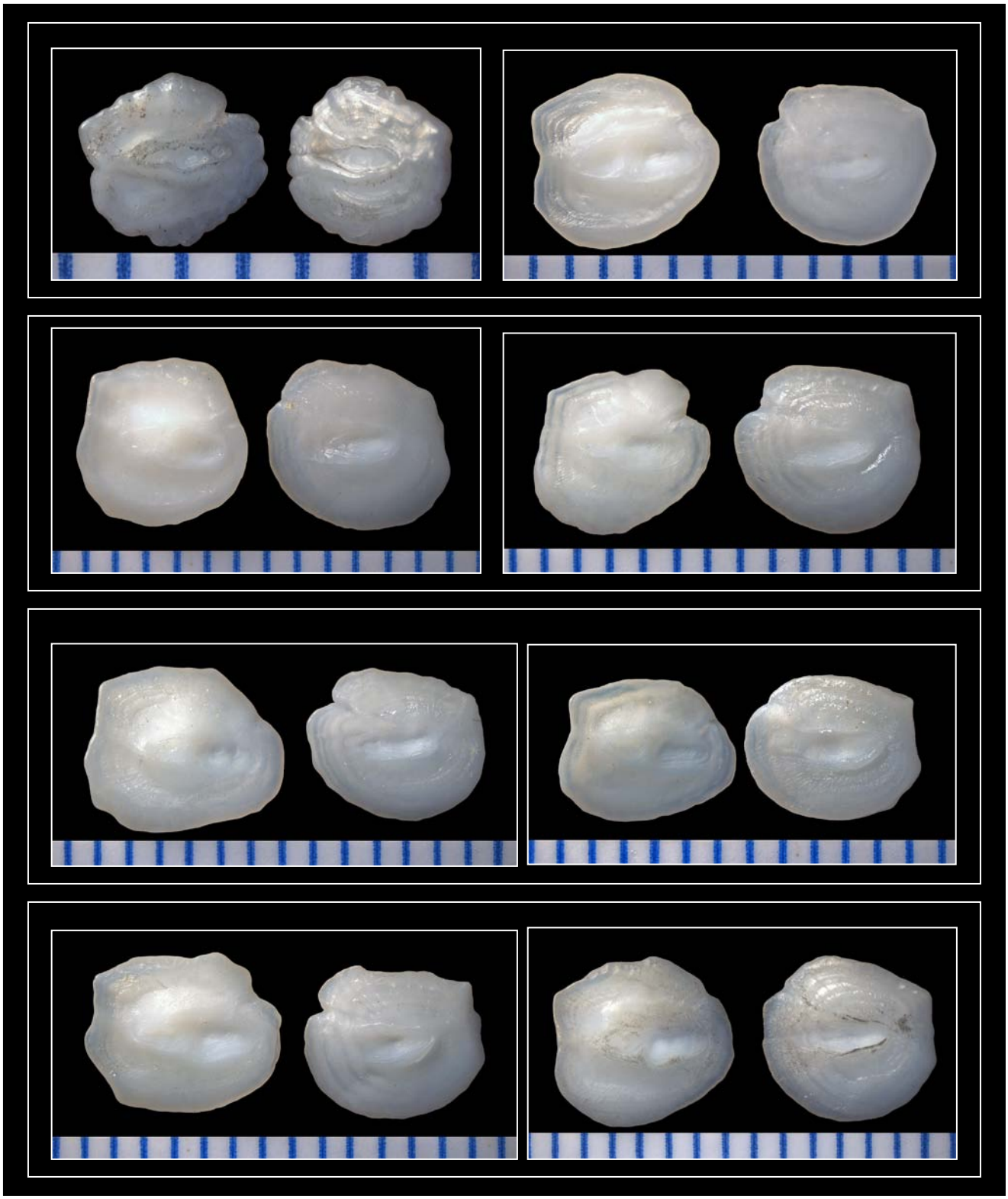
Paralichthyidae
Hippoglossina stomata, bigmouth sole, LACM 56715-1

Paralichthyidae
Hippoglossina stomata, bigmouth sole, LACM 56715-1



Pleuronectidae
Glyptocephalus zachirus, rex sole, LACM 56672-1

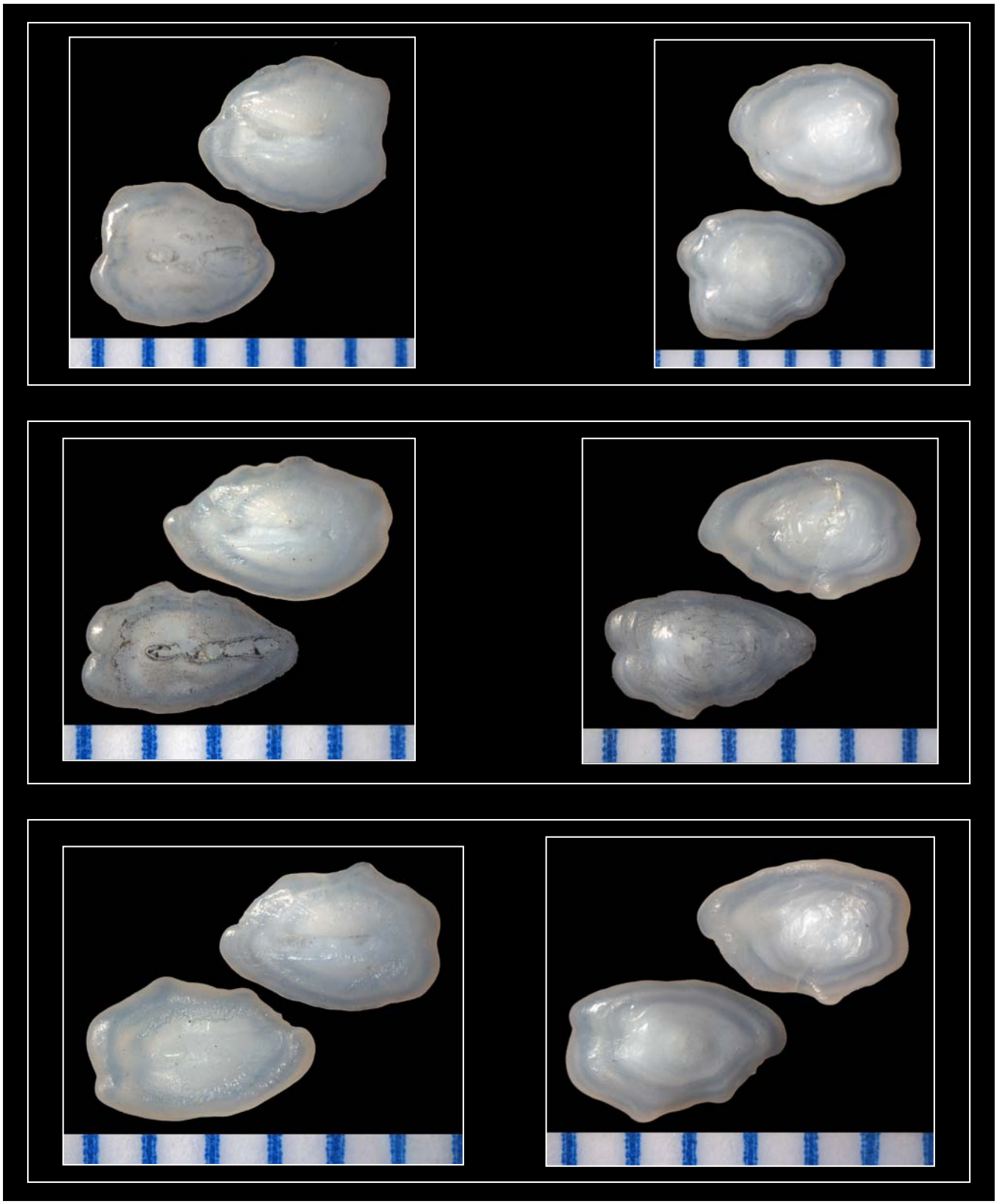
Pleuronectidae
Glyptocephalus zachirus, rex sole, LACM 56672-1



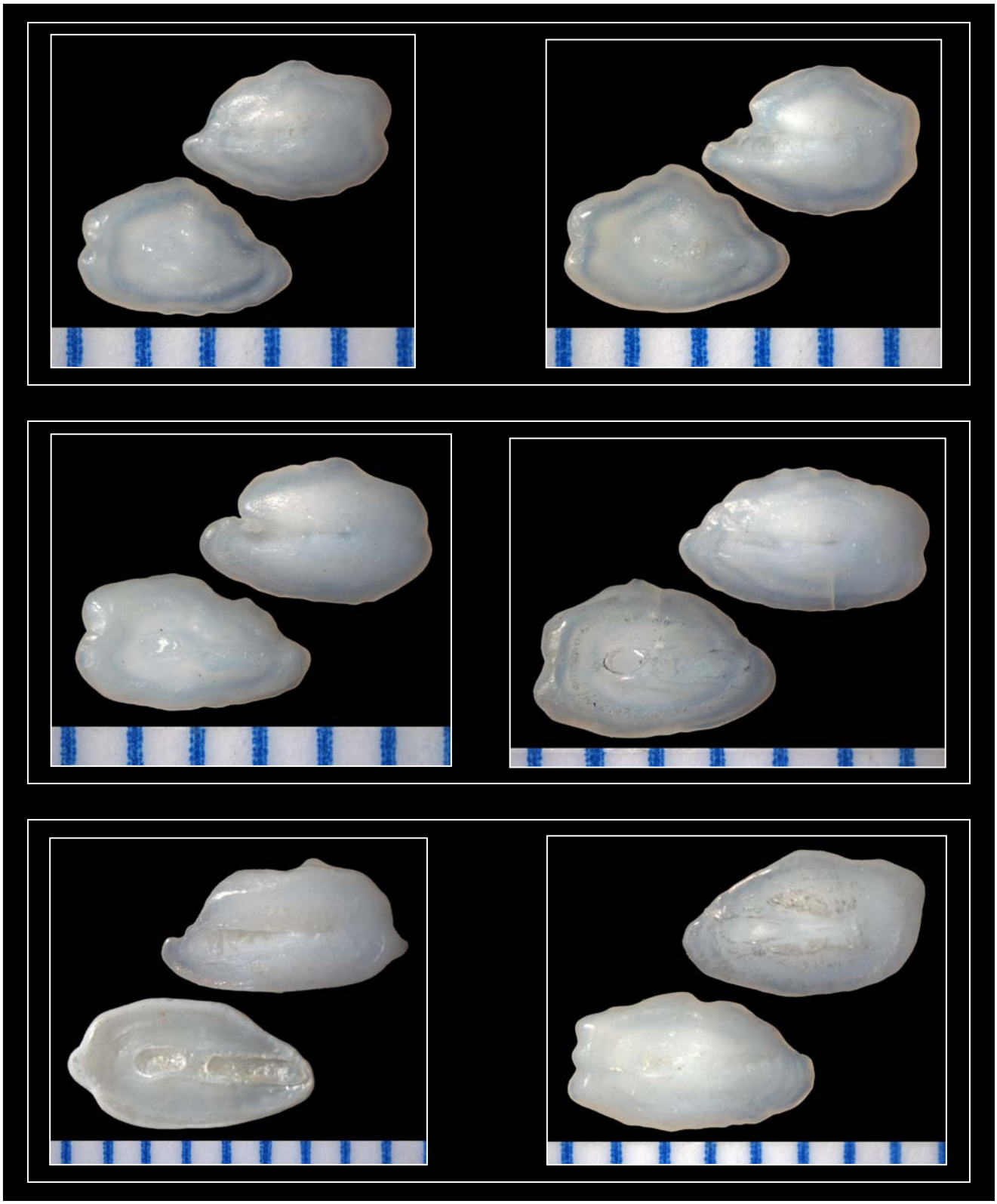
Pleuronectidae
Lepidopsetta bilineata, rock sole, LACM 56716-1

Pleuronectidae
Lyopsetta exilis, slender sole, LACM 56639-1

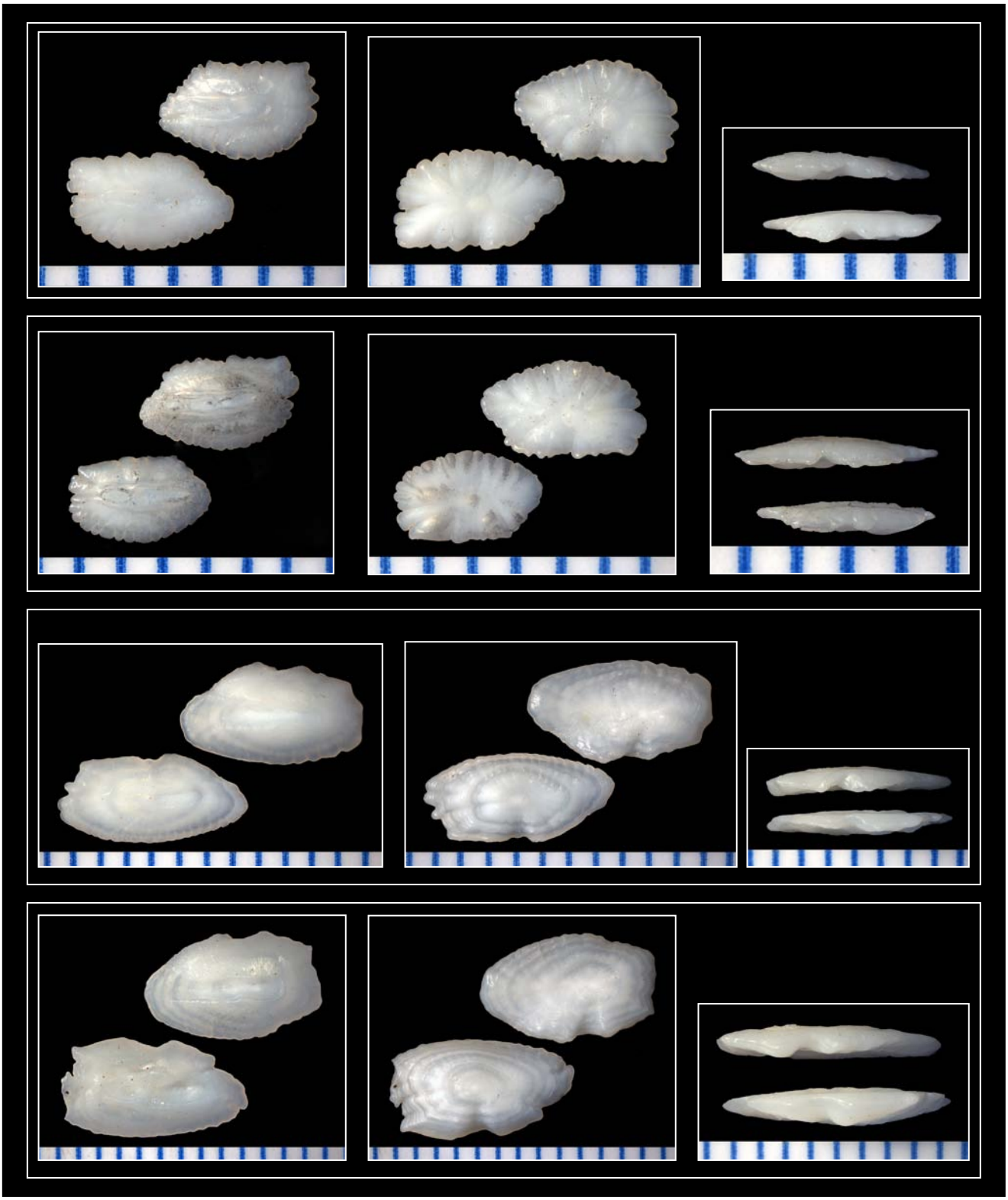
Pleuronectidae
Microstomus pacificus, dover sole, LACM 56640-1



Pleuronectidae
Microstomus pacificus, dover sole, LACM 56640-1



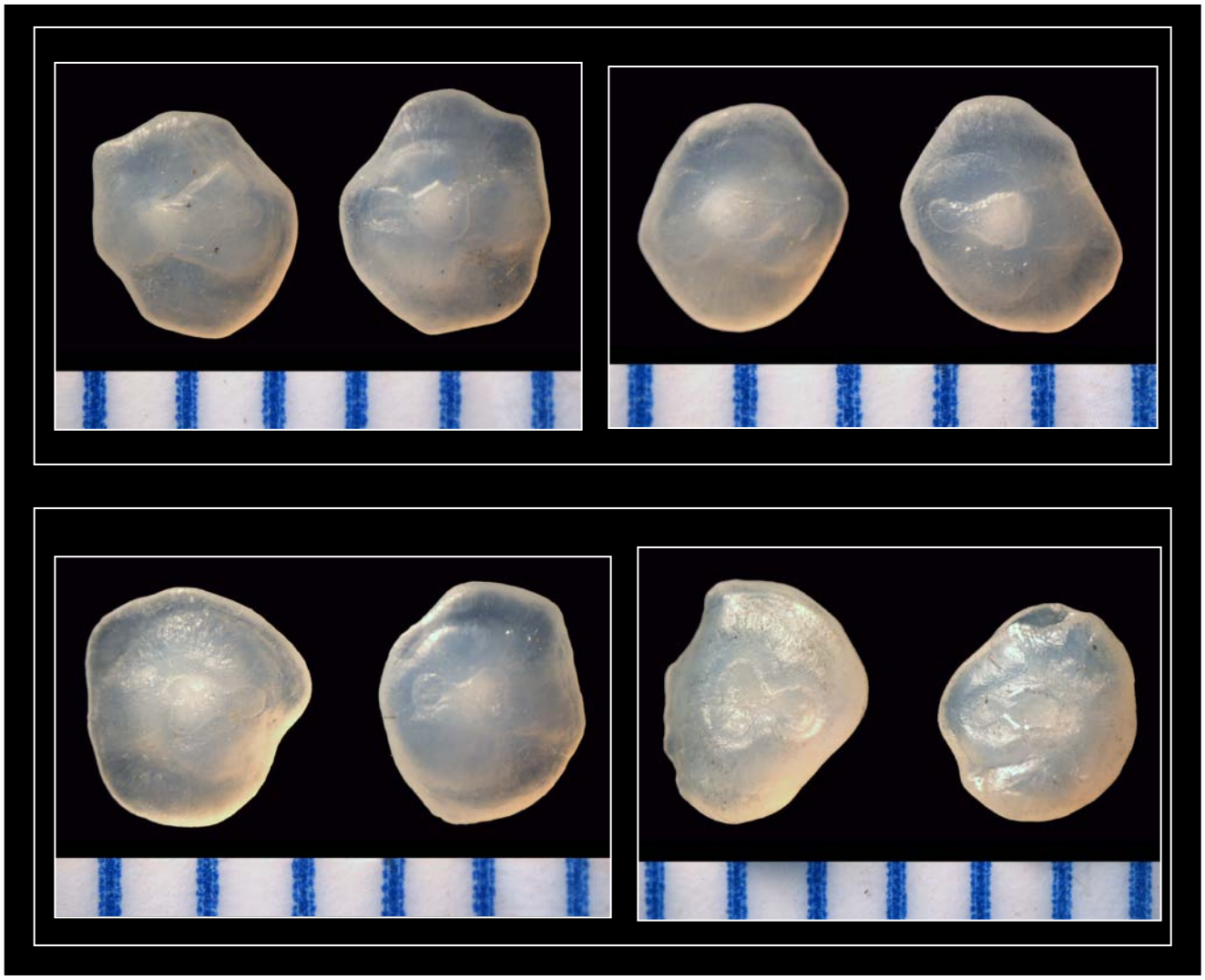
Pleuronectidae
Parophrys vetulus, English sole, LACM 56691-1



Pleuronectidae
Parophrys vetulus, English sole, LACM 56691-1

Cynoglossidae
Symphurus atricauda, California tonguefish, LACM 56688-1

Cynoglossidae
Symphurus atricauda, California tonguefish, LACM 56688-1



RECENT TECHNICAL MEMORANDUMS

SWFSC Technical Memorandums are accessible online at the SWFSC web site (http://swfsc.noaa.gov). Copies are also available form the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (http://www.ntis.gov). Recent issues of NOAA Technical Memorandums from the NMFS Southwest Fisheries Science Center are listed below:

NOAA-TM-NMFS-SWFSC-473 Comparison of real-time and post-cruise acoustic species identification of dolphin whistles using ROCCA (Real-time Odontocete Call Classification Algorithm).
Y. BARKLEY, J.N. OSWALD, J.V. CARRETTA, S. RANKIN, A.RUDD, and M.O. LAMMERS
(February 2011)

474 Global review of Humpback whale, *(Megaptera novaeangliae)*
A. FLEMING and J. JACKSON
(March 2011)

475 Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Central California Coast Coho Salmon ESU.
B.C. SPENCE and T.H. WILLIAMS
(March 2011)

476 U.S. Pacific marine mammal stock assessments: 2011.
J.V. CARRETTA, K.A. FORNEY, E. OLESON, K. MARTIEN, M.M. MUTO, M.S. LOWRY, J. BARLOW, J. BAKER, B. HANSON, D. LYNCH, L. CARSWELL, R.L. BROWNELL JR., J. ROBBINS, D.K. MATTILA, K. RALLS, and M.C. HILL
(June 2011)

477 Osteological specimens of tropical dolphins *(Delphinus, Grampus, Lagenodelphis, Stenella, Steno and Tursiops)* killed in the tuna fishery in the tuna fishery in the eastern tropical Pacific (1966-1992) and placed in museums by the Southwest Fisheries Science Center.
W.F. PERRIN and S.J. CHIVERS
(May 2011)

478 Ichthyoplankton and station data for surface (Manta) and oblique (Bongo) plankton tows for California Cooperative Oceanic Fisheries Investigations Survey cruises in 2007.
S.R. CHARTER, W. WATSON, and S.M. MANION
(May 2011)

479 Passive acoustic beaked whale monitoring survey of the Channel Islands, CA.
T.M. YACK, J. BARLOW, J. CALAMBOKIDIS, L. BALLANCE, R. PITMAN, and M. McKENNA
(May 2011)

480 Determining transmitter drag and best-practice attachment procedures for sea turtle biotelemetry studies.
T.T. JONES, B. BOSTROM, M. CAREY, B. IMLACH, J. MIKKELSEN, P. OSTAFICHUK, S. ECKERT, P. OPAY, Y. SWIMMER, J.A. SEMINOFF, and D.R. JONES
(November 2011)

481 Ichthyoplankton, paralarval cephalopod, and station data for surface (Manta) and oblique (Bongo) plankton tows for California Cooperative Oceanic Fisheries Investigations Survey and California Current Ecosystem Survey cruises in 2008.
W. WATSON and S.M. MANION
(May 2011)

482 Toward a national animal telemetry observing network (ATN) for our oceans, coasts and great lakes: Workshop synthesis report.
H. MOUSTAHFID, C GRIMES, J. KOCIK, B. BLOCK, K. HOLLAND, J. PAYNE, D. FOX, A. SEITZ, and C. ALEXANDER
(July 2011)