

APPENDIX II

ILLUSTRATED QUICK REFERENCE GUIDE TO SPECIES PROHIBITED IN TEXAS

The following quick reference pages group fishes, invertebrates, and aquatic plants which are similar in appearance so that prohibited species can be identified with a minimal number of characters and can be quickly compared to other unprohibited species with which they may be confused. These guides are only for quick reference. Detailed text references should be consulted. Additionally, these species include only those specifically listed by Texas Parks and Wildlife Department; however, in several cases, comments on species covered under federal regulations are also noted. These groupings, which are sometimes rather artificial, include:

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EEL-LIKE FISHES WITHOUT JAWS

LAMPREYS

Prohibited

Pacific Lamprey *Entosphenus tridentata*

divided dorsal fin



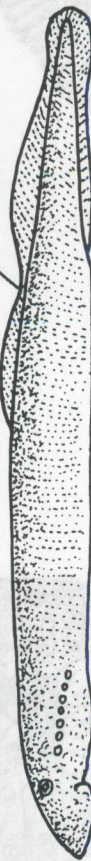
Sea Lamprey *Petromyzon marinus*

divided dorsal fin



Silver Lamprey *Ichthyomyzon unicuspis*

deeply-notched dorsal fin



Pouched Lamprey *Geotria australis*

divided dorsal fin



pouch

Unprohibited

Chestnut Lamprey *Ichthyomyzon castaneus*

shallow notch



Southern Brook Lamprey *Ichthyomyzon gagei*

shallow notch



RESTRICTED LAMPREYS INCLUDE:

- Any with two dorsal fins
- Any with a deeply notched dorsal fin
- Any with two anterior central dental plates in mouth
- Any with two points and two prongs on the central dental plate
- Any with spatula-like teeth
- Any with single-pointed circumoral teeth
- Any with more than 54 muscle segments between the last gill opening and the vent (usually)
- Any without fringed papillae around mouth

NOTE

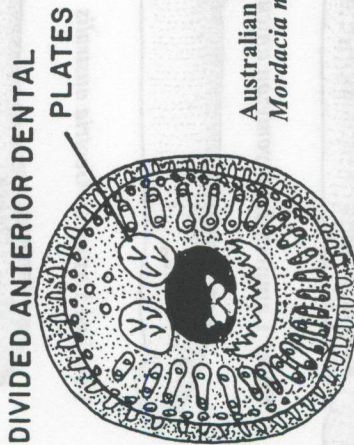
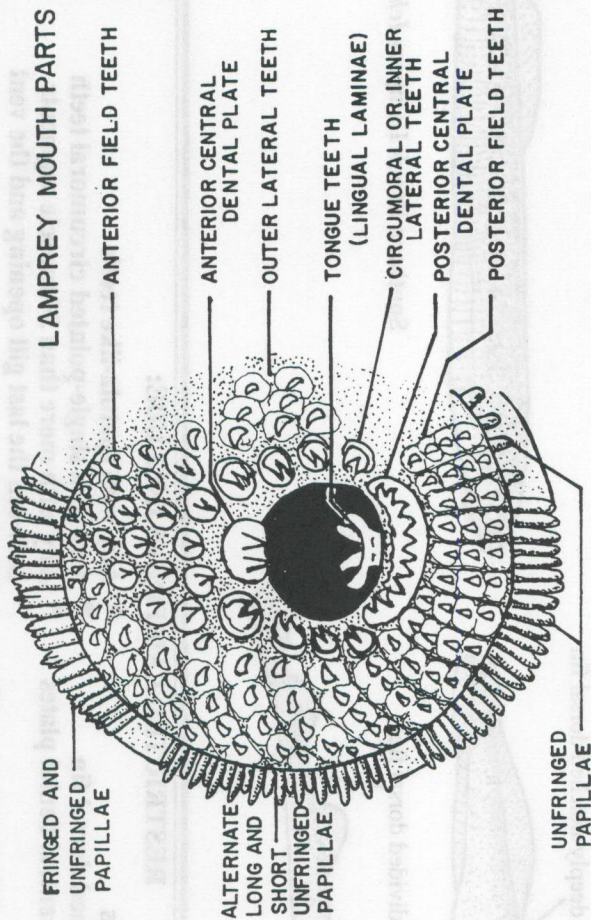
Larvae are often difficult or impossible to identify; if problems develop, contact TPWD Inland Fisheries Research staff at Heart of the Hills Research Station, Ingram, Texas

EEL-LIKE FISHES WITHOUT JAWS

LAMPREYS

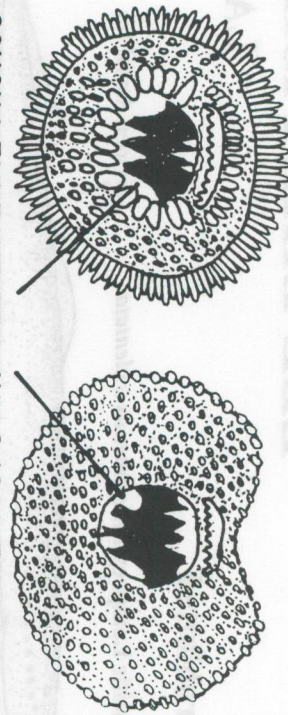
Unprohibited

Prohibited

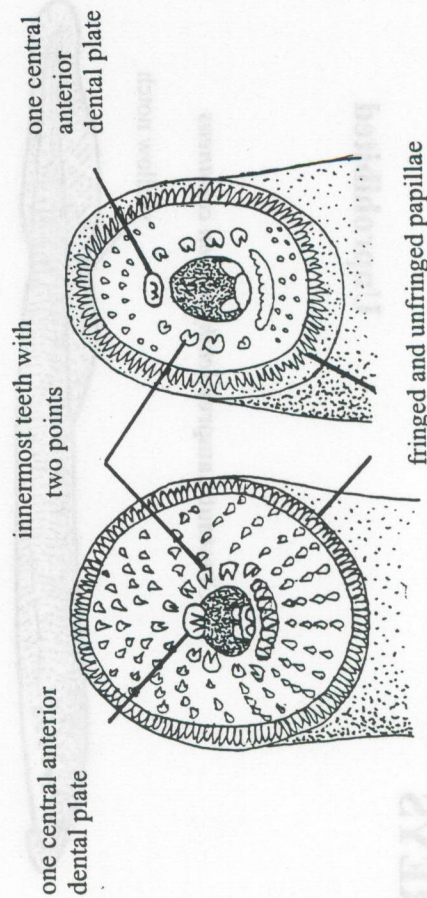


Australian Lamprey
Mordacia mordax

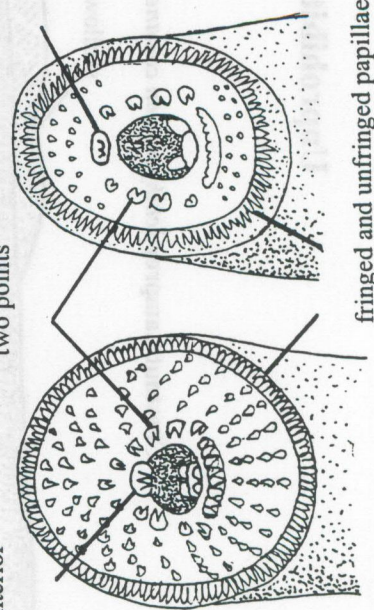
ANTERIOR DENTAL PLATE SET DEEP IN MOUTH WITH TWO CENTRAL CUSPS AND TWO LATERAL PRONGS



Pouched Lamprey
Geotria australis



Chestnut Lamprey
Ichthyomyzon castaneus



Southern Brook Lamprey
Ichthyomyzon gagei

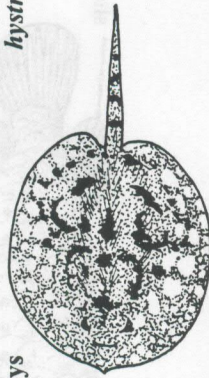
STINGRAYS

SOUTH AMERICAN FRESHWATER STINGRAYS

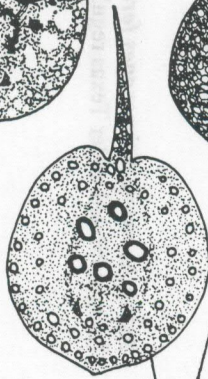
Prohibited

South American
Freshwater Stingrays

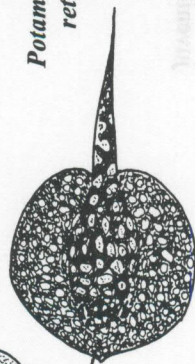
Potamotrygon
hystrix



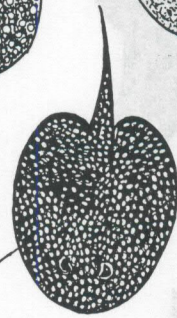
Potamotrygon
motoro



Potamotrygon
reticulatus



Potamotrygon
signata



Paratrygon
aiereba



Plesiотrygon iwamae

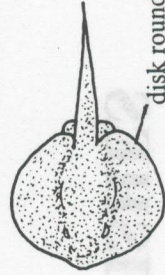


TAIL FINFOLDS

Paratrygon

Potamotrygon

Plesiотrygon

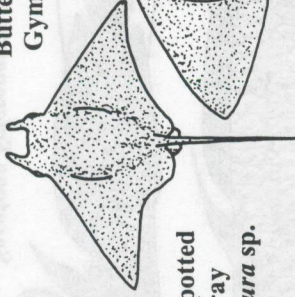


but

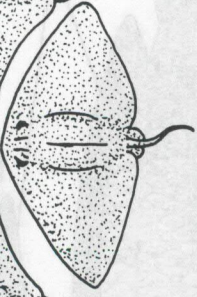
tail finfold distinct

Unprohibited

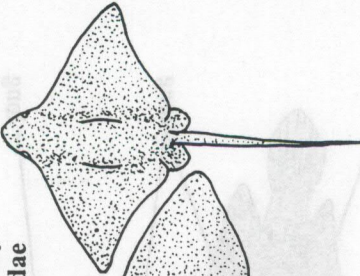
Manta
Mobulidae



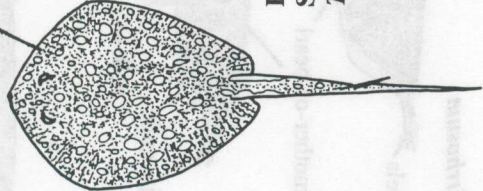
Butterfly Ray
Gymnuridae



Eagle Ray
Myliobatidae



Bluespotted
Stingray
Taeniura sp.



disks not round

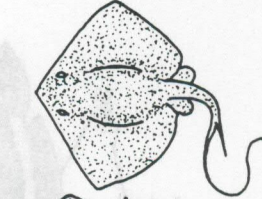
Marine Stingrays
Dasyatidae



Himantura



Dasyatis



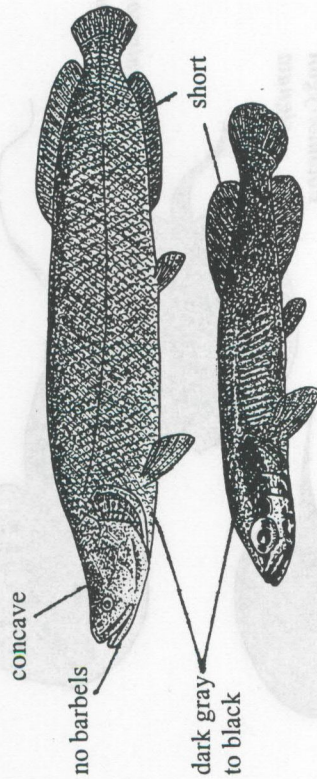
Round Stingrays Urolophidae

BONY-TONGUE FISHES

ARAPAIMA

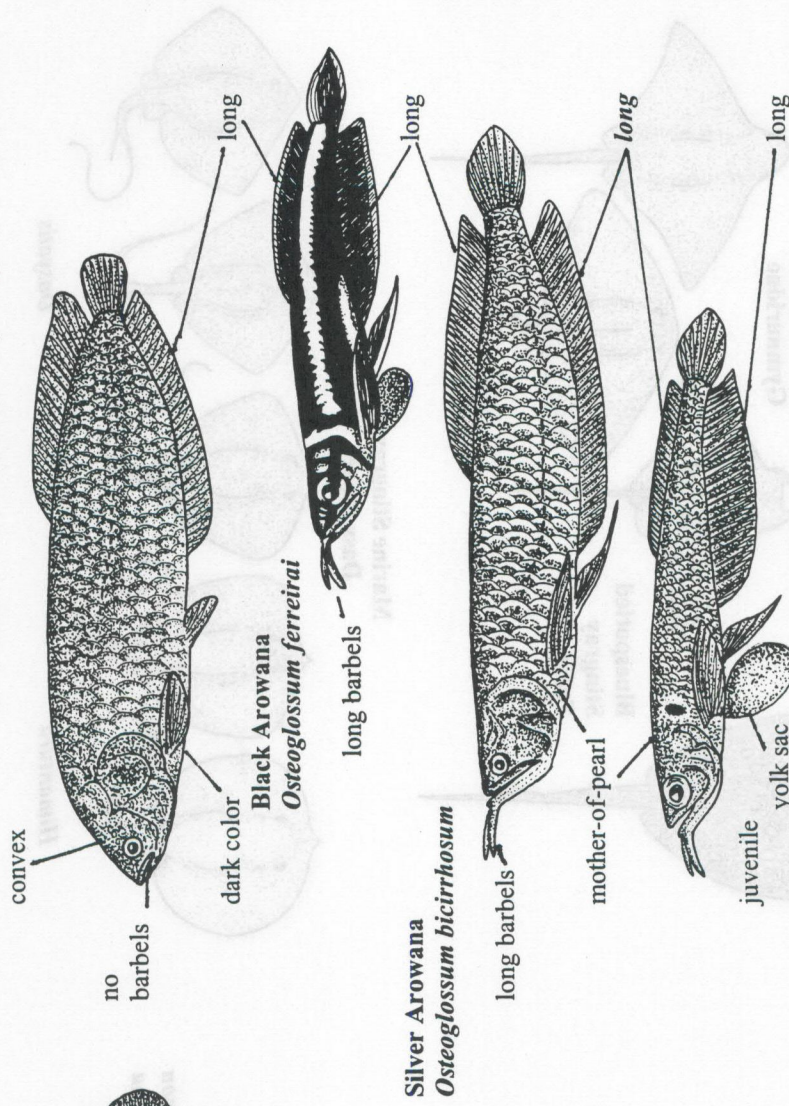
Prohibited

Arapaima Arapaima gigas

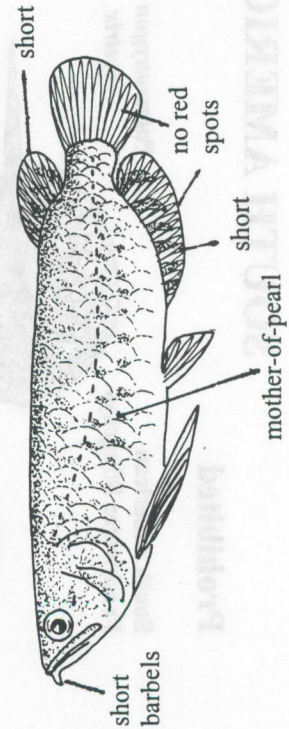


Unprohibited

African Bony-tongue Heterotis niloticus



Asian Arowana Scleropages formosus
(not prohibited under Texas regulations)



EEL-LIKE FISHES WITH JAWS FRESHWATER EELS AND SWAMP EELS

Prohibited

Japanese Eel *Anguilla japonica*

grooved maxillary
tooth band

vertebrae 111-119



preanal length 27% TL

Pacific Eel *Anguilla bicolor*

dorsal and anal fins near-equal length



not mottled

pectoral fins present

Marbled Eel *Anguilla marmorata*

mottled



two gill openings

Mottled Eel *Anguilla nebulosa*

mottled



lower jaw protrudes

Swamp Eel *Monopterus albus*

one gill opening

short, rayless dorsal fin



jaws near equal length

short, rayless anal fin

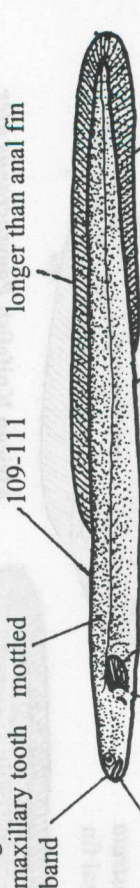
no pectoral fins

Unprohibited

American Eel *Anguilla rostrata*

no groove in
maxillary tooth
band

vertebrae
109-111



lower
jaw protrudes

two gill openings

pectoral fins

preanal length 30% TL

anal rayed

Conger Eel *Conger oceanicus*

upper jaw
protrudes

dorsal fin very long and rayed



two gill
openings

pectoral fins
present

long, rayed anal fin

Freshwater Moray Eel *Gymnothorax polyuranodon*

very long dorsal fin with rays



tubular
nostrils

two gill
openings

no pectoral fins

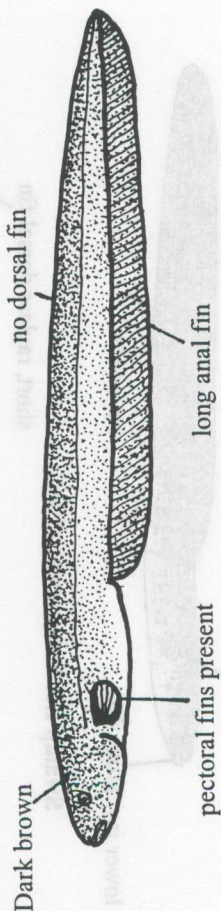
long, rayed anal fin

EEL-LIKE FISHES WITH JAWS

ELECTRIC EEL

Prohibited

Electric Eel *Electrophorus electricus*

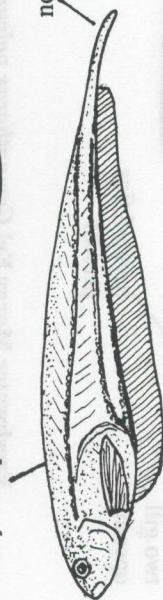


Unprohibited

Banded Knifefish *Gymnotus carapo*



nearly transparent



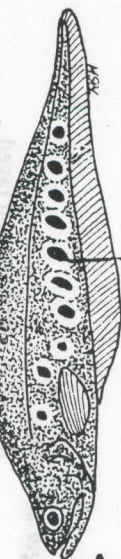
Green Knifefish
Eigenmannia virescens

South American Lungfish
Lepidosiren paradoxa



dorsal fin

Clown Knifefish
Notopterus chitala

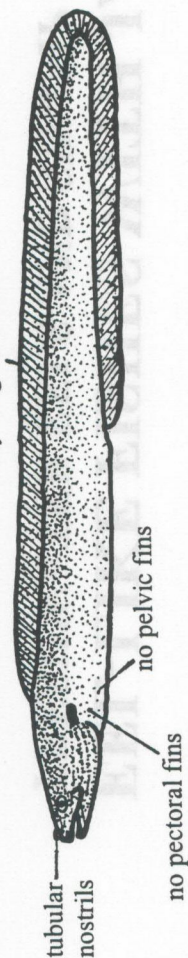


no dorsal fin

American Eel *Anguilla rostrata*

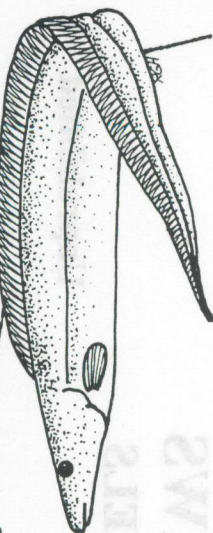


Freshwater Moray Eel *Gymnothorax polyuranodon*



African Knifefish *Papyrocranus afer*
Aba *Gymnarchus niloticus*

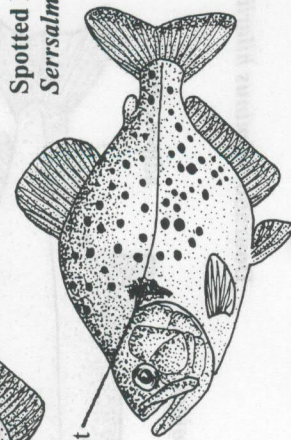
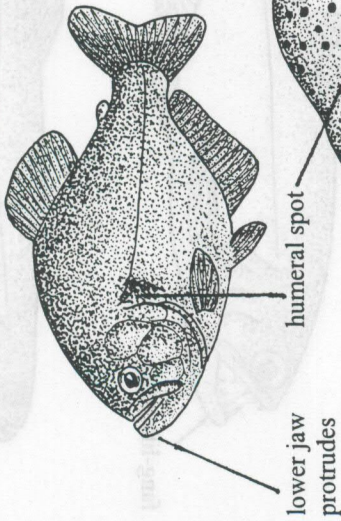
long dorsal fin



PIRANHAS

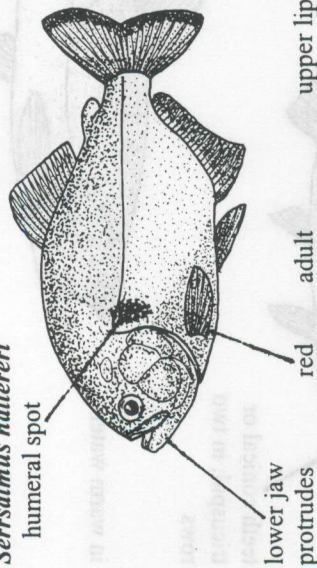
Prohibited

Black Piranha *Serrasalmus niger*



Spotted Piranha
Serrasalmus rhombeus

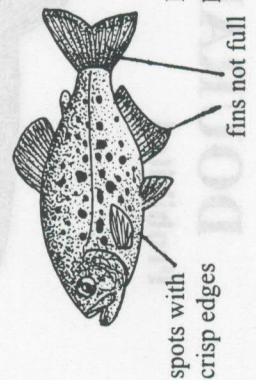
Redbellied Piranha
Serrasalmus nattereri



upper lip straight

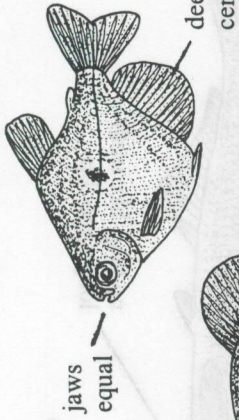
one tooth row

juvenile

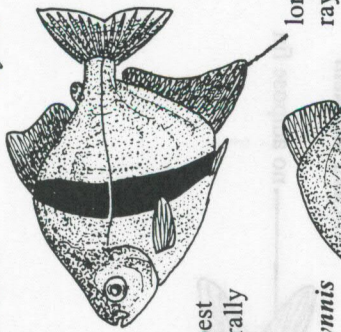


Piranha *Serrasalmus*

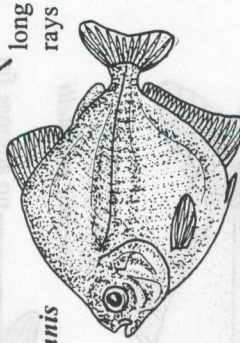
SILVER DOLLARS



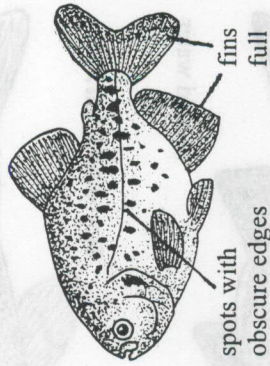
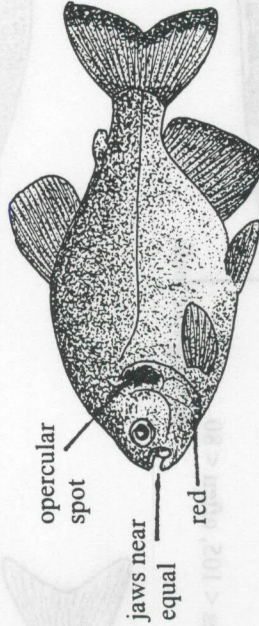
Unprohibited
Mylossoma
Mylopus



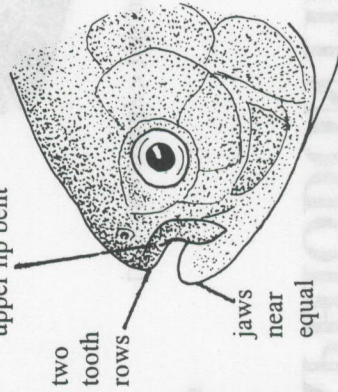
Metynnis



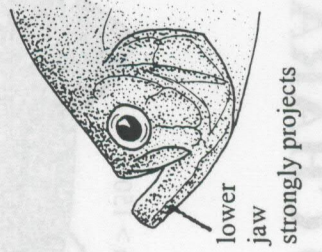
Black Pacu *Colossoma macropomum*
Redbellied Pacu *Colossoma brachypomum*



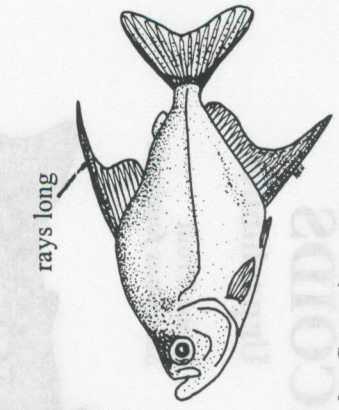
upper lip bent



Pacu *Colossoma*



Wimple Piranha *Catopristion mento*

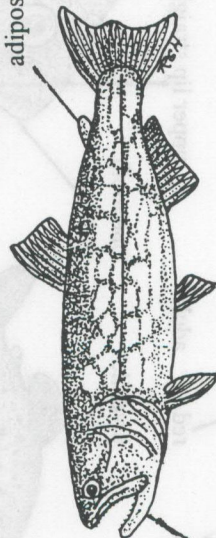


DOURADOS AND RHAPHIODONTID CHARACIDS

Prohibited

Unprohibited

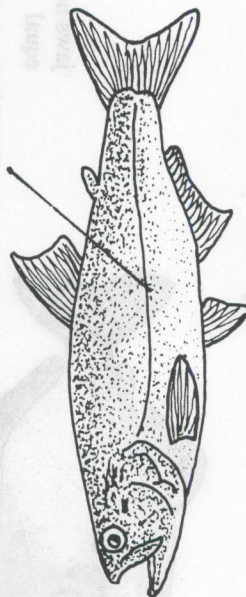
Dourado *Salminus maxillosus*



teeth conical or
tricuspid; in two
rows

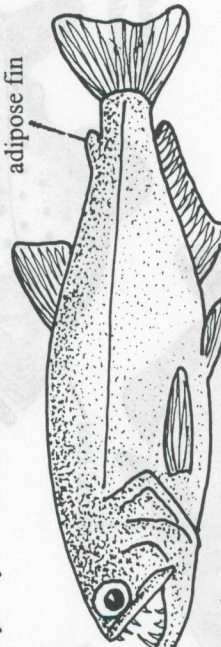
adipose fin

LL scales < 105, often < 80



in warm water

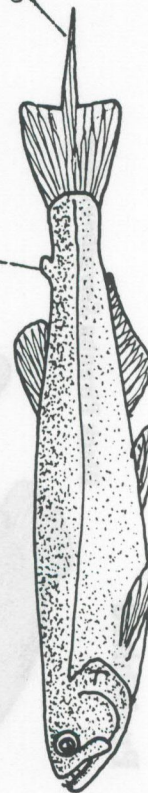
Dourado *Salminus hilarii*



adipose fin

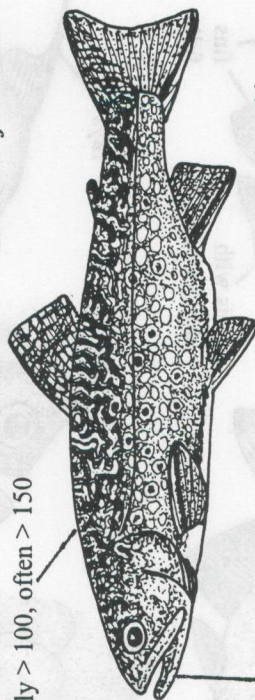
fang-like teeth

adipose fin



Biara *Rhaphiodon vulpinus*

Brook Trout
Salvelinus fontinalis

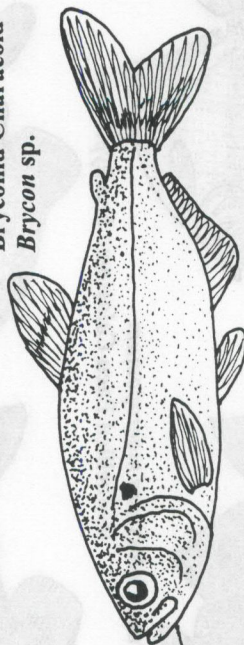


LL scales usually > 100, often > 150

no fang-like teeth

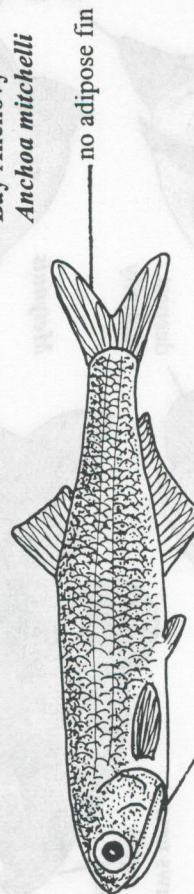
in cold water

Bryconid Characoid
Brycon sp.



upper teeth multicuspid
two rows in lower jaw
three rows in upper jaw

Bay Anchovy
Anchoa mitchelli



no adipose fin

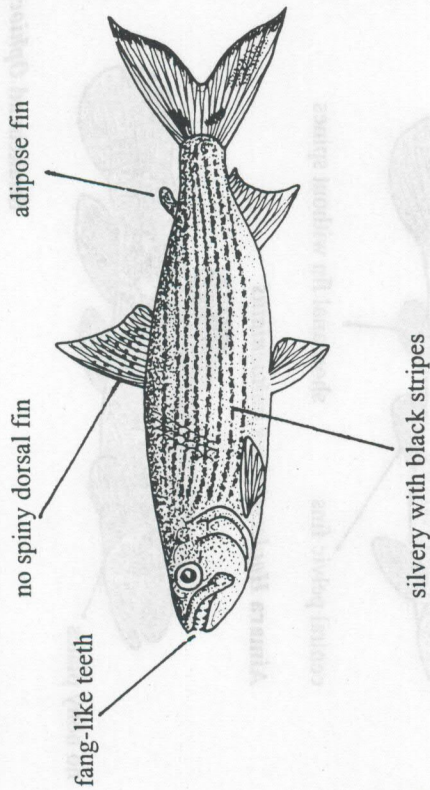
no fang-like teeth
long upper lip

caudal extension

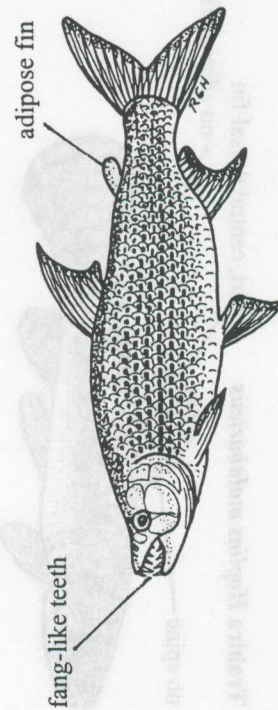
AFRICAN TIGER FISHES

Prohibited

African Tiger Fish
Hydrocynus vittatus

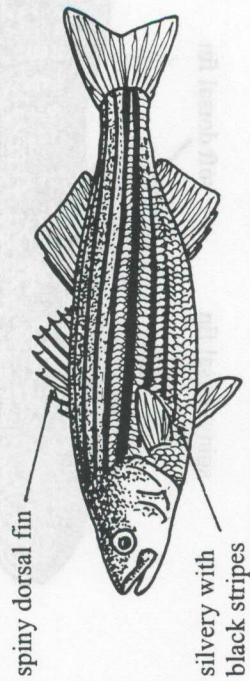


African Tiger Fish
Hydrocynus goliath

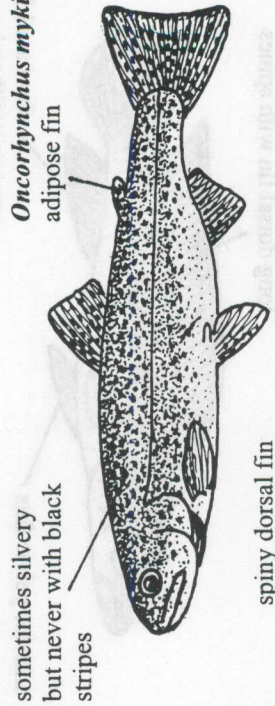


Unprohibited

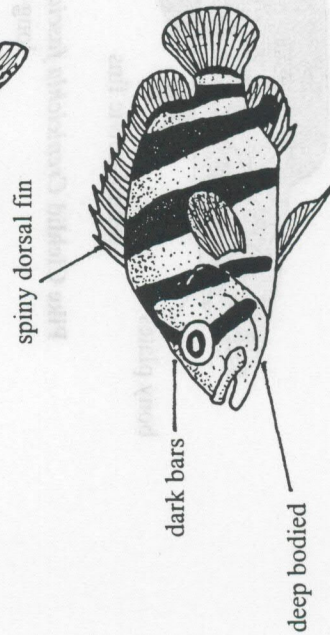
Striped Bass
Morone saxatilis



Rainbow Trout
Oncorhynchus mykiss

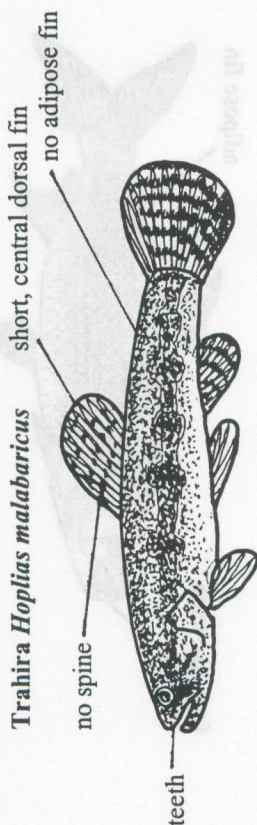


Asian Tiger Fish
(Tripletail)
Danioiodes sp.

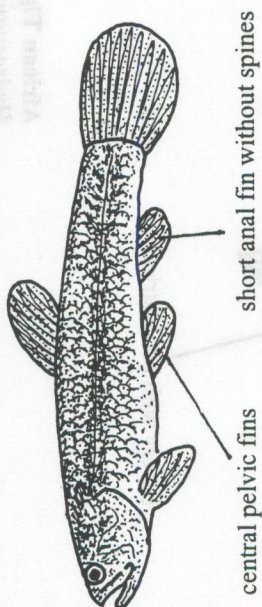


SOUTH AMERICAN TIGER FISHES

Prohibited



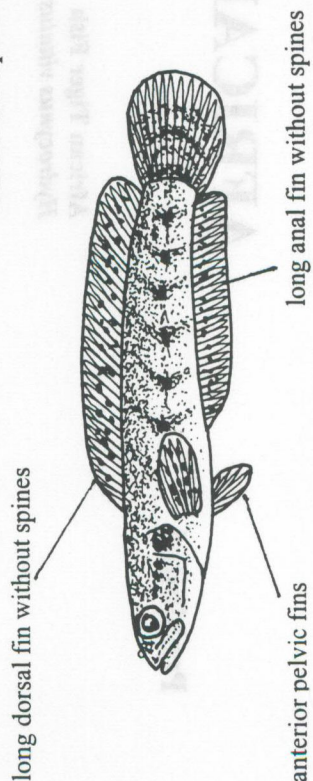
South American Tiger Fish *Erythrinus erythrinus*



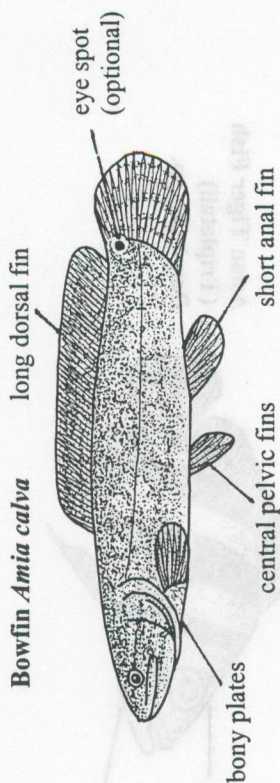
Aimara *Hoplerethrinus unitaeniatus*



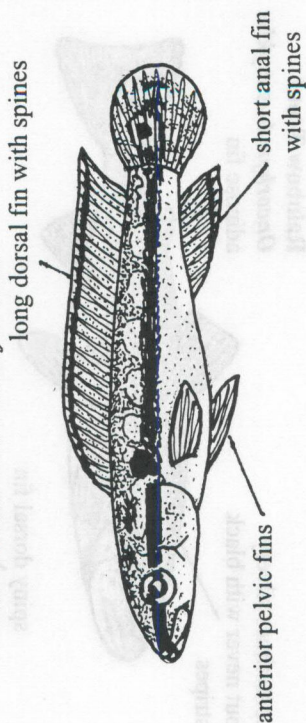
Snakehead *Ophiocephalus africanus*



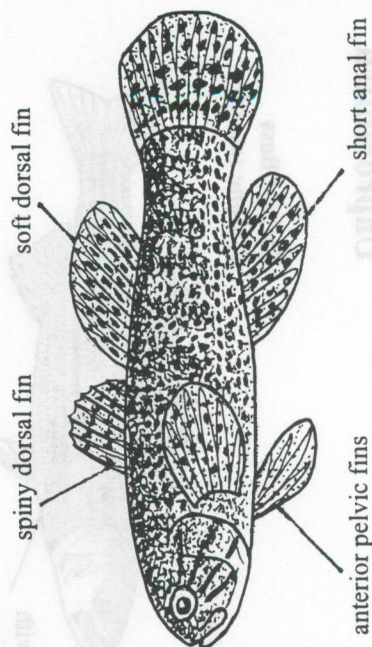
Unprohibited



Pike Cichlid *Crenicichla fasciatus*



Pacific Fat Sleeper *Dormitator latifrons*



ELONGATE PIKE-LIKE FISHES

PIKE CHARACOIDS

Prohibited

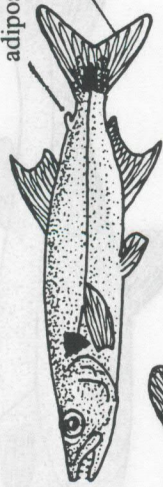
upper jaw flap



SOUTH AMERICAN SPECIES

posterior dorsal fin

Speckled Pike Characoid
Luciocharax maculata



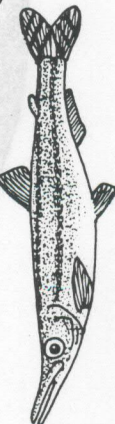
Pike Characoid
Acestrorhynchus falcatus

adipose fin
forked caudal fin

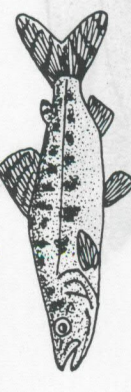


Gar Characin
Ctenolucius hujeta

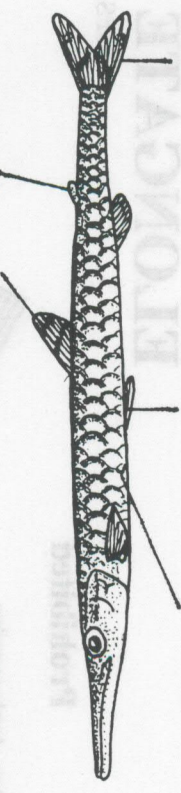
Pike Characoid
Gavialocharax sp.



Pike Characoid
Mesoborus sp.



African Gar Characoid
Belonophago sp.

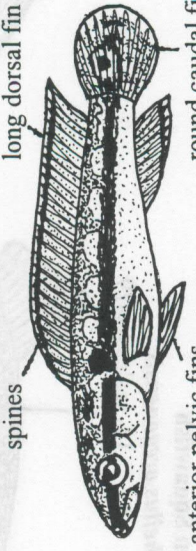


large scales
central pelvic fins
forked caudal fin

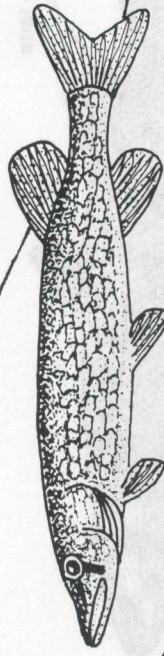
Unprohibited

Pike Cichlid

Crenicichla lepidota



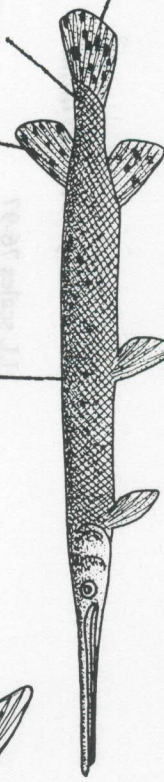
spines
long dorsal fin
anterior pelvic fins
round caudal fin
Chain Pickerel *Esox niger*
no adipose fin



Kafue Pike

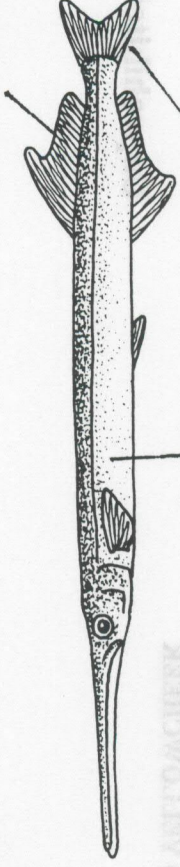
Hepsetus odoe

bony ganoid scales
posterior dorsal fin
no adipose fin



Atlantic Needlefish *Strongylura marina*

posterior dorsal fin
no adipose fin



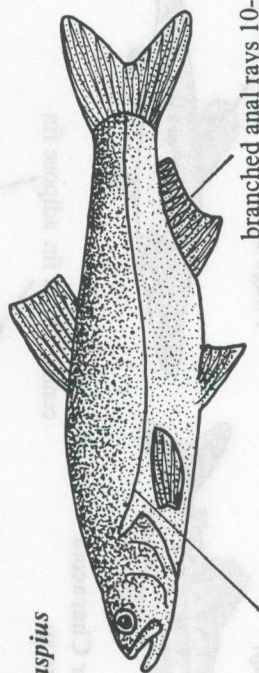
small scales
forked caudal fin

ELONGATE PIKE-LIKE FISHES

ASPS AND YELLOWCHECK

Prohibited

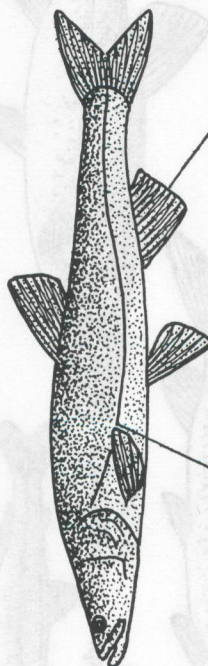
Unprohibited



branched anal rays 10-15

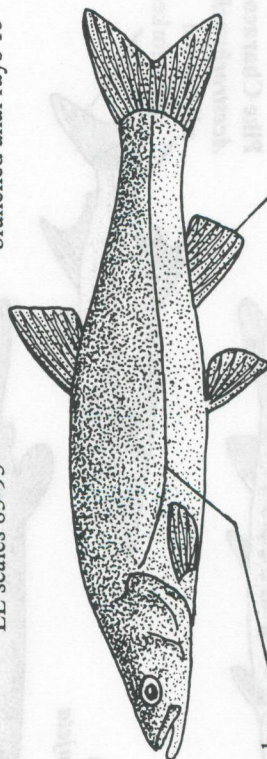
LL scales 62-105

Asp-pike *Aspiolucis eocinus*



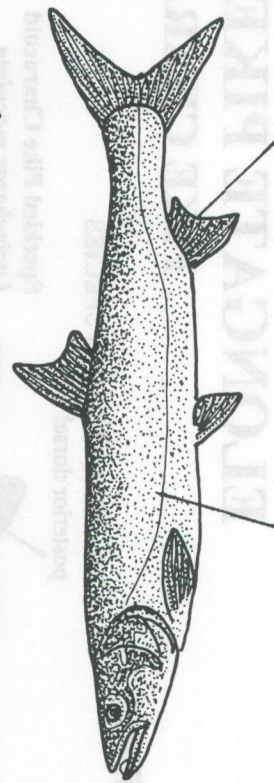
LL scales 83-95

branched anal rays 15



LL scales 91-102

branched anal rays 8-9

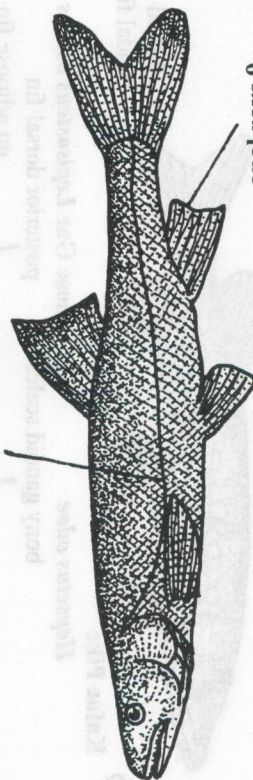


LL scales 105-110

branched anal rays 10-13

Colorado Squawfish
Ptychocheilus lucius

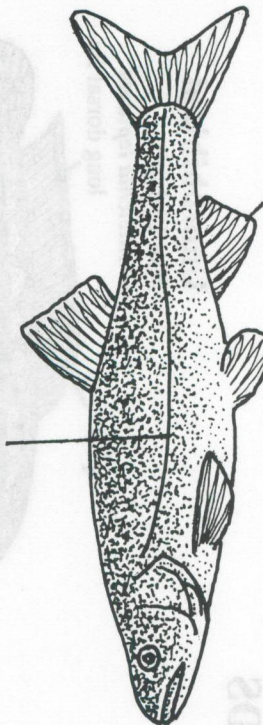
LL scales 76-97



anal rays 9

Northern Squawfish
Ptychocheilus oregonensis

LL scales 64-79



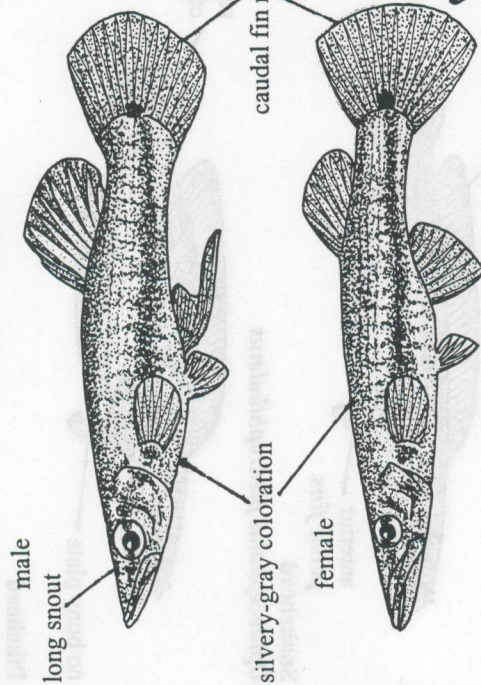
anal rays 8

ELONGATE PIKE-LIKE FISHES

PIKE KILLIFISH

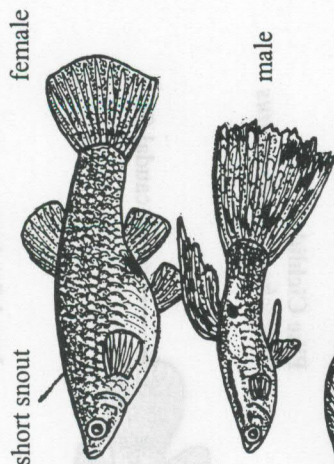
Prohibited

Pike Killifish
Belonesox belizanus

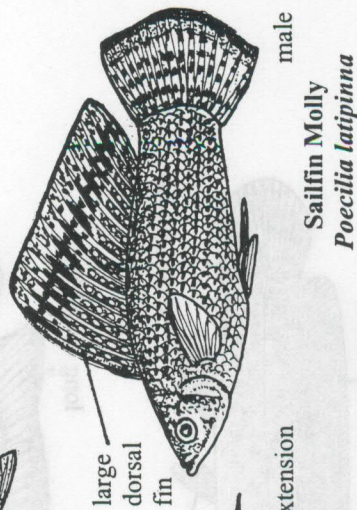
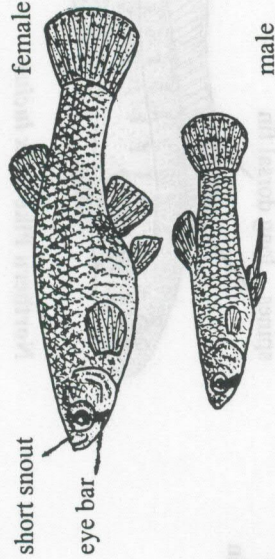


Unprohibited

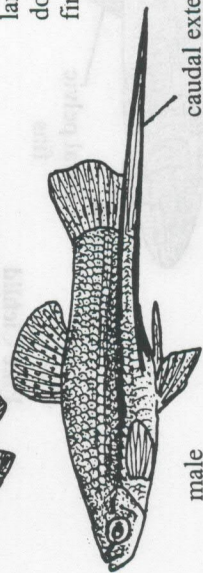
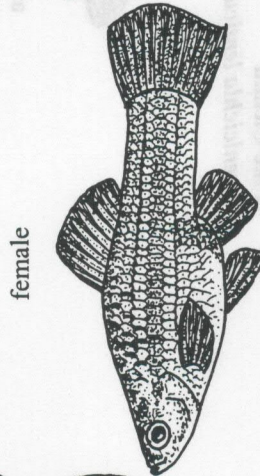
Guppy
Poecilia latipinna



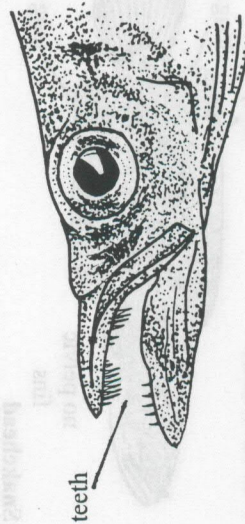
Mosquitofish
Gambusia affinis



Sailfin Molly
Poecilia latipinna



Green Swordtail
Xiphophorus helleri

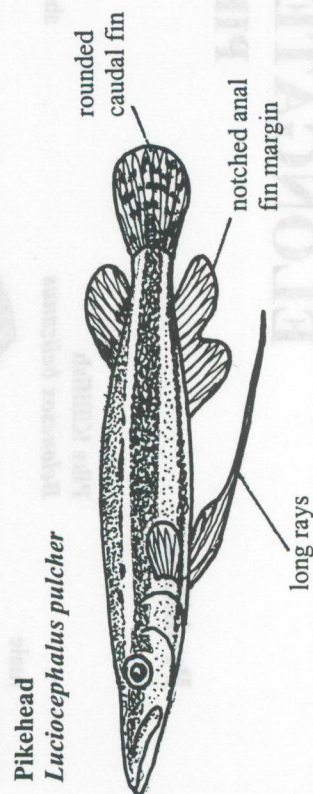
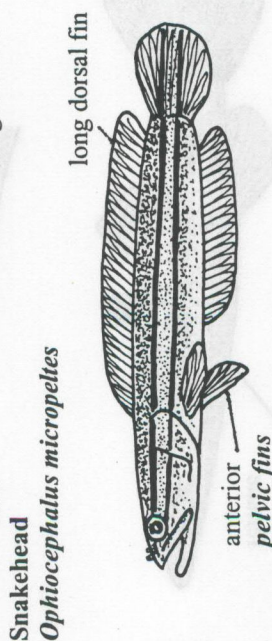
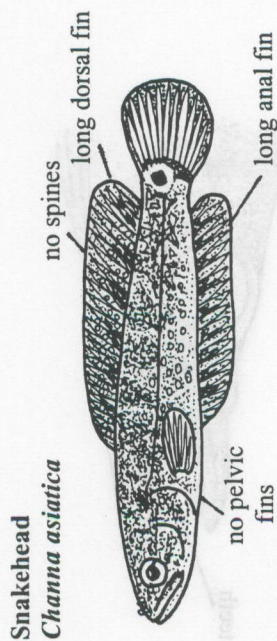


Amur Pike
Esox reichertii

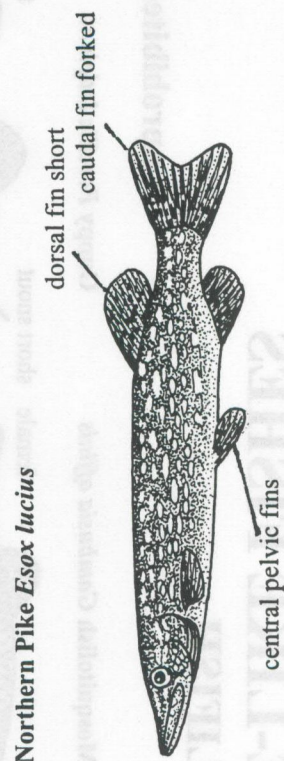
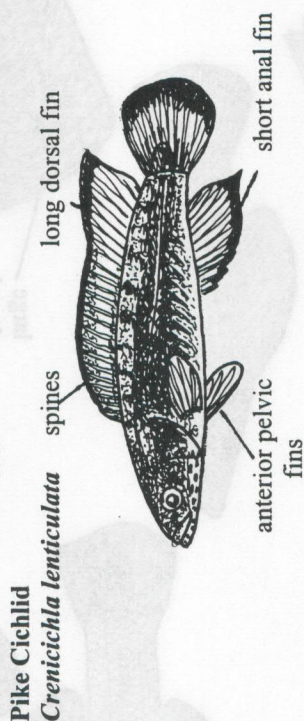
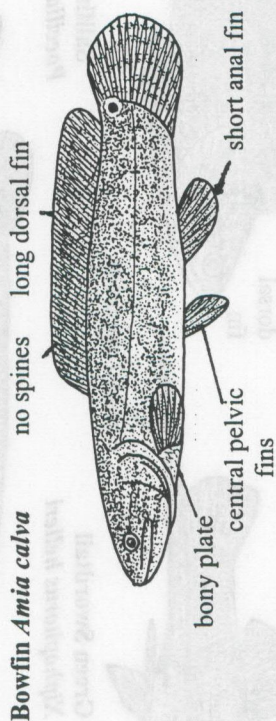
ELONGATE PIKE-LIKE FISHES

SNAKEHEADS AND PIKEHEAD

Prohibited



Unprohibited



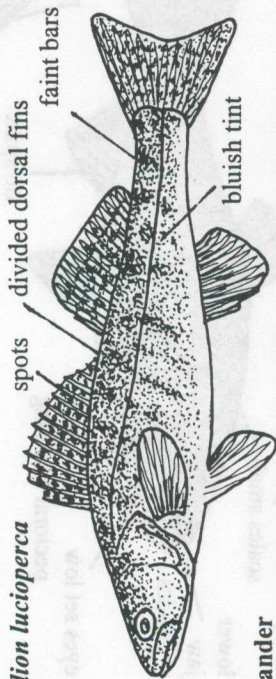
ELONGATE PIKE-LIKE FISHES

ZANDERS (EUROPEAN PIKE-PERCH) AND SOME NILE PERCHES

Prohibited

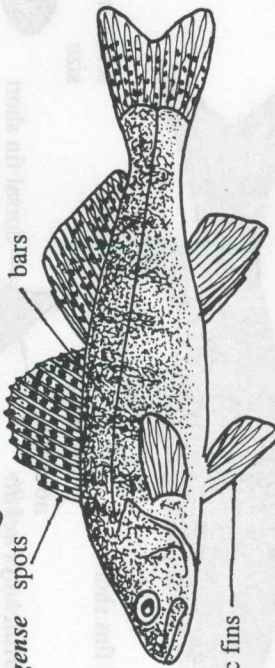
Zander

Stizostedion lucioperca



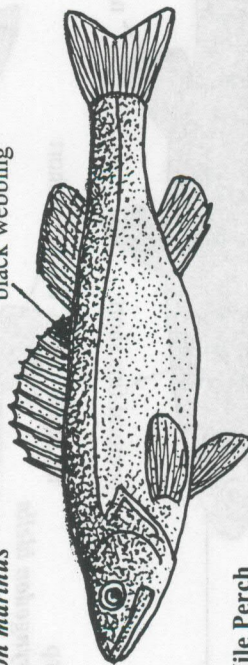
Volga Zander

Stizostedion volgense



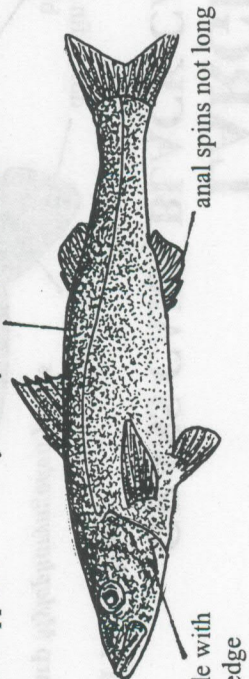
Sea Zander

Stizostedion marinus



Slender Nile Perch

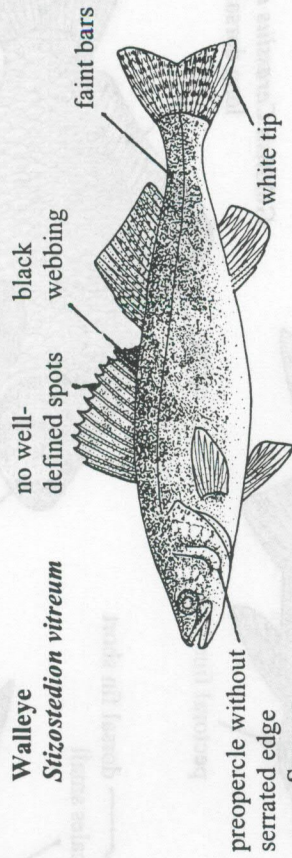
Lucioides stappersi



Unprohibited

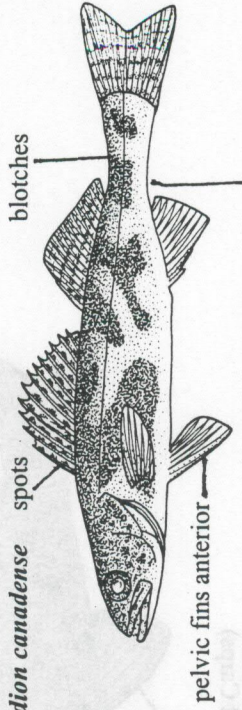
Walleye

Stizostedion vitreum



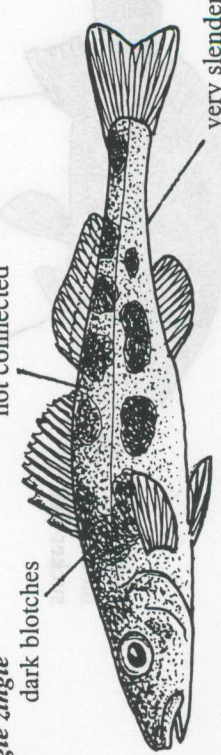
Sauger

Stizostedion canadense



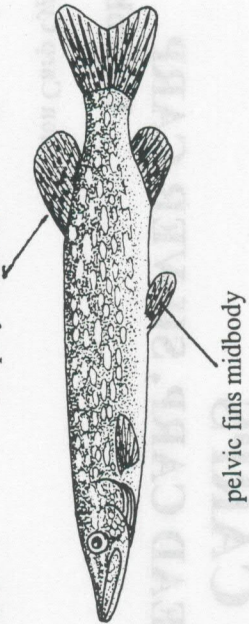
Zingie

Zingie zingie



Northern Pike

Esox lucius

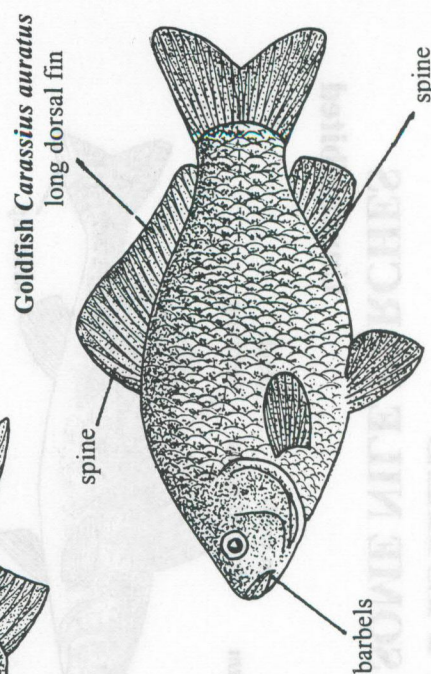
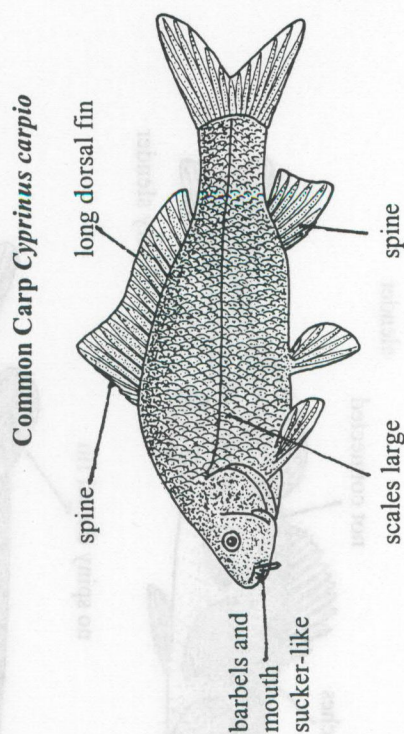
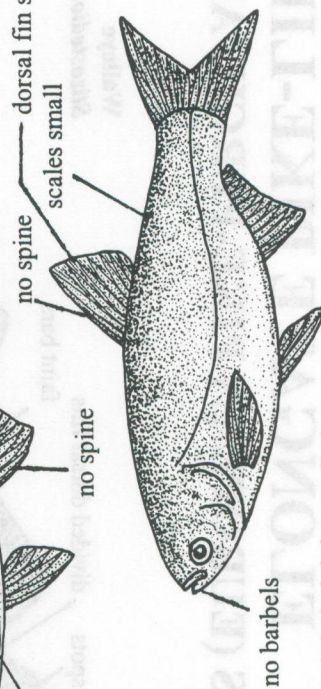
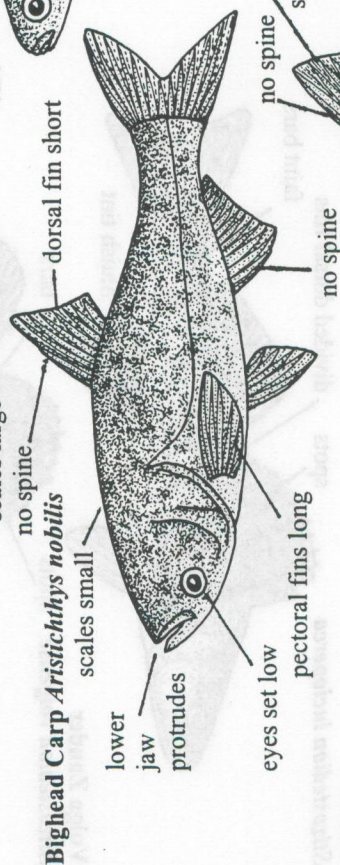
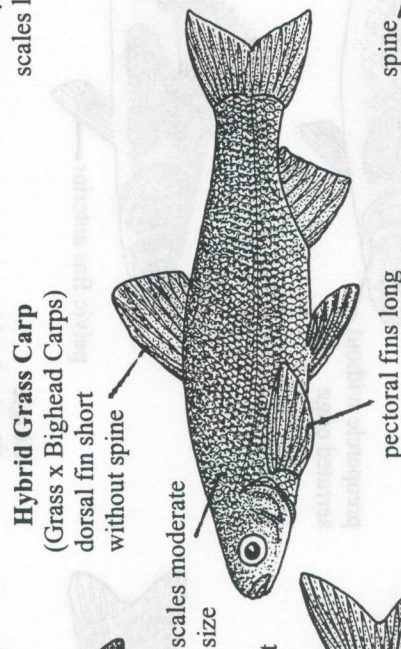
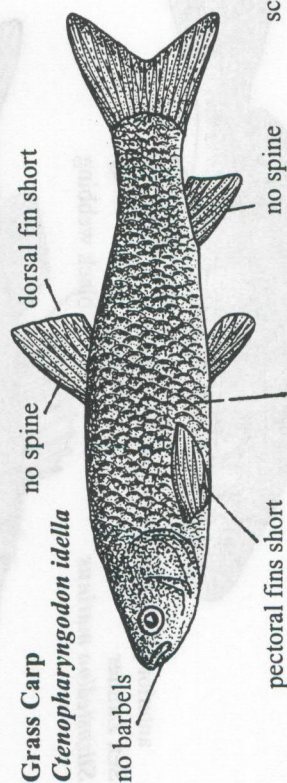
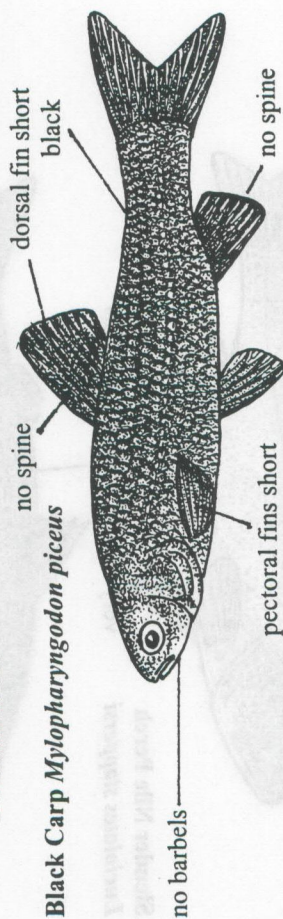


LARGE ASIAN CARPS

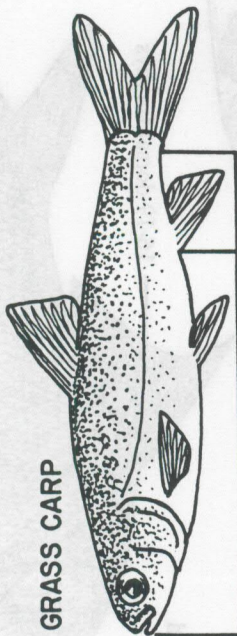
GRASS CARP, BLACK CARP, BIGHEAD CARP, SILVER CARP

Prohibited

Unprohibited

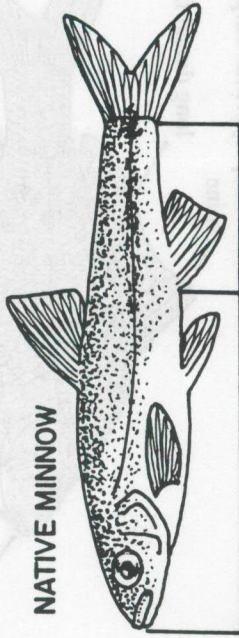


LARGE ASIAN CARPS IDENTIFICATION GUIDE



GRASS CARP

VENT
POSITION



NATIVE MINNOW

CHINESE CARP IDENTIFICATION GUIDE: Texas Parks and Wildlife Department
Robert G. Howells, Heart of the Hills Research Station

CHINESE CARP IDENTIFICATION GUIDE: Texas Parks and Wildlife Department Robert G. Howells, Heart of the Hills Research Station							
SPECIES	DORSAL FIN RAYS	ANAL FIN RAYS	SCALES			GILL RAKERS	PHARYNGEAL TEETH
			LATERAL LINE	ROWS ABOVE LL	ROWS BELOW LL		
Grass carp	i-iii, 7-11	ii-iii, 7-11	36-45 large	6-7	4-5	12-15 short	2, 5-4, 1 2, 4-4, 2
Hybrid** grass carp	ii, 7-8	ii, 8-11	42-65 medium	8-13	6-10	18-23 medium	5-4
Black carp	iii, 7-8	iii, 8-9	39-45 large	6	4	19-21 short	1, 4-4, 1 4-5
Bighead carp	ii, 8 (10?)	ii, 11-14 (16?)	98-100 (to 120?) small	26-28	15-19	many, long, not connected	4-4
Silver carp	iii, 7 (8-10?)	ii-iii, 12-14 (13-17?)	107-125 small (83?)	28-33	16-28	many, long, connected in a single band	4-4
SPECIES	JAW LENGTHS	PECTORAL FIN LENGTH	VENTRAL KEEL	COLOR			
Grass carp	near equal, or upper jaw projects slightly	does not reach pelvic fins	none	olive above; silver below			
Hybrid** grass carp	near equal, or lower jaw projects slightly	reaches to or beyond pelvic fins	present, pelvics to anal fin	olive above; silvery below			
Black carp	near equal, or upper jaw projects slightly	does not reach pelvic fins	none	black			
Bighead carp	lower jaw protrudes to anal fin	reaches beyond pelvic fins	present, scaled, pelvics	tan above; silvery below			
Silver carp	near equal, or lower jaw projects	reaches beyond pelvic fins	present, unscaled (?), breast to anal fin	tan above; silvery below			

** Hybrid grass carp = grass carp x bighead carp

? Data questionable or unclear

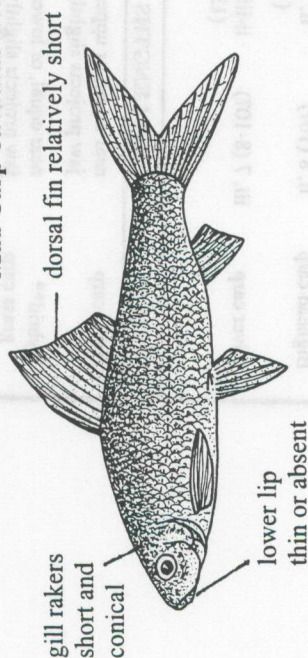
LARGE ASIAN CARPS

MUD CARP, SANDHKOL CARP, AND RELATED SPECIES, CATLA

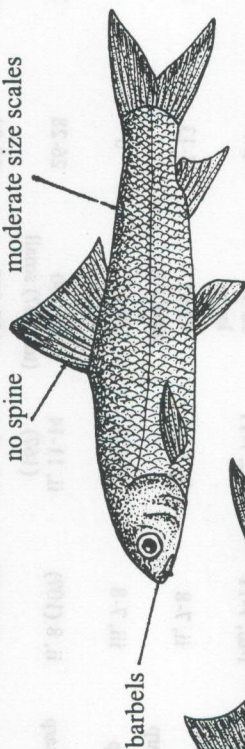
Prohibited

Unprohibited

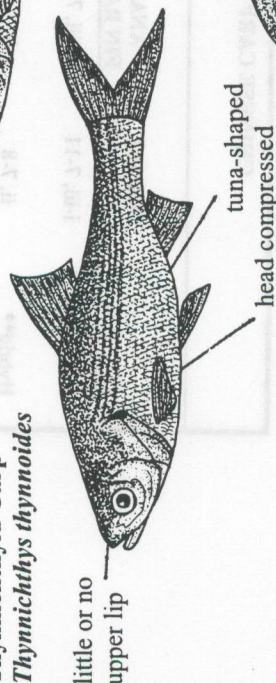
Mud Carp *Cirrhinus molitorella*



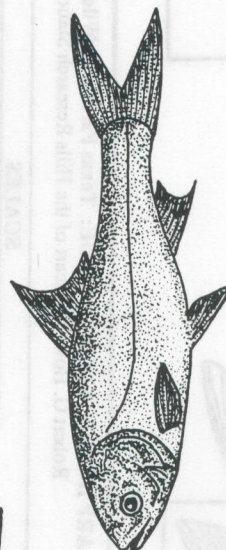
Mrigala *Cirrhinus mrigala*
no spine
moderate size scales



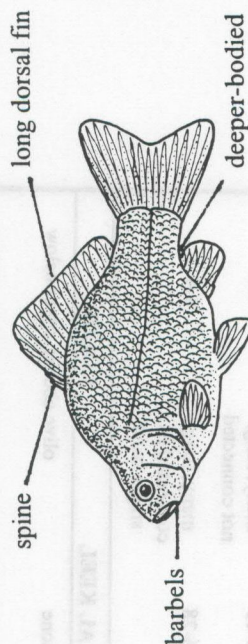
Thynnichthyid Carp
Thynnichthys thynnoides



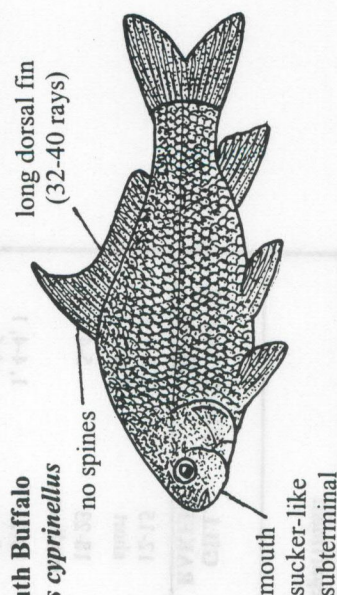
Sandhkol Carp
Thynnichthys sandhkol



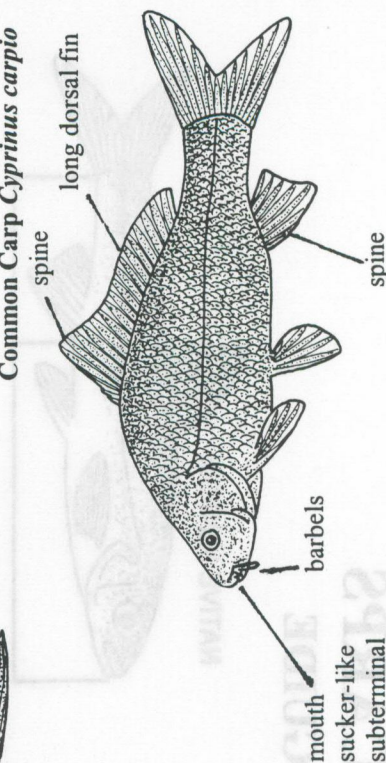
Goldfish *Carassius auratus*



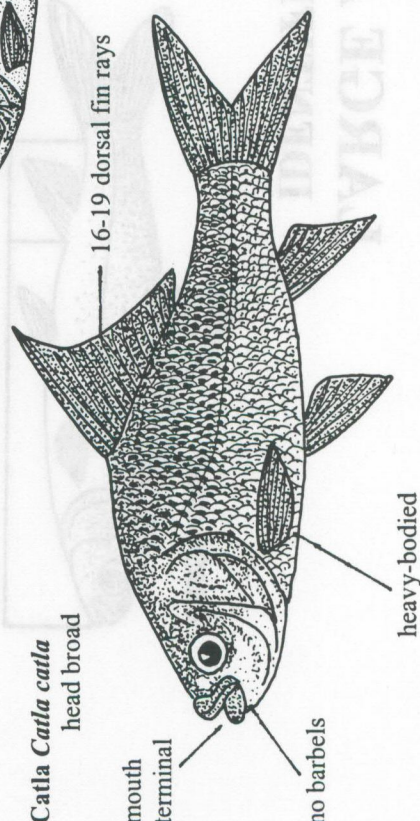
Bigmouth Buffalo
Ictiobus cyprinellus



Common Carp *Cyprinus carpio*

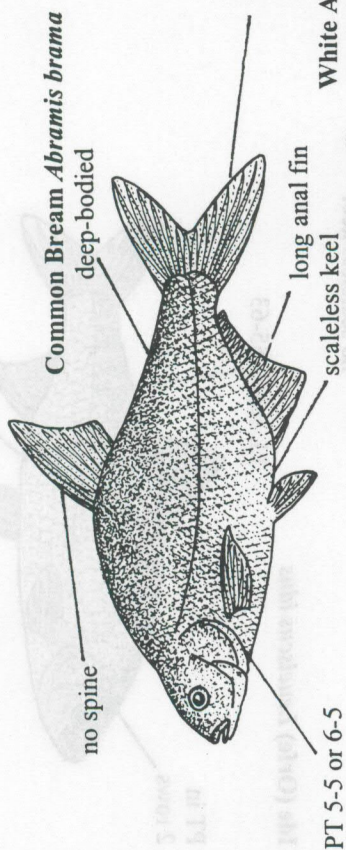


Catla *Catla catla*
head broad

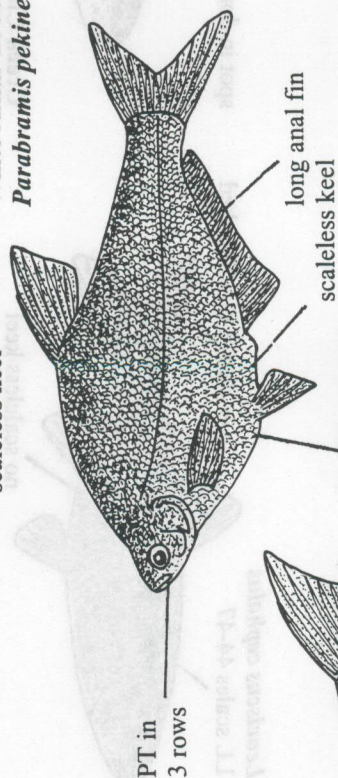


OLD WORLD BREAMS

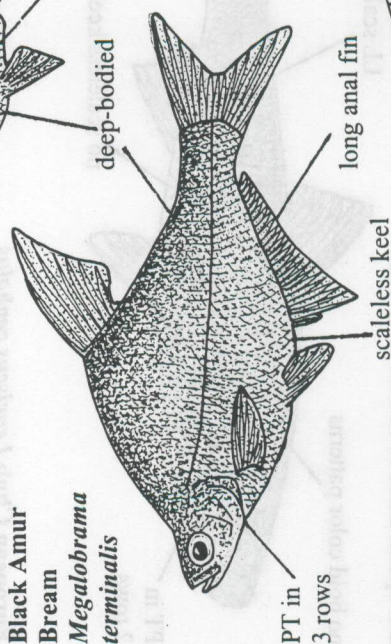
Prohibited



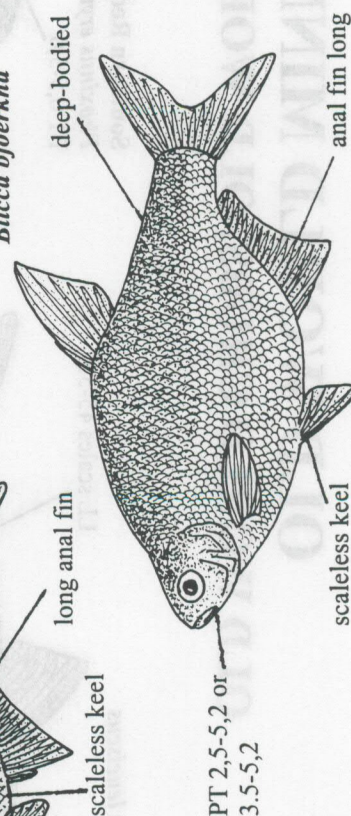
White Amur Bream
Parabramis pekinensis



Black Amur Bream
Megalobrama terminalis

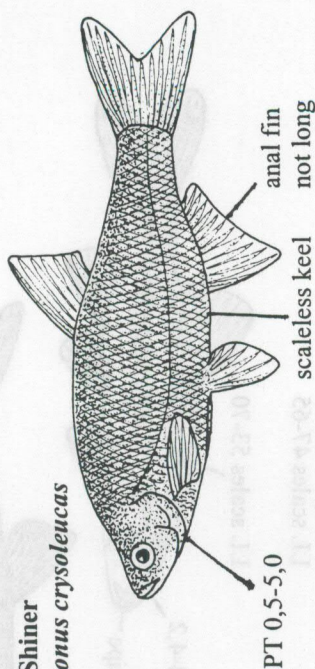


Silver Bream
Blicca bjoerkna

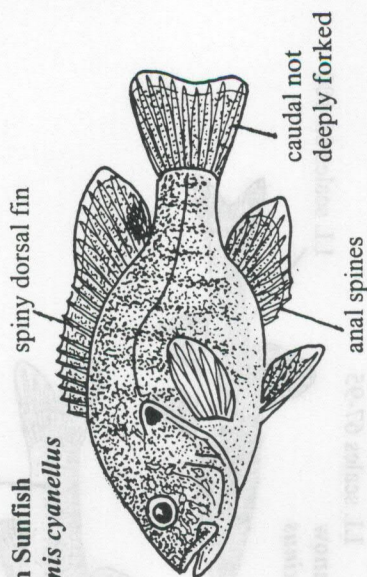


Unprohibited

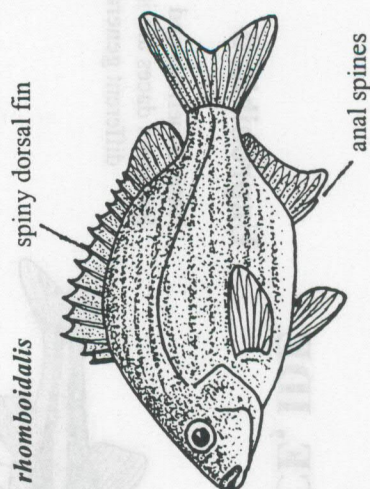
Golden Shiner
Notemigonus crysoleucas



Green Sunfish
Lepomis cyanellus



Sea Bream
Archosargus rhomboidalis



OLD WORLD MINNOWS

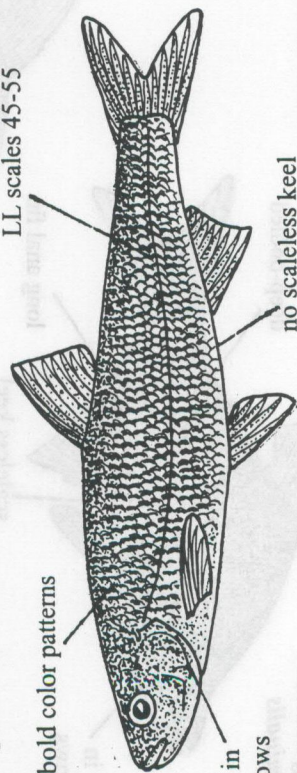
OLD WORLD CHUBS, OLD WORLD DACE, IDE

Prohibited

European Dace *Leuciscus leuciscus*

no bold color patterns

LL scales 45-55

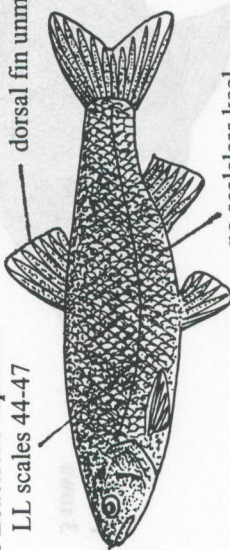


PT in 2 rows

no scaleless keel

European Chub *Leuciscus cephalus*

LL scales 44-47



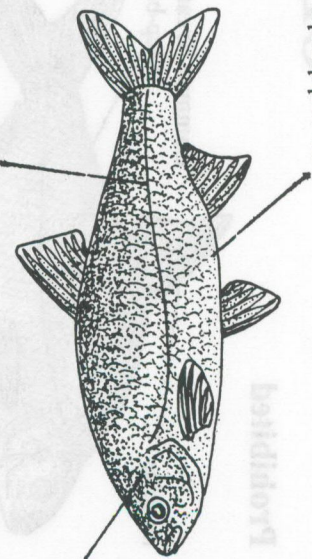
PT in 2 rows

dorsal fin unmarked

no scaleless keel

Ide (Orfe) *Leuciscus idus*

LL scales 55-63



PT in 2 rows

no scaleless keel

Note: Minnows of the Genus *Leuciscus* are very similar to native minnows; consult text.

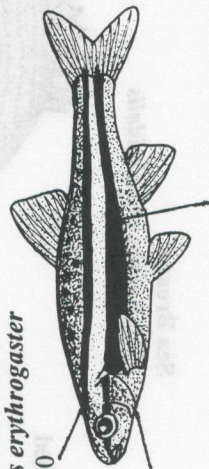
Unprohibited

Note: American and European daces are in different genera

Southern Redbelly Dace

Phoxinus erythrogaster

PT 0,5-5,0



black stripes
red belly

LL scales 67-95

European Minnow

Phoxinus phoxinus

LL scales 85-100

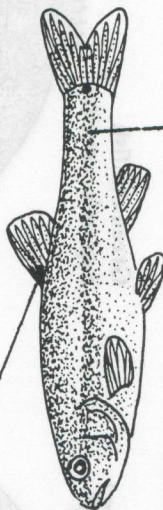


spot in dorsal fin

Creek Chub

Semotilus atromaculatus

LL scales 47-65



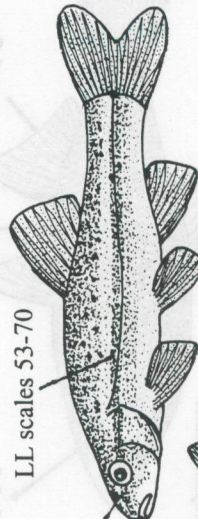
Blacknose Dace

Rhinichthys atratulus

LL scales 53-70

PT 2,4-4,2

reddish lateral stripe



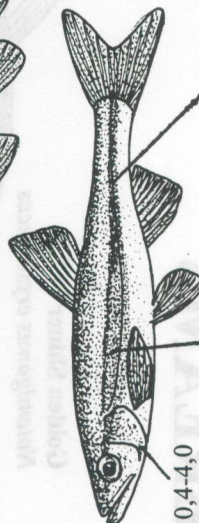
Redside Dace

Clinostomus elongatus

PT 0,4-4,0

reddish lateral stripe

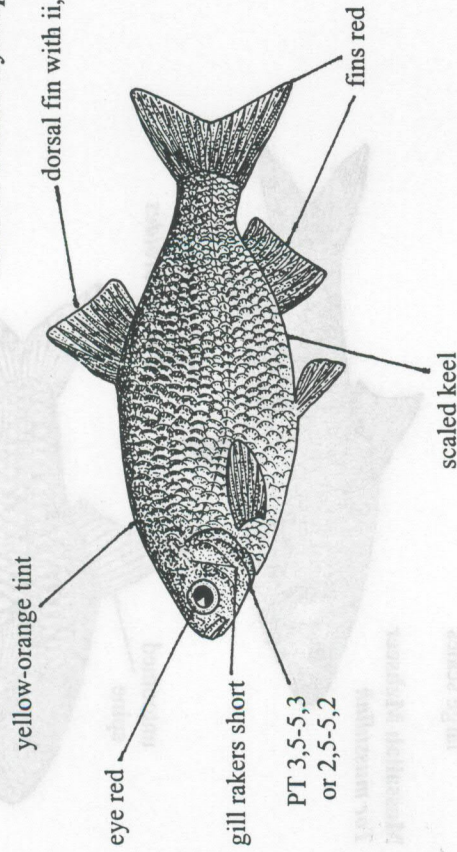
LL scales 55-75



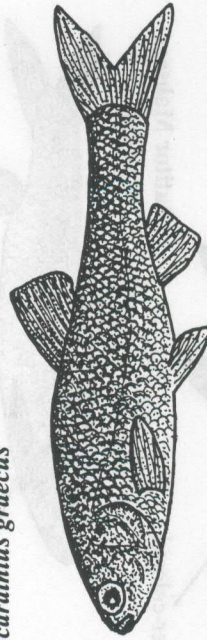
OLD WORLD MINNOWS RUDD AND ROACH

Prohibited

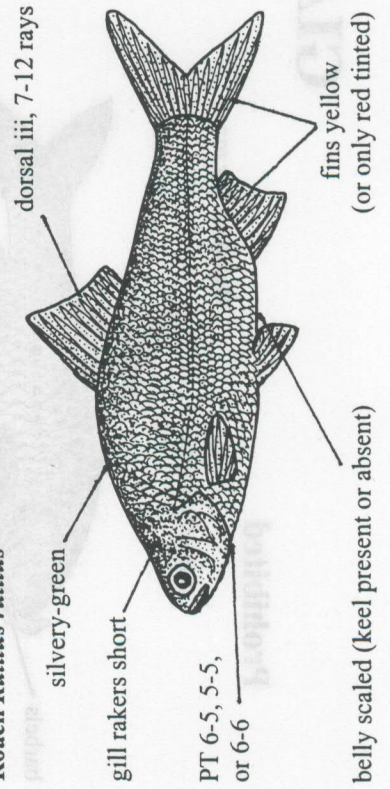
Rudd *Scardinius erythrophthalmus*



Calamityra *Scardinius graecus*

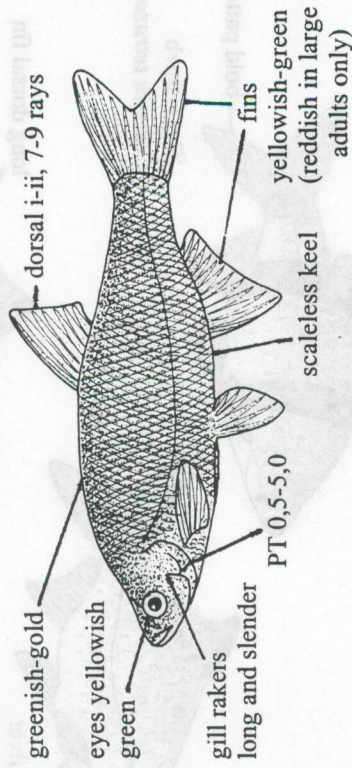


Roach *Rutilus rutilus*

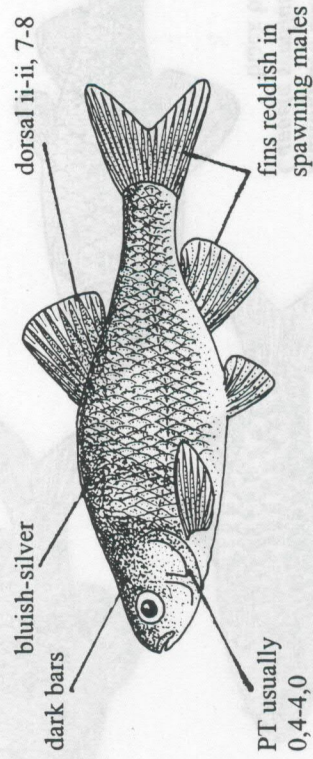


Unprohibited

Golden Shiner *Notemigonus crysoleucas*



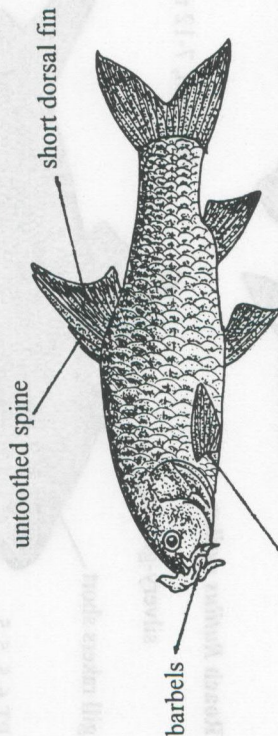
Red Shiner *Cyprinella lutrensis*



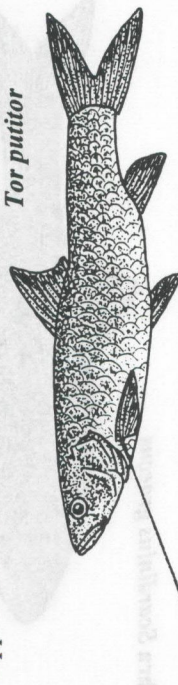
GIANT BARBS

Prohibited

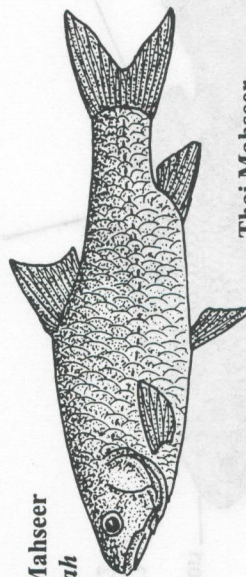
Mahseer *Tor tor*



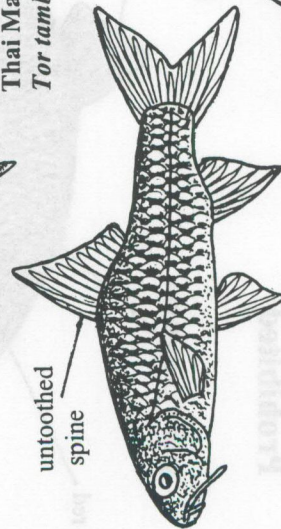
Putitor Mahseer
Tor putitor



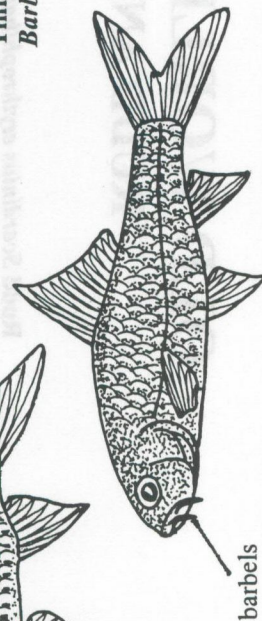
Mussallah Mahseer
Tor mussallah



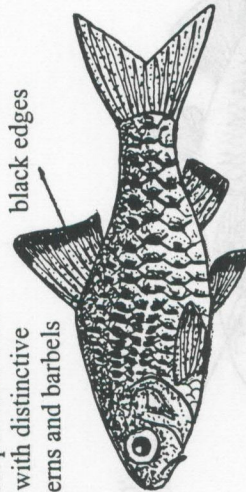
Thai Mahseer
Tor tambroides



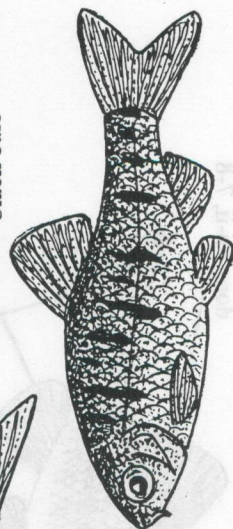
Soro Mahseer
Tor soro



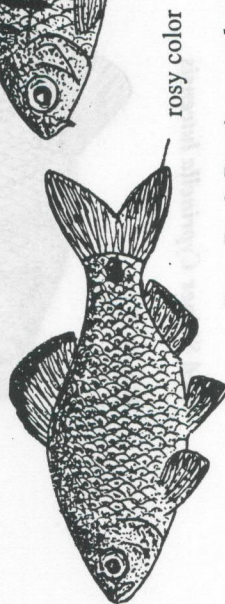
Note: Most pet-trade barbs are small with distinctive color patterns and barbels 0, 2, or 4



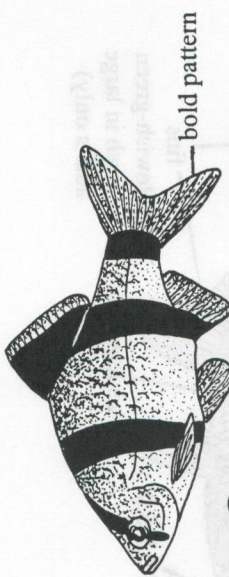
Checkered Barb
Capoeta oligolepis



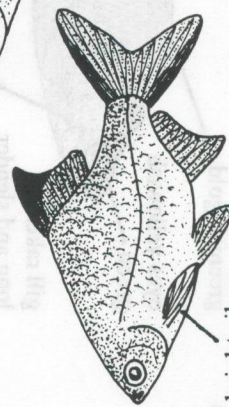
Halfbanded Barb
Capoeta semifasciatus



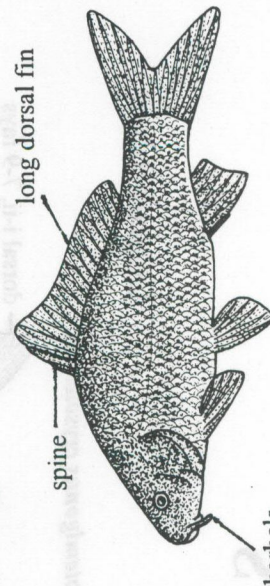
Rosy Barb *Puntius conchoniis*



Tiger Barb
Capoeta tetrazona



Tinfoil Barb
Barbodes schwanefeldi



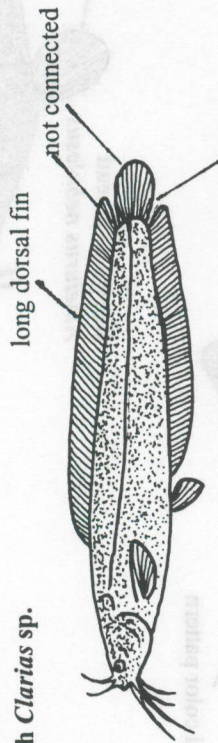
Common Carp *Cyprinus carpio*

CATFISHES

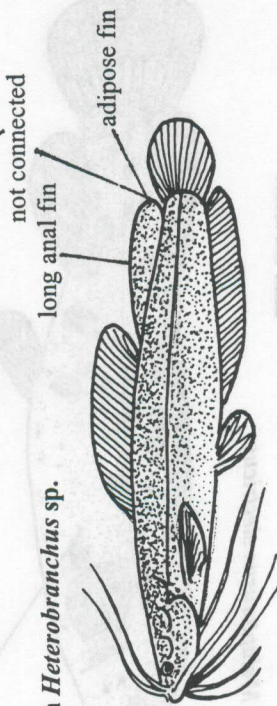
WALKING CATFISHES AND AIRSAC CATFISHES

Prohibited

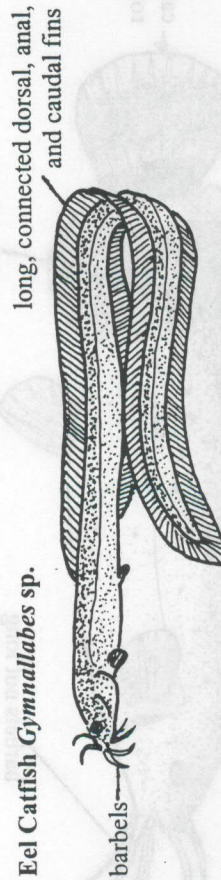
Walking Catfish *Clarias* sp.



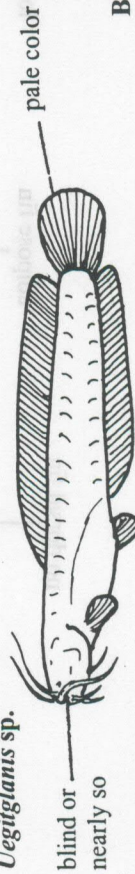
Walking Catfish *Heterobranchius* sp.



Eel Catfish *Gymnallabes* sp.



Blind Walking Catfish *Uegitlanis* sp.

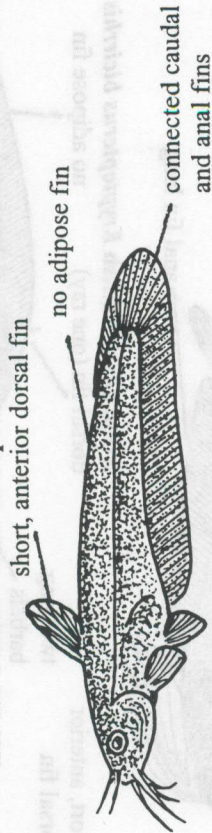


Airsac Catfish *Heteropneustes* sp.

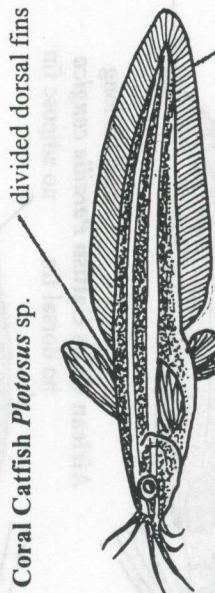


Unprohibited

Eel-tail Catfish *Neosilurus* sp.



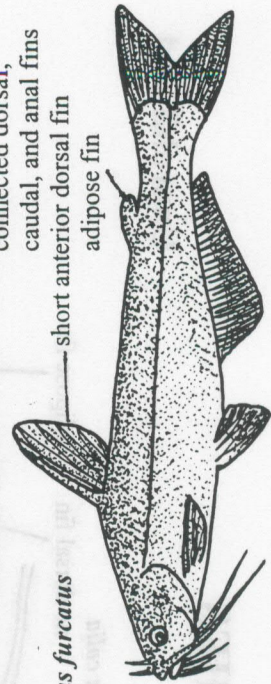
Coral Catfish *Plotosus* sp.



Pimelodid Catfish *Phreatobius* sp.



Blue Catfish *Ictalurus furcatus*

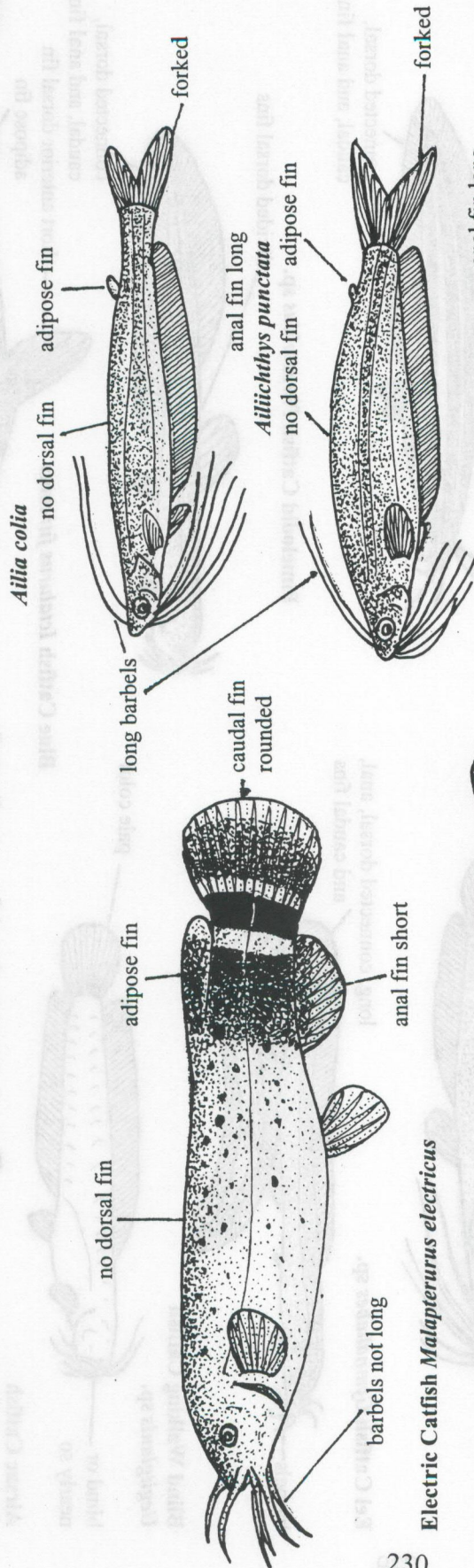


CATFISHES

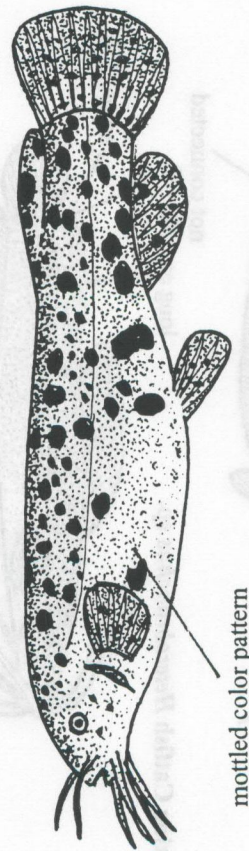
ELECTRIC CATFISHES

Prohibited

Unprohibited



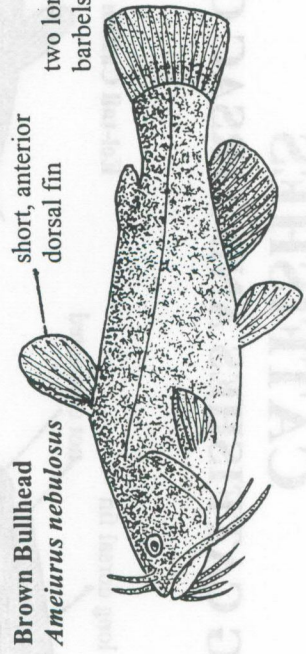
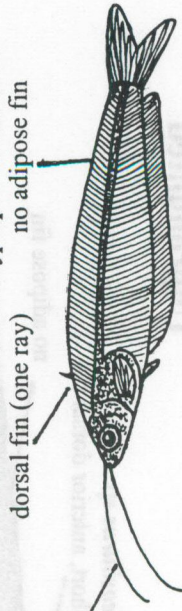
Electric Catfish *Malapterurus electricus*



African Glass Catfish *Parailia congica*



Asian Glass Catfish *Kryptopterus bicirrhus*



Brown Bullhead
Ameiurus nebulosus

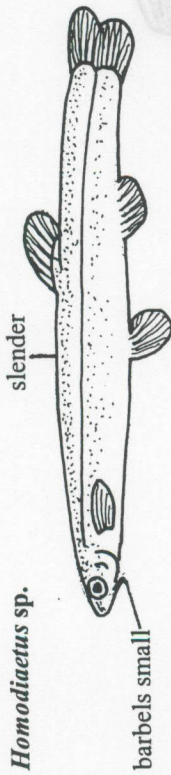
CATFISHES

PARASITIC AND WHALE CATFISHES

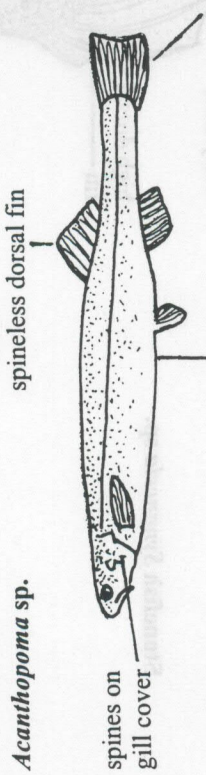
Prohibited

Parasitic Trichomycterid Catfishes

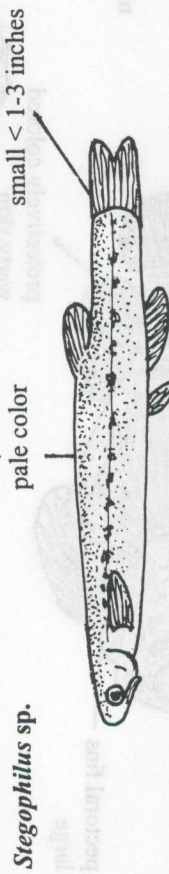
Homodiaetus sp.



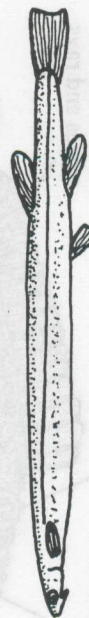
Acanthopoma sp.



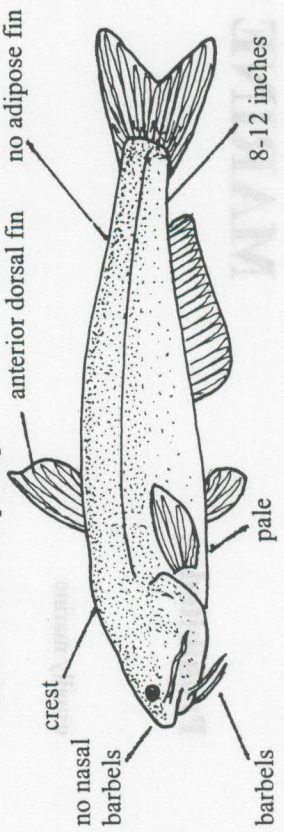
Stegophilus sp.



Vandellia sp.



Whale Catfish *Cetopsis* sp.

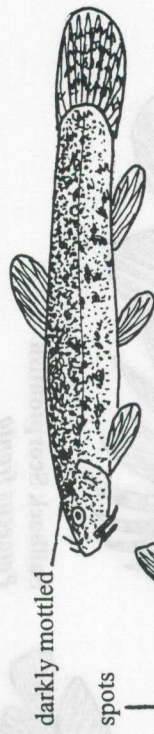


Unprohibited

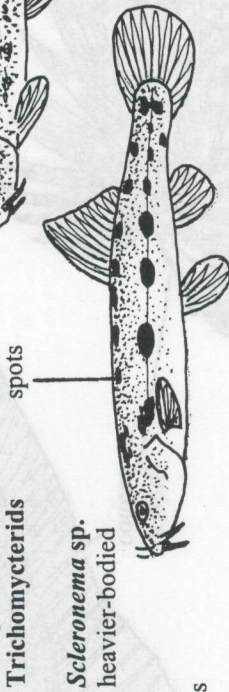
Coolie Loach
Acanthopthalmus myersi



Nematogenys sp.



Coolie Catfishes
Non-parasitic
Trichomycterids



Scleronema sp.
heavier-bodied



Burrowing
Trichomycterids
(Non-parasitic)

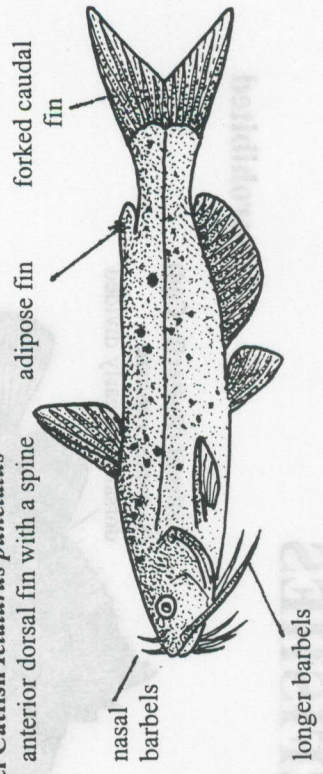


Pygidianops sp.



Typhlobelus sp.

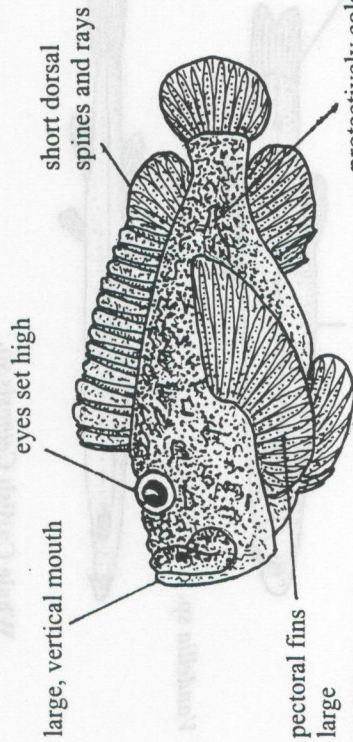
Channel Catfish *Ictalurus punctatus*



MARINE STONEFISHES

Prohibited

usually marine



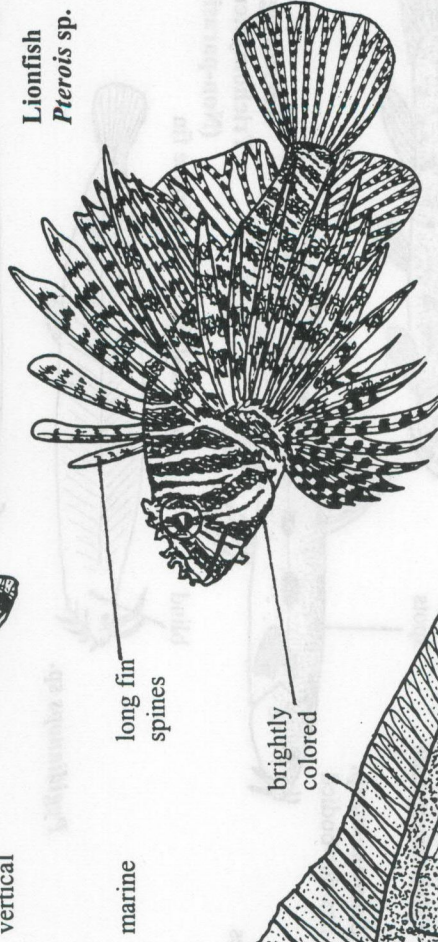
Stonefish *Synanceia* sp.

Unprohibited

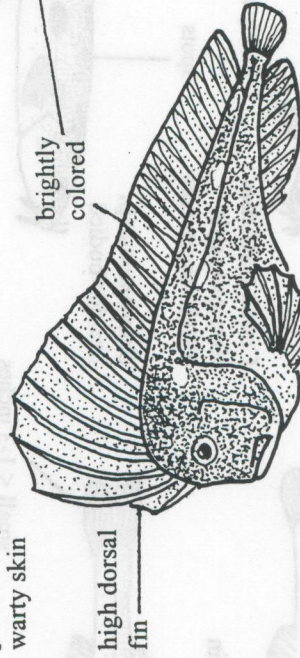
Bullrout (Butterfly Cod)
Notesthes robusta



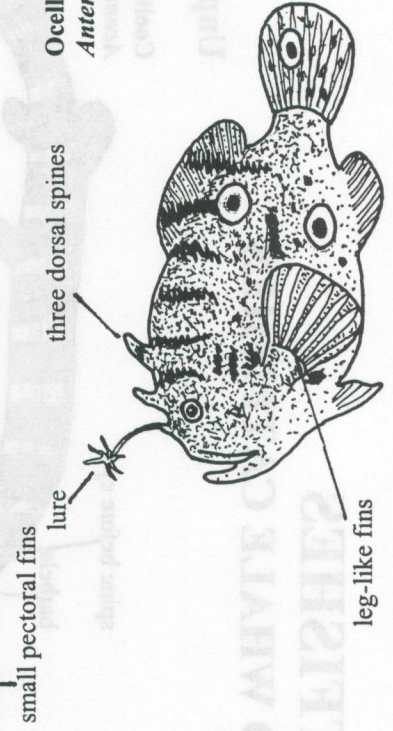
Lionfish
Pterois sp.



Sailback Scorpionfish
Pataecus fronto



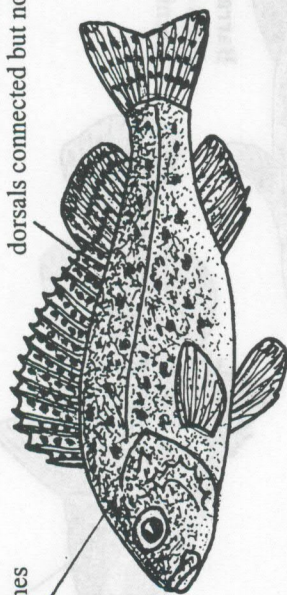
Ocellated Frogfish
Antennarius ocellatus



PERCH-LIKE FISHES RUFFES AND SCHRAETZERS

Prohibited

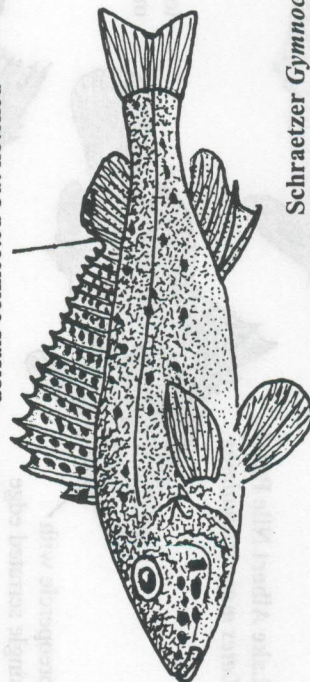
brown with
darker blotches



Ruffe *Gymnocephalus cernuus*

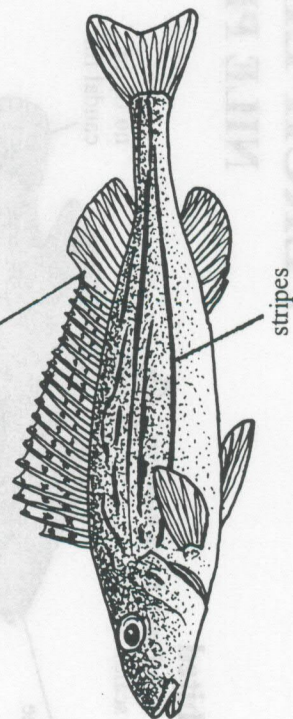
dorsals connected but notched

dorsals connected but notched



Don Ruffe *Gymnocephalus acerinus*

dorsals connected but notched

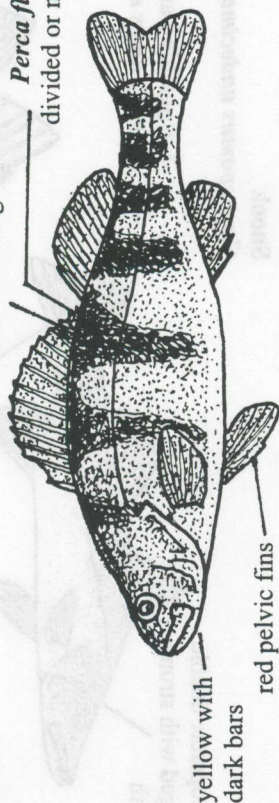


Schraetzer *Gymnocephalus schraetser*

stripes

Unprohibited

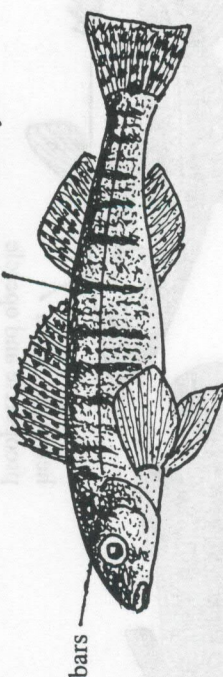
black webbing
Yellow Perch
Perca flavescens
divided or nearly so



yellow with
dark bars

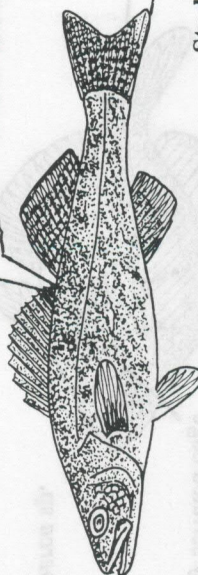
red pelvic fins

Logperch
Percina sp.



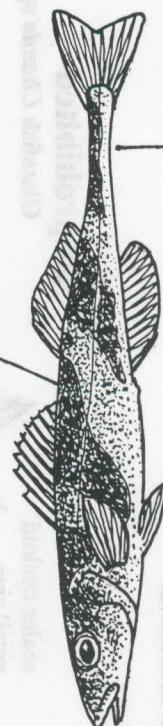
bars

Walleye
Stizostedion vitreum
divided dorsal fins



black webbing

white tip
Streber
Zingle streber
widely divided



very slender

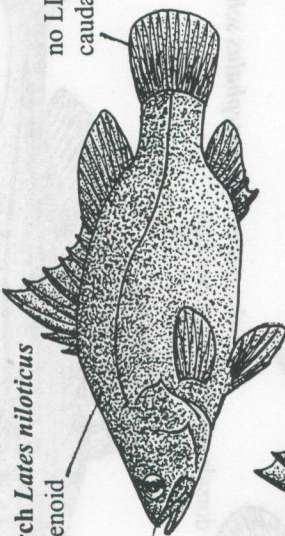
PERCH-LIKE FISHES

NILE PERCHES

Prohibited

Nile Perch *Lates niloticus*
scales ctenoid

no teeth
on tongue



no LL in
caudal fin

Lake Albert Nile Perch
Lates macrophthalmus



preopercle with
single serrated edge

Bigeye Nile Perch
Lates mariae
juvenile

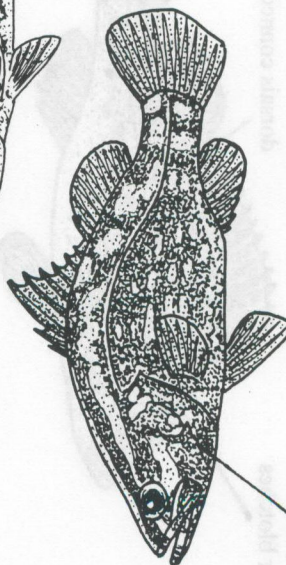


tooth patch
on tongue

Sand Perch *Psammoperca* sp.
preopercle smooth
edged

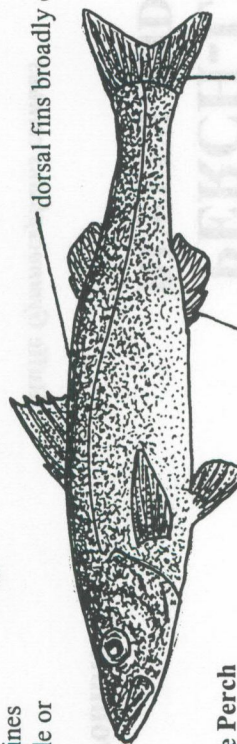


Barramundi
Lates calcarifer
juvenile



no heavy spines
on preopercle or
opercle

dorsal fins broadly divided



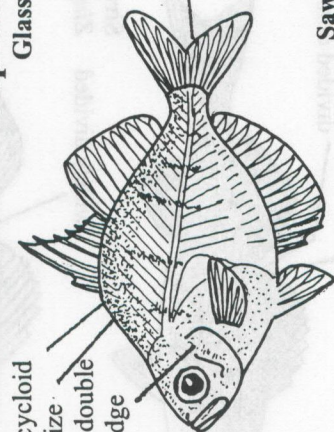
Slender Nile Perch
Luciolates stappersi

anal spines not long

no LL in caudal fin

Unprohibited

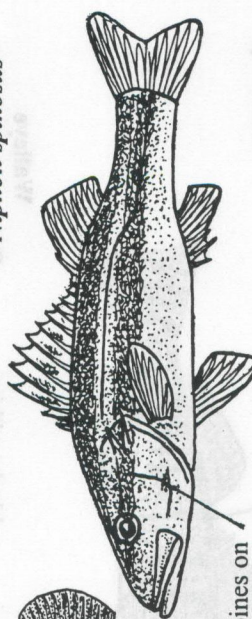
Glassfish *Chanda* sp.



scales cycloid
small size
preopercle with double
finely serrated edge

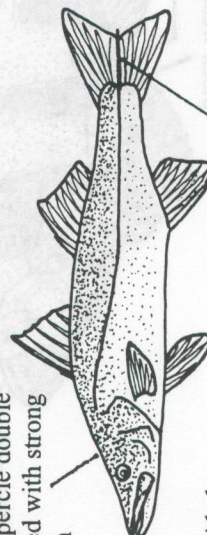
nearly
transparent

Sawedged Perch
Niphon spinosus



heavy spines on
preopercle and opercle

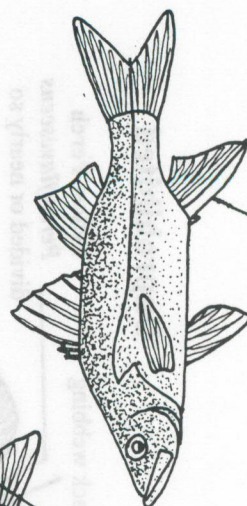
Snook
Centropomus undecimalis



preopercle double
edged with strong
teeth

LL in caudal fin

Largescale Fat Snook
Centropomus mexicanus



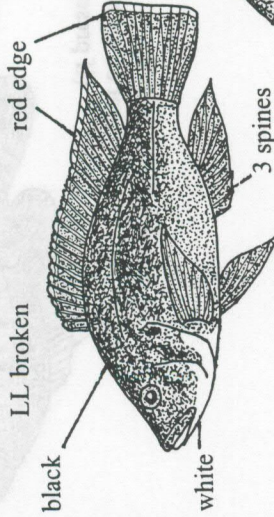
2nd-3rd spines very long

PERCH-LIKE FISHES

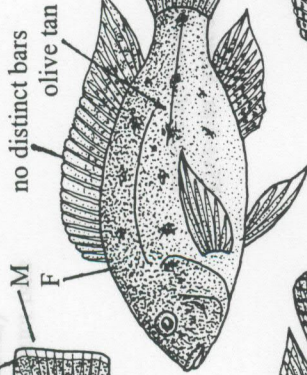
TILAPIA

Prohibited

LL broken



Mozambique Tilapia
Tilapia (O.) mossambica



Wami Tilapia

Tilapia (O.) urolepis honorum

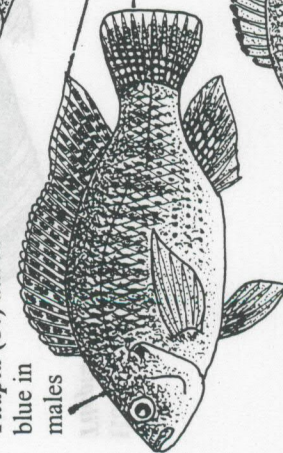


black edge

violet in males

Blue Tilapia
Tilapia (O.) aurea

blue in males



grayish-tan

black

Blackchin Tilapia

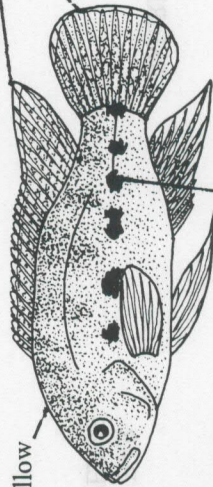
Tilapia (S.) melanotheron

3 anal spines

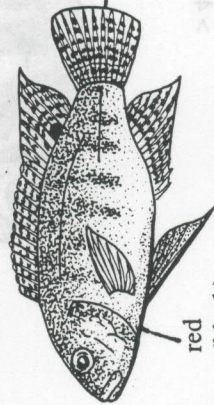
red edge

yellow

LL broken

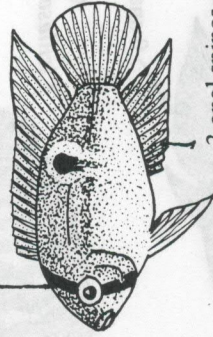


Nile Tilapia
Tilapia (O.) nilotica



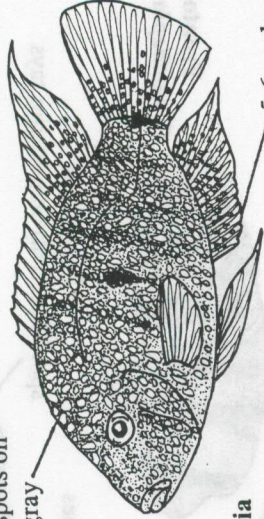
Redbelly Tilapia
Tilapia zillii

distinctive color patterns



Keyhole Cichlid
Aequidens maroni

silver spots on olive-gray

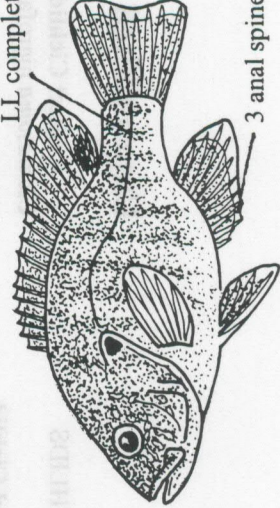


Unprohibited
Rio Grande Cichlid
Cichlasoma cyanoguttatum

Green Sunfish

Lepomis cyanellus

LL complete



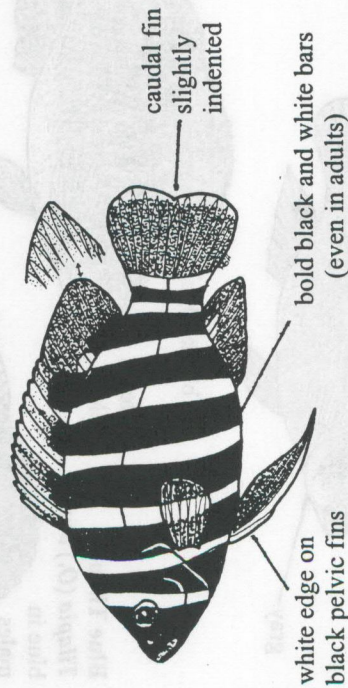
Spotted Tilapia
Tilapia mariae

PERCH-LIKE FISHES

TILAPIA

Prohibited

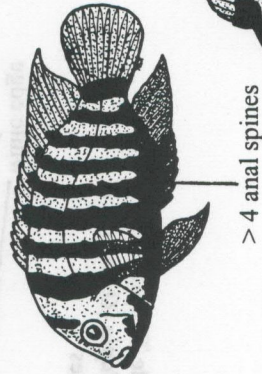
Hornet Tilapia
Tilapia buttikoferi



NOTE BAR PATTERNS

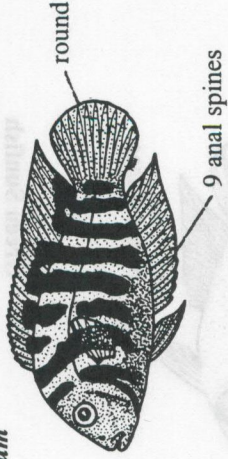
AMERICAN CICHLIDS

Blue-eyed Cichlid
Cichlasoma spilurum

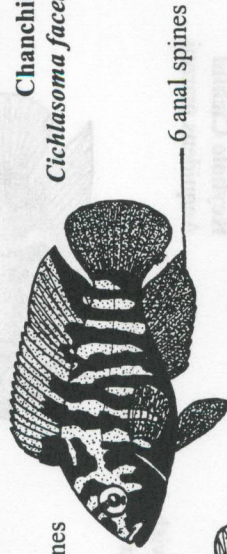


Unprohibited

Convict Cichlid
Cichlasoma nigrofasciatum

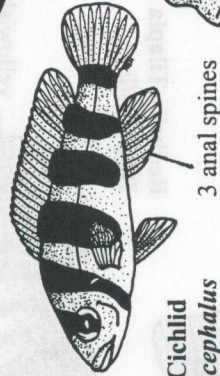


Chanchito
Cichlasoma facetum



AFRICAN CICHLIDS

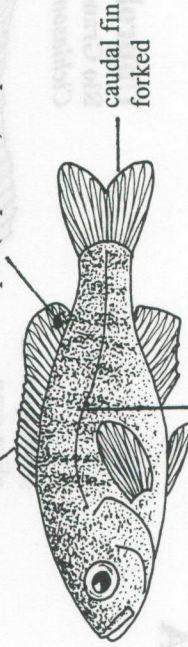
Five-bar African Cichlid
Lamprologus tetracephalus



Frontosa
Cyphotilapia frontosa



9-11 dorsal spines



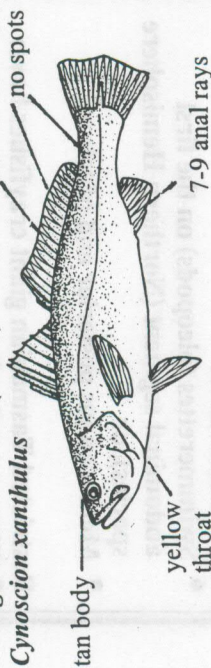
JUVENILE
SUNFISH *Lepomis*

JUVENILE
TILAPIA

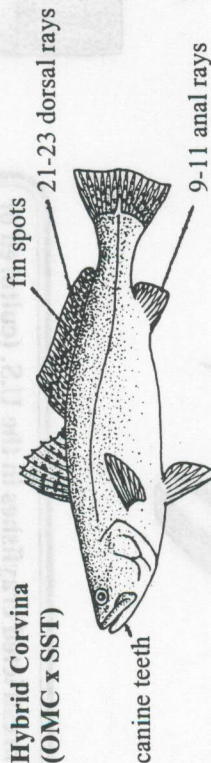
SEATROUTS AND CORVINAS

Prohibited

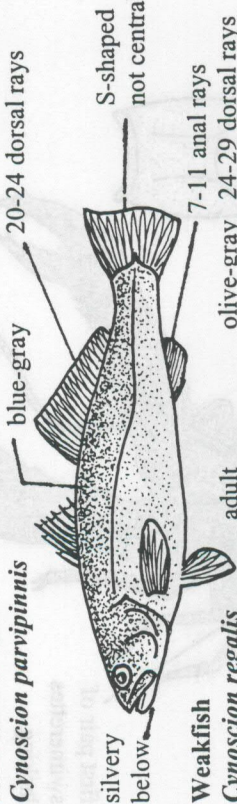
Orangemouth Corvina (OMC)
Cynoscion xanthulus



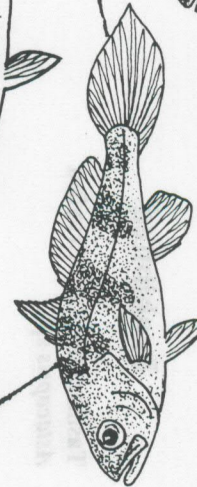
Hybrid Corvina
(OMC x SST)



Shortfin Corvina
Cynoscion parvipinnis



Weakfish
Cynoscion regalis

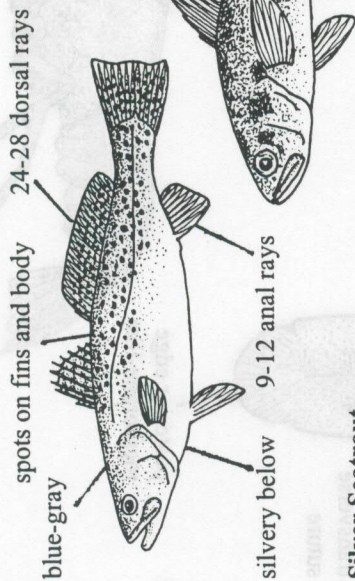


Totoaba
Cynoscion macdonaldi
FEDERALLY ENDANGERED

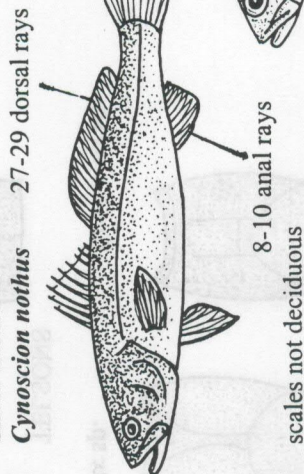


Unprohibited

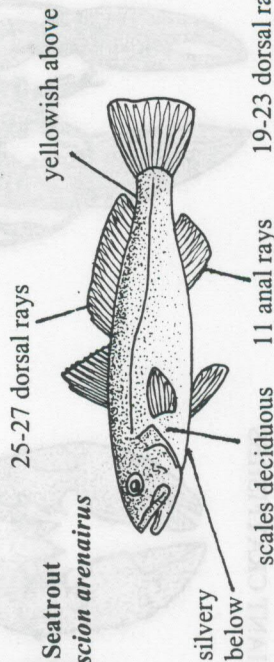
Spotted Seatrout (SST)
Cynoscion nebulosus



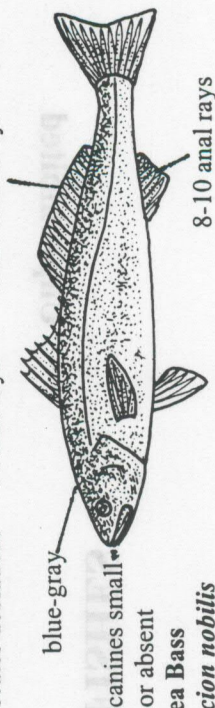
Silver Seatrout
Cynoscion nothus



Sand Seatrout
Cynoscion arenarius



White Sea Bass
Atractoscion nobilis

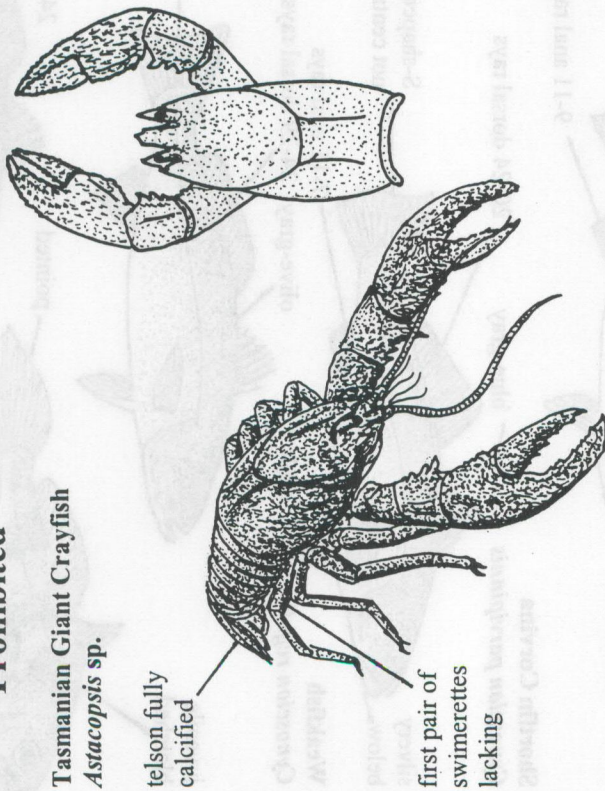


CRAYFISHES

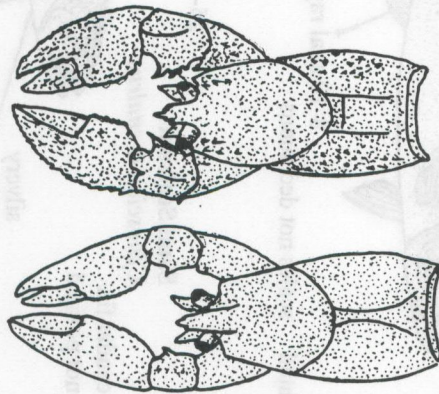
TASMANIAN GIANT CRAYFISHES

Prohibited

Tasmanian Giant Crayfish
Astacopsis sp.



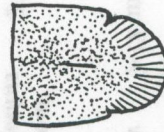
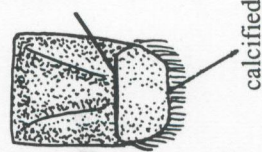
AUSTRALIAN GIANT CRAYFISHES



Cherax sp.

Euastacus sp.

TELSONS



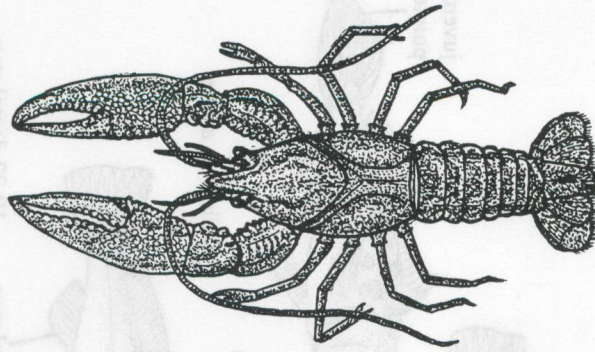
Unrestricted crayfishes in the U.S. (cultured or wild) should have:

- Swimmerettes (pleopods) on the first abdominal segment (Northern Hemisphere species), or
- Membranous posterior end of telson.

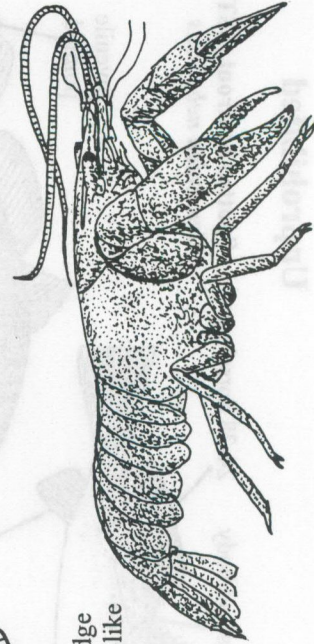
Restricted Tasmanian giant crayfishes have:

- First pair of swimmerettes lacking, and
- Telson calcified its entire length.

Unprohibited



Australian Yabby
Cherax destructor



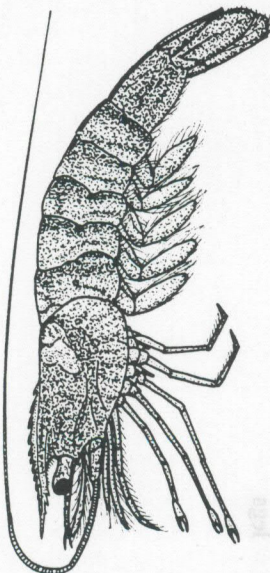
SHRIMPS

PENAEID SHRIMPS

Prohibited

Mexican White Shrimp
Penaeus vannamei

rostrum

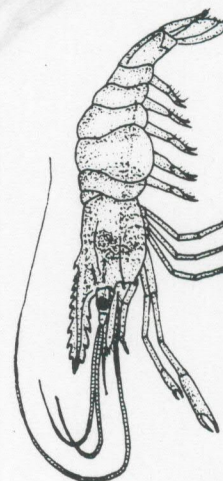


White Shrimp
Penaeus setiferus
rostrum



Brown Shrimp
Penaeus aztecus
rostrum

Pink Shrimp
Penaeus duorarum



small
transparent

Grass Shrimp
Palaemonetes vulgaris



with movable
spines



with fixed
spines



without
spines

TELSONS

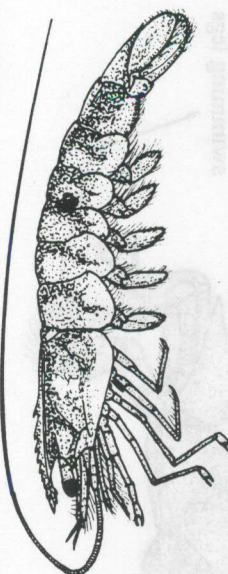
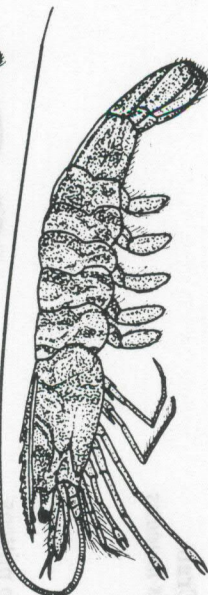
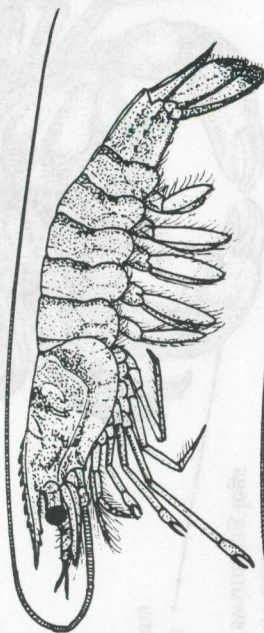
NOTE

Penaeid shrimps can be very difficult to identify. Consult more detailed descriptions in the text and seek expert advice.

Be cautious of penaeid shrimps

- with a spiny thelycum
- without exopodites on 5th legs
- with a high, triangular rostral crest
- larger than 8 inches in length
- with a bold black banding pattern
- with movable telson spines
- with fixed telson spines (in adults)
- with coxae of chelapeds armed (spined)
- with only a single ventral rostral tooth
- with dorsal carapace grooves crossing to form an "X" pattern

Unprohibited



long arms and chela

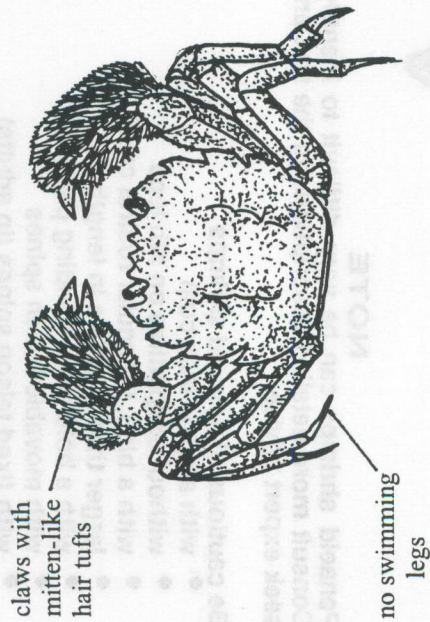
Cinnamon River Shrimp *Macrobrachium acanthurus*

CRABS

MITTEN CRAB

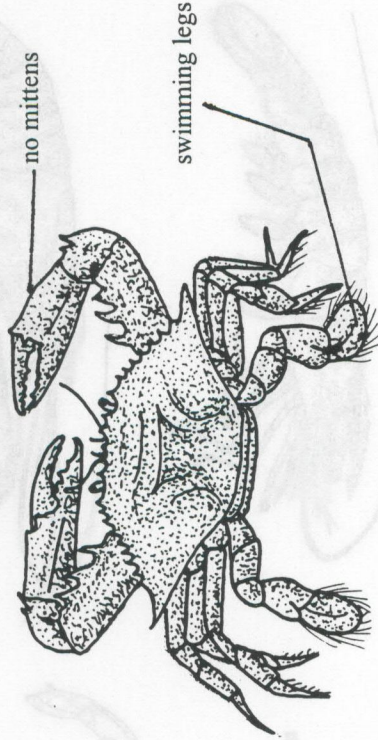
Prohibited

Mitten Crab *Eriocheir* sp.



Unprohibited

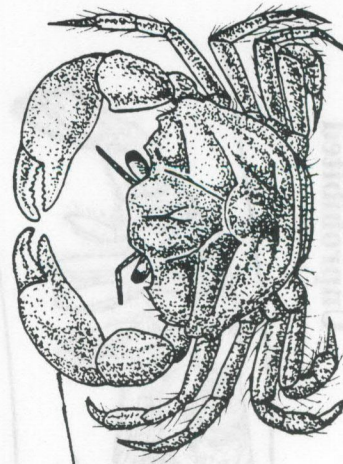
Blue Crab *Callinectes sapidus*



Green Crab *Carcinus maenas*



a few hairs but no mittens



White-fingered Mud Crab
Rithropanopeus harrisi

Marsh Crab
Sesarma sp.

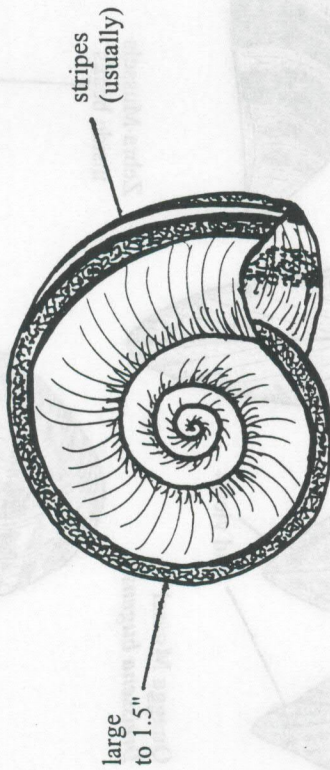


SNAILS

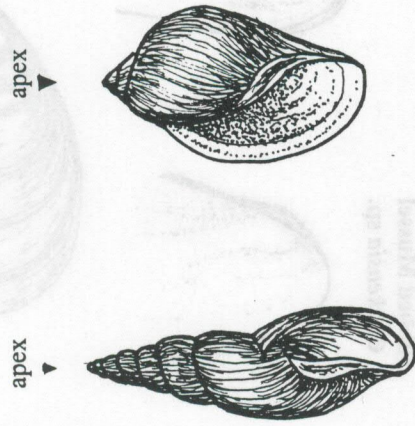
GIANT RAMSHORN SNAIL

Prohibited

Giant Ramshorn Snail
Marisa sp.

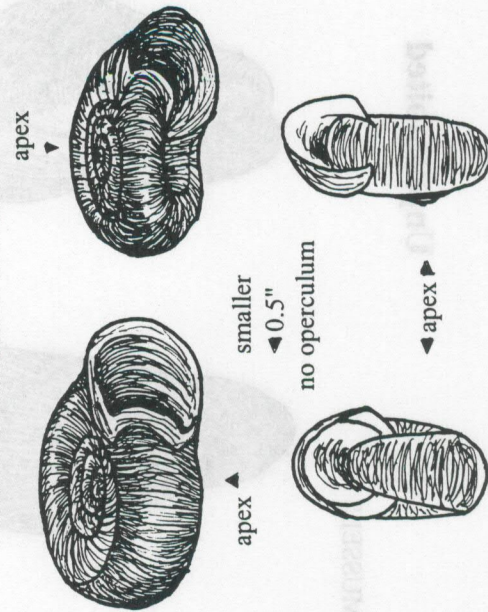


Unprohibited



Pond Snail *Stagnicola* sp. Right-handed (dextral)
Pond Snail *Physella* sp. Left-handed (sinistral)

NATIVE RAMSHORN SNAILS



Planorbella sp. Left-handed (sinistral)

Planorbula ap. Right-handed (dextral)

Right-handed (dextral)

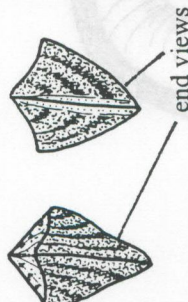
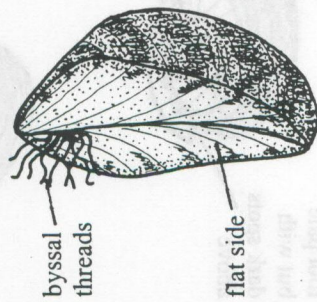


BIVALVE MOLLUSKS

ZEBRA MUSSELS

Prohibited

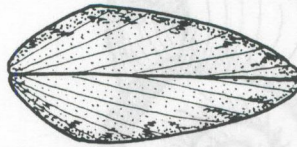
Zebra Mussel *Dreissena polymorpha*



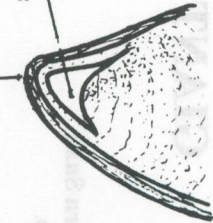
Quagga Mussel
Dreissena bugensis



color variation

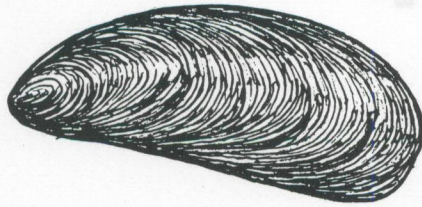


Zebra Mussels
inside beaks

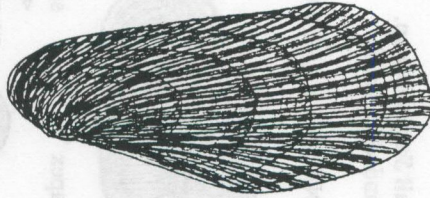
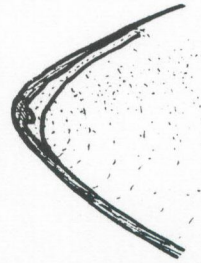


Unprohibited

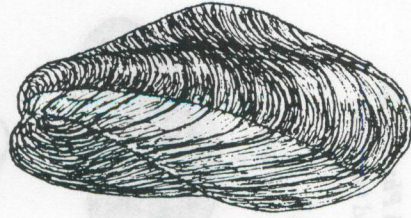
MYTILID MUSSELS



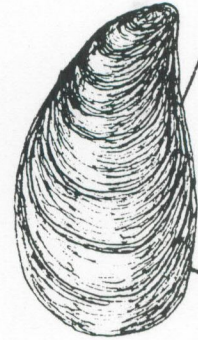
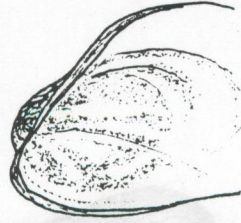
Blue Mussel
Mytilus edulis
(also *Perna*)



Ribbed Mussel
Geukensia sp.



Tulip Mussel
Modiolus sp.



usually unmarked brown

no flat side

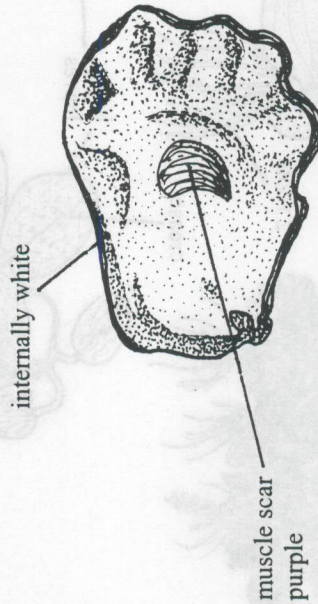
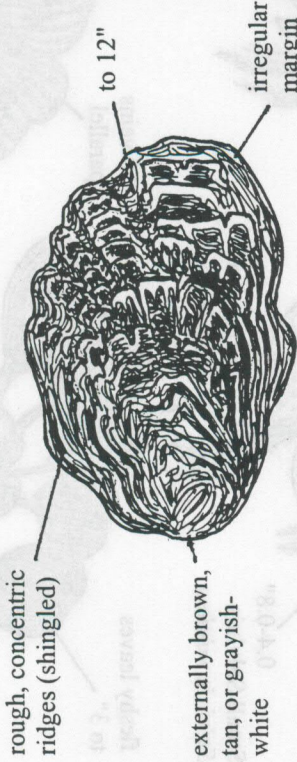
Dark Falsemussel *Mytilopsis leucophaea*

BIVALVE MOLLUSKS

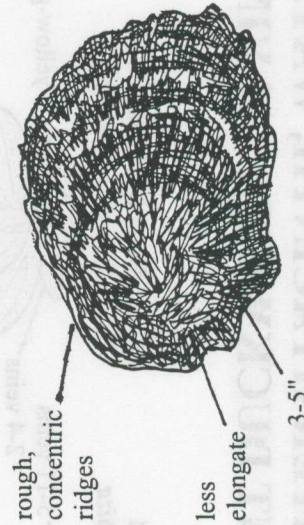
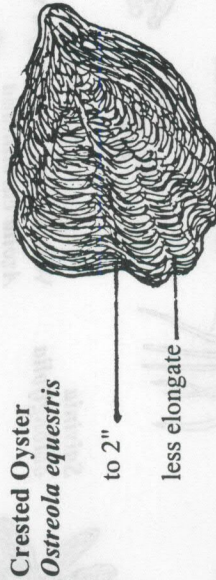
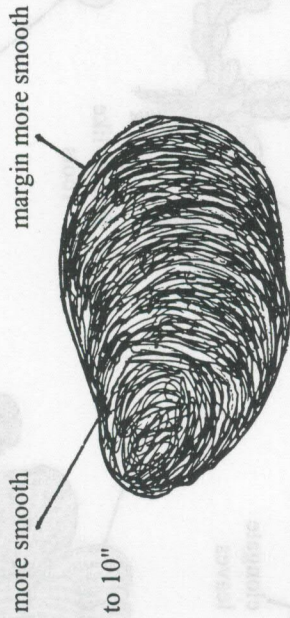
PACIFIC OYSTER

Prohibited

Pacific Oyster *Crassostrea gigas*



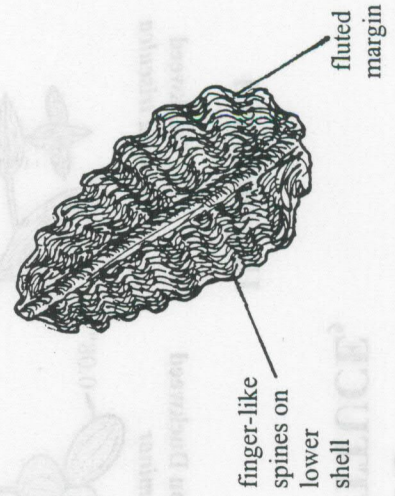
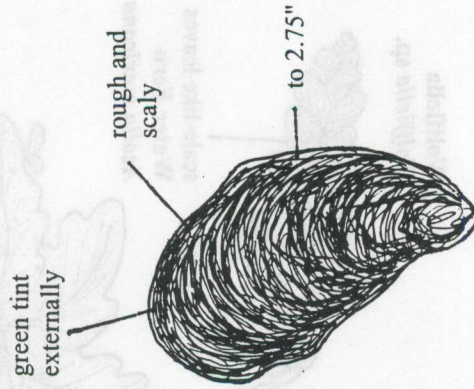
Eastern Oyster *Crassostrea virginica*



Edible European Oyster
Ostrea edulis

Unprohibited

Native Pacific Oyster *Ostrea lurida*

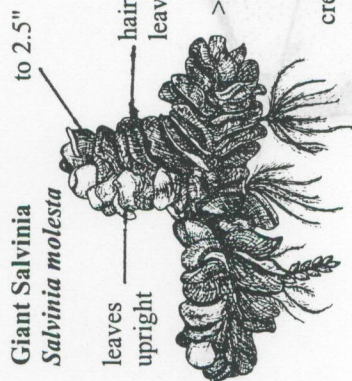


Coon Oyster
Dendostrea frons

FLOATING AQUATIC PLANTS

FLOATING WATER HYACINTH, WATER LETTUCE, GIANT DUCKWEED, SALVINIAS

Prohibited



Giant Salvinia
Salvinia molesta

leaves upright

to 2.5"

hairy leaves

> 2 roots

crease

hairy, root-like leaves

0.4-0.8"

Small Salvinia

Salvinia minima

fleshy leaves to 3"

inflated stems

fibrous, branched roots

Floating Water Hyacinth

Eichhornia crassipes

Water Lettuce

Pistia stratiotes

10 veins parallel

hairy

elongate leaves

Salvinia oblongifolia

hairy leaves

5-11 veins

2-4 veins

leaves 0.08-0.20"

green above, red below

> 2 roots

Giant Duckweed

Spirodela oligorhiza

yellow-green

1 root

0.08"

Common Duckweed

Lemna minor

no roots

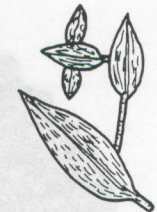
< 0.04"

filament-like roots

Ivy Duckweed

Lemna trisulca

Unprohibited



Ivy Duckweed

Lemna trisulca



Common Duckweed

Lemna minor



Giant Duckweed

Spirodela polyrhiza

yellow-green

1 root

0.08"

Common Duckweed

Lemna minor

no roots

< 0.04"

filament-like roots

Ivy Duckweed

Lemna trisulca

scale-like leaves

Water Fern

Azolla mexicana

veins not parallel

leaves not fleshy or hairy

light green

Water Sprite

Ceratopteris sp.

feather-like roots

small 0.01-0.04"

Water Fern

Azolla caroliniana

Wolfia

Wolfia sp.

Wolfia

Wolfia sp.

Water Fern

Azolla caroliniana

Wolfia

Wolfia sp.

Water Fern

Azolla caroliniana

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Water Fern

Azolla caroliniana

Wolfia

Wolfia sp.

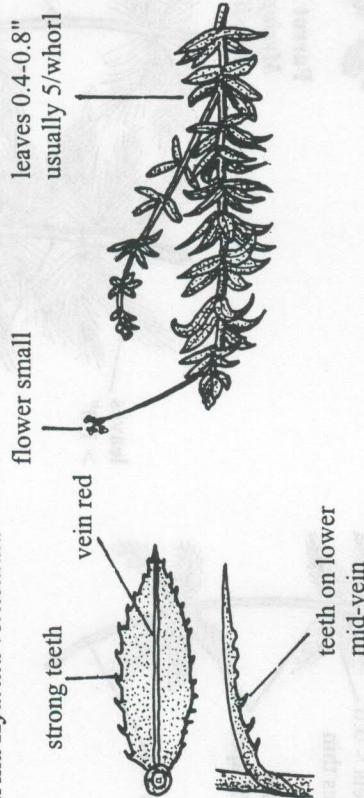
Water Fern

SUBMERGED AQUATIC PLANTS WITH UNBRANCHED LEAVES

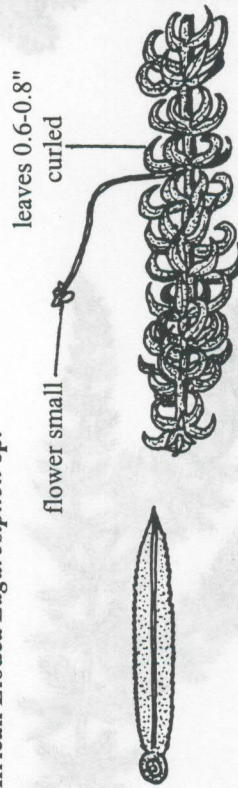
HYDRILLA, AFRICAN ELODEA, ROOTED WATER HYACINTH

Prohibited

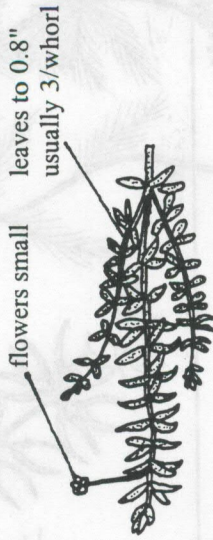
Hydrilla Hydrilla verticillata



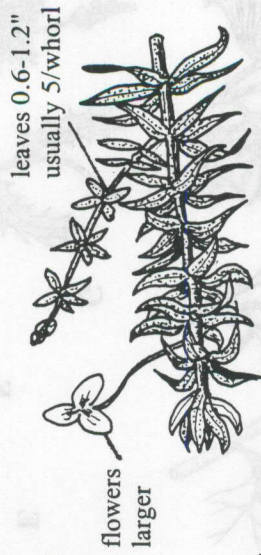
African Elodea Lagarosiphon sp.



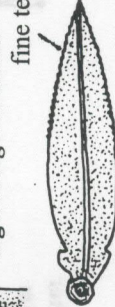
Unprohibited



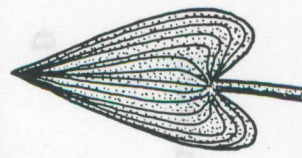
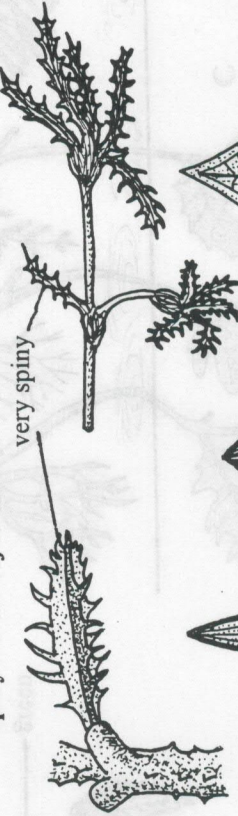
Waterweed Elodea sp.



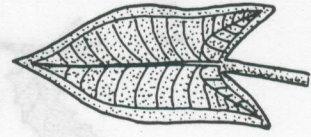
Egeria Egeria densa



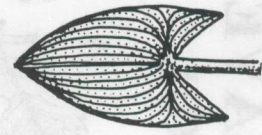
Spiny Naiad Najas marina



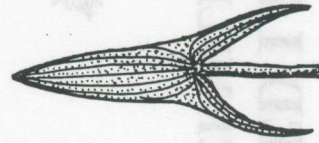
Pickerelweed Pontederia sp.



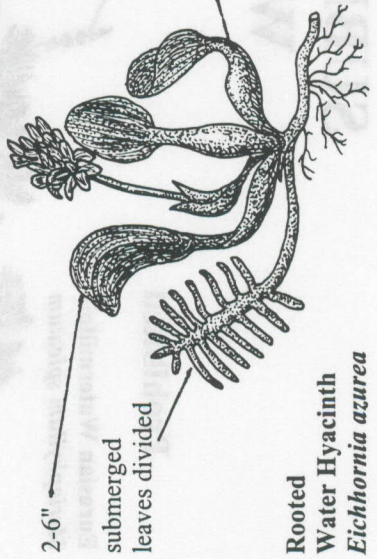
Arrow-arum Peltandra sp.



Arrowhead Sagittaria sp.



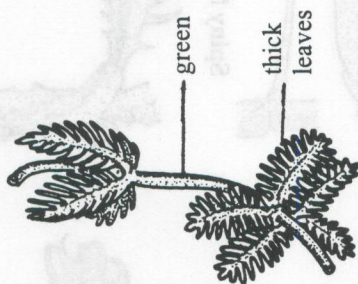
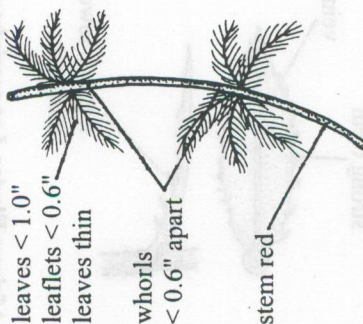
Rooted Water Hyacinth Eichhornia azurea



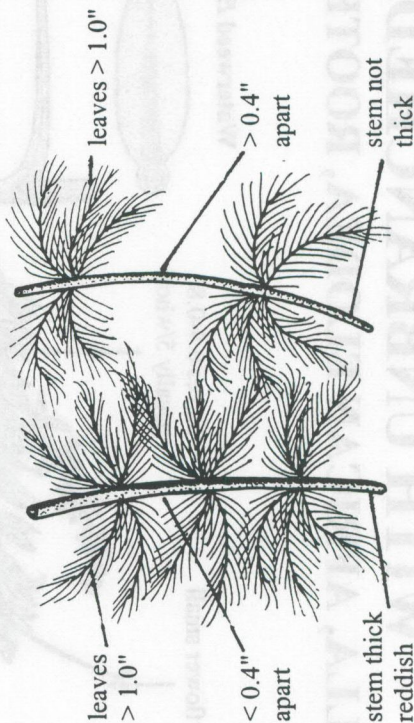
SUBMERGED AQUATIC PLANTS WITH BRANCHED LEAVES EURASIAN WATERMILFOIL

Prohibited

Eurasian Watermilfoil
Myriophyllum spicatum



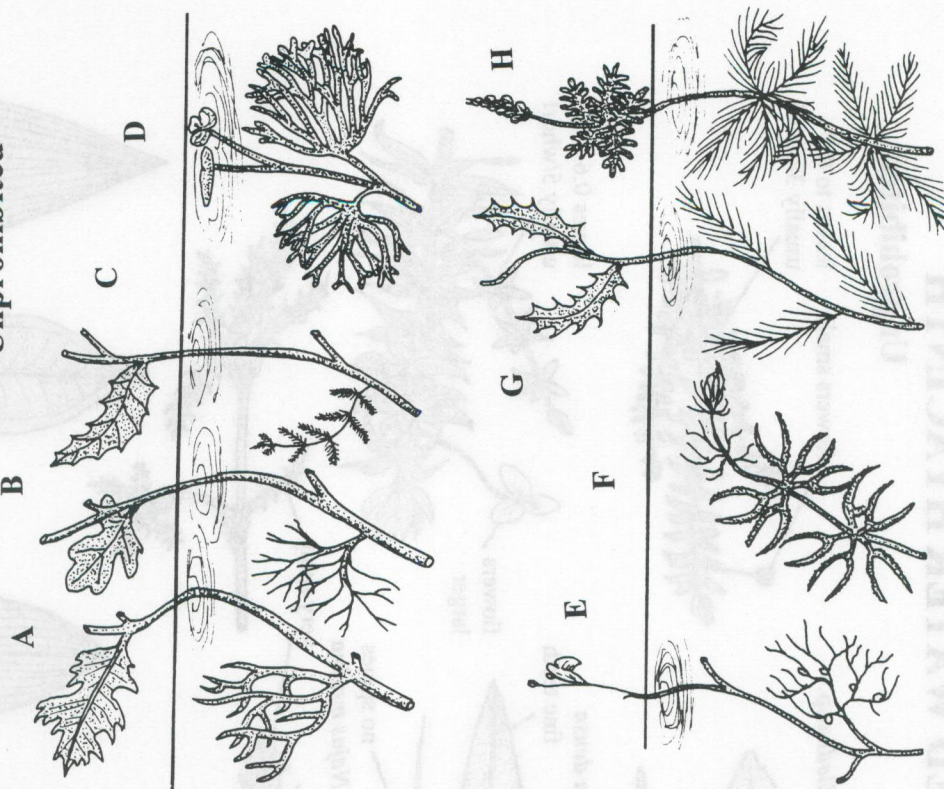
Parrot Feather
Myriophyllum brasiliensis



Myriophyllum verticillatum

Myriophyllum exalbesces

Unprohibited



A. Water Marigold *Megalodonta*
B. Water Buttercup *Ranunculus*
C. Lake Cress *Neobeckia* sp.
D. Fanwort *Cabomba*

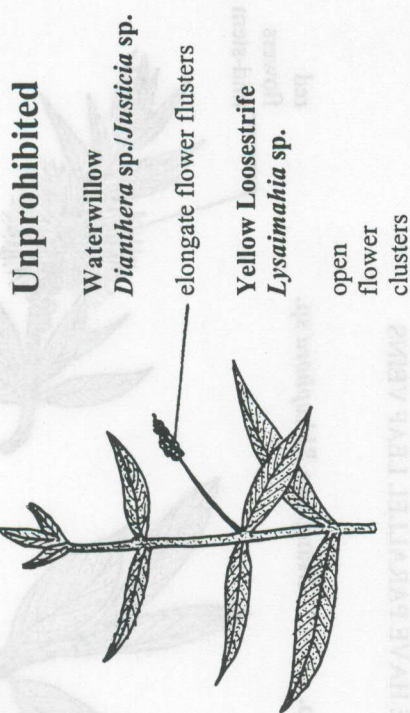
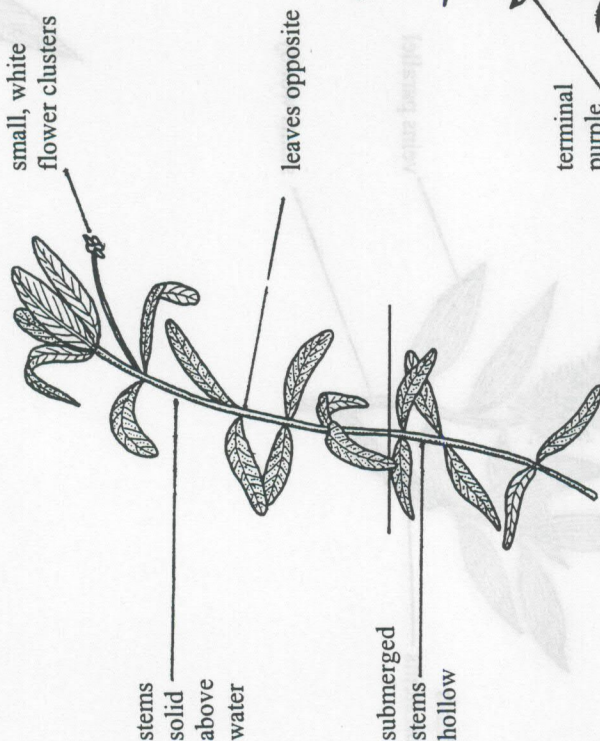
E. Bladderwort *Utricularia*
F. Hornwort *Ceratophyllum*
G. Mermaid Weed *Proserpinaca*
H. Watermilfoil *Myriophyllum*

EMERGENT PLANTS

ALLIGATORWEED

Prohibited

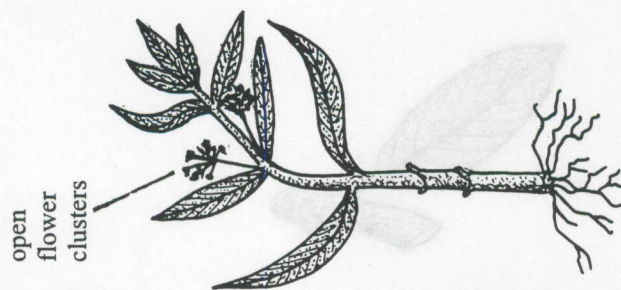
Alligatorweed *Alternanthera philoxeroides*



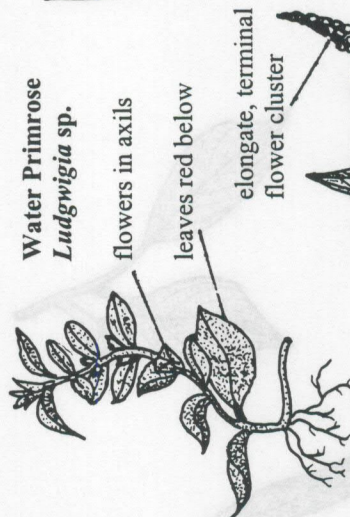
Unprohibited

Waterwillow
Dianthera sp./Justicia sp.

Yellow Loosestrife
Lysaimahia sp.



Water Primrose
Ludwigia sp.



elongate, terminal
flower cluster

Knotweed
Polygonum sp.



Purple Loosestrife
Lythrum salicaria



SHOREZONE TREES AND SHRUBS

PAPERBARK (MELALEUCA)

Prohibited

Unprohibited

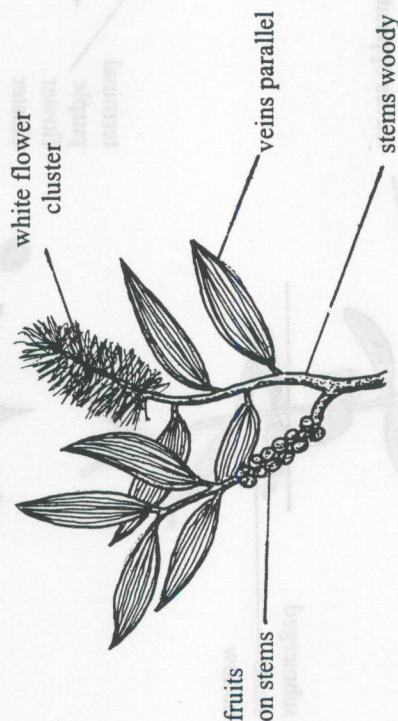
Magnolia
Magnolia sp.

Willow *Salix* sp.
toothed leaf edge

Tupelo *Nyssa* sp.



Paperbark *Melaleuca* sp.

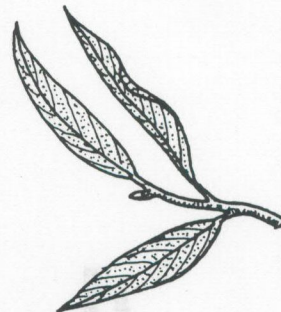


NONE HAVE PARALLEL LEAF VEINS

Willow Oak *Quercus* sp.

Mangrove *Rhizophora* sp.

red
flowers
mid-stem



Bottlebrush *Callistemon* sp.

AQUATIC GRASSES

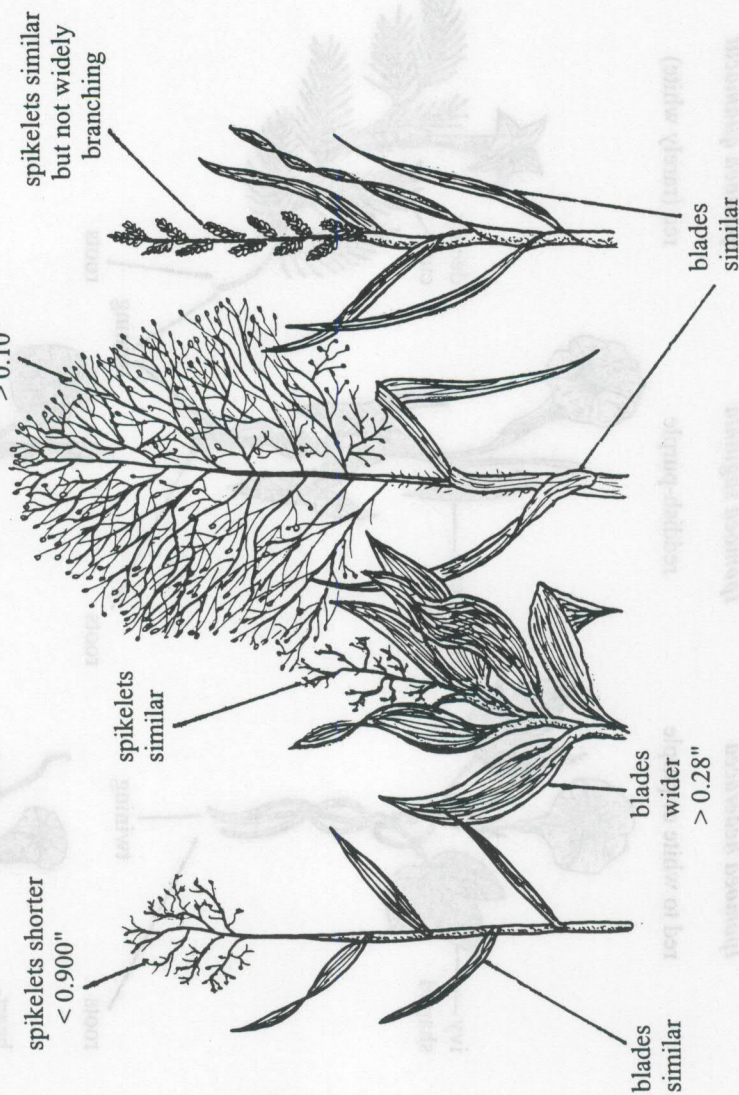
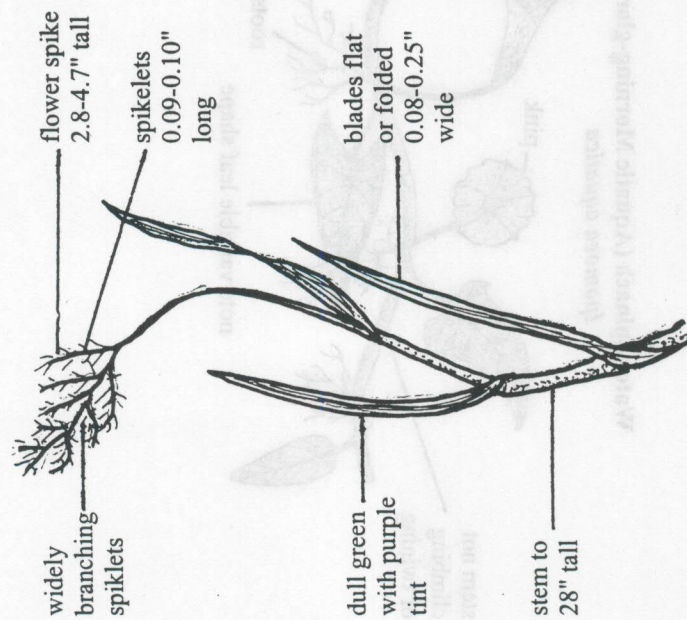
TORPEDOGRASS

Prohibited

Unprohibited

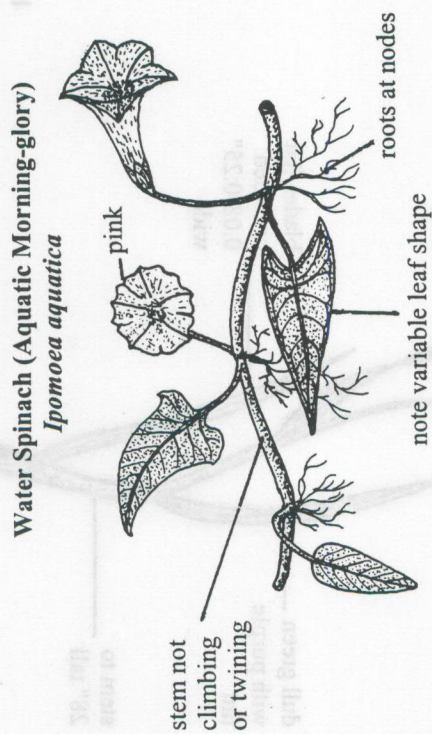
OTHER PANIC GRASSES

Torpedograss *Panicum repens*



AQUATIC VINES WATER SPINACH

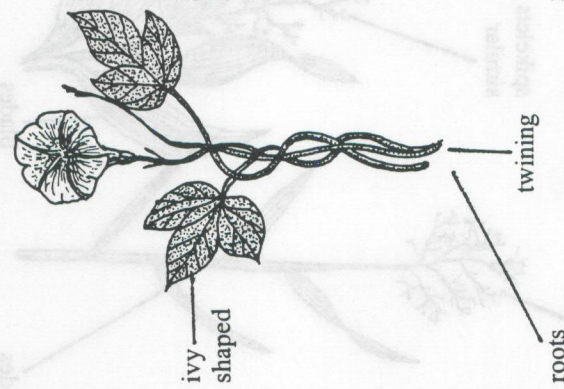
Prohibited



Unprohibited

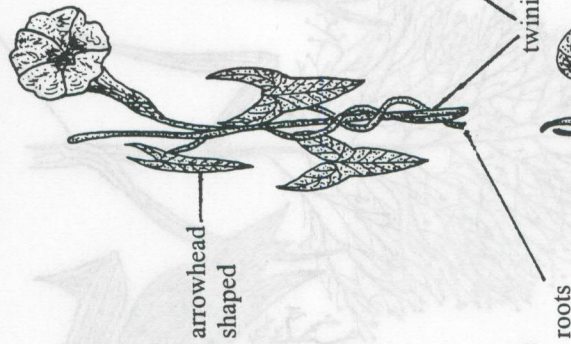
Ivy-leaf Morning-glory
Ipomoea hederacea

red to white or purple



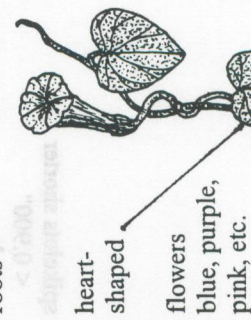
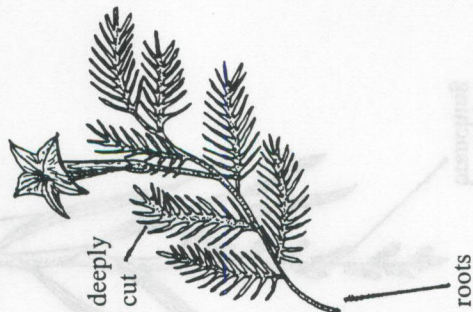
Saltmarsh Morning-glory
Ipomoea sagittata

reddish-purple



Cypress Vine
Ipomoea quamoclit

red (rarely white)



Domestic Morning-glory
Ipomoea purpurea

APPENDIX III:

STATUS OF COMMON CARP, KOI CARP, GOLDFISH, AND CRUCIAN CARP IN TEXAS

Introduction:

Common carp *Cyprinus carpio* and goldfish *Carassius auratus* were imported and stocked into U.S. waters, including Texas, in the 1800's; however, informal introductions of goldfish may have occurred as early as the 1600's. Both are now well established. Both species have been used as bait in Texas and elsewhere. However, with the passage of the Texas Fish Farmer Act of 1989 (SB 1507) which prohibited placing fish in state waters, except for native nongame fish, and concurrent TPWD restricted fish regulations, the legality of continued use of common carp and goldfish as bait has become unclear to some. Although subsequent TPWD regulations specified that common carp, goldfish and Crucian carp *Carassius carassius* could still be legally used as live bait, some confusion remains. Further, the identification of some genetic variants (especially of common carp) has also caused problems.

Although SB 1507 and TPWD restricted fish regulations define "exotic species", neither "native", "indigenous" or "commonly found" are actually defined. The TPWD Austin staff has interpreted regulation wording to mean that common carp and goldfish are considered native to Texas because they are commonly found in state waters, but neither is considered indigenous to the state (W.D. Harvey, TPWD, Austin; personal communication); therefore, they have concluded that both common carp and goldfish can continue to be legally used as bait in Texas. The hybrids between these species are also legal bait fish.

Crucian carp is very similar to goldfish and largely differs only in historical range and in some meristic counts. It too is propagated by aquaculturists, but to a much lesser extent than common carp or goldfish. Crucian carp is prohibited in at least two states (Arizona and Connecticut); however, positive identification could be very problematic. Some exotic fish experts in the U.S. believe goldfish typically seen in American waters are actually Crucian carp x goldfish hybrids. Indeed, gill raker counts on goldfish from TPWD hatcheries and Heart of the Hills Research Station are often lower than described for goldfish,

possibly reflecting Crucian carp influence. Crucian carp is not restricted as a harmful or potentially harmful species, and although not "commonly found" in Texas waters (in the strictest sense), it can be used as a bait fish. Because of similarity to and hybridization with goldfish, it was specifically exempted from inclusion in regulations on introduction of exotic species (actual identification of specimens would be difficult regardless of legal status).

Taxonomic Status:

Common Carp - *Cyprinus carpio*. Historically, other species of this genus have been reported (*micristius*, *pellegrini*, *fossicola*, *rabaudi*, *acuminatus*, *coriaceus*, *elegans*, *elatus*, *hungaricus*, *macrolepidotus*, *regina*, *rex*, and *specularis*, with *rabaudi* also given as a subspecies of *C. carpio*). One recent publication listed *C. carpio haematopterus* as the Amur-Chinese or Far Eastern subspecies, *C. c. carpio* from Europe and the Transcaucas, *C. c. aralensis* from central Asia and *C. c. viridivio-laceus* from North Vietnam. All probably represent only local variations of common carp, and with widespread stocking of *C. carpio* strains and subsequent hybridization and intergradation, any initially valid differences have likely been lost. Note also terms like *C. carpio* morpha *acuminatus* (high-backed), *C. carpio* morpha *hungaricus* (elongated body), and *C. carpio* var. *flavipinnis* (long-finned) represent only morphologically variant strains. *C. carpio* var. *koi* refers to domestically-produced colored common carp.

Goldfish - *Carassius auratus*. Also given as *C. auratus auratus* for Asian goldfish and *C. auratus gibelio* for the European goldfish; however, the validity of the European subspecies is questionable and probably represents only feral goldfish released after imports from the Far East to Portugal in 1611 and thereafter. The term *C. auratus* morpha *humilis* refers to strains of bigheaded, slender-bodied individuals. Similarly, some domestic strains have been given names like *C. auratus* var. *bicaudatus* (two-tailed), etc.; none are taxonomically significant.

Crucian Carp - *Carassius carassius*. Variant forms have been described as *C. carassius* morpha *humilis*

(bigheaded, slender-bodied) and *C. carassius morpha gibelio* (deep-bodied) but are not taxonomically distinct.

Distribution:

Common Carp - This species was originally native to Asia and believed transported to Europe by the Romans. It was imported into the U.S. in the mid-1800's, and to Texas shortly thereafter; now it is almost cosmopolitan (reportedly cultured for over 20 centuries).

Goldfish - This species was originally native to Asia, possibly to Europe if the *C. auratus gibelio* is valid (and not just a feral introduction). Like common carp, goldfish has attained nearly cosmopolitan distribution over nearly 10 centuries of cultivation. It entered the U.S. in the mid-1800's (possibly earlier) and was brought to Texas before the turn of the century.

Crucian Carp - This species was native to central and eastern Europe with introductions into western and northern Europe and England. Old records from China are believed invalid. Although occasionally cultured in Europe and Russia, it has not received the aquacultural attention given goldfish and common carp, and subsequently does not occur in the wide variety of domestic forms and colors seen in those species. Lack of major aquacultural interest has probably served to limit wide introductions outside its native range.

Descriptions:

Common carp - Coloration is a slaty or bronzish golden-olive, sometimes with red or yellow tints in lower fins; domestic color variants (koi) exist. Common carp have two pair of barbels (although one pair may be small); body depth is usually 25.8-32.8% total length, but long and slender individuals as well as very deep-bodied specimens (body depth may be nearly 50% body length) occur. Meristics: dorsal fin I, 18-20; anal fin I (III), 5 (6); lateral line scales 32-41 (usually > 32, most 36-39) with 5-7 scale rows both above and below the lateral line; gill rakers 21-29 on the first arch;

and pharyngeal teeth 1,1,3-3,1,1 and molar-like (domestic strains may have different numbers and rows). Domestic variants include:

● Variation in scale patterns.

● **Scale Pattern:** Common carp with unusual scale patterns apparently appeared in Germany and were sent to Japan in the 1800's, with subsequent breeding in eastern Asia and distribution elsewhere. There are four basic scale patterns; however, there may be a great deal of variation within each type.

● **Scaled** - the normal wild-type pattern.

● **Mirror** - scales are restricted to the dorsal and ventral surfaces with additional scales randomly scattered along the sides; these scales are often much larger than normal and often do not overlap.

● **Line-pattern** - scales are restricted to the dorsal and ventral surfaces and in a row along the lateral line; scales are often larger than normal. Also called sparse-scaled, linear-scaled and frame-scaled.

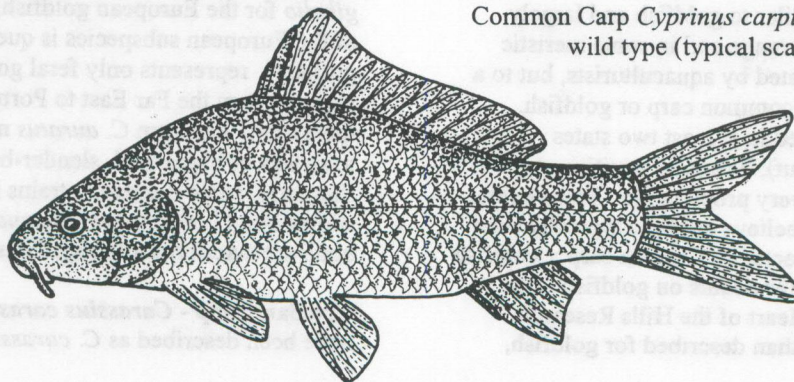
● **Leather** - scales are lacking or only present in small numbers along the dorsal and ventral surfaces. Also called bare-scaled.

● **Coloration:** Color variants exist in common carp as in goldfish and are known as koi or koi carp. Colored or multi-colored common carp may occur with any of the previously described scale patterns.

● **Long-finned forms:** Long-finned koi have been imported in recent years through the pet trade as veiltailed koi; however, carp with long fins were described by Weber from fish ponds in western Java in 1916 and may have been alluded to by Cuvier and Valenciennes as early as 1842. Specimens with long fins are currently sold in the pet trade as butterfly koi.

● Some domestic carp strains, especially certain inbred koi, often show genetic deformities such as pugheadedness and curved spines.

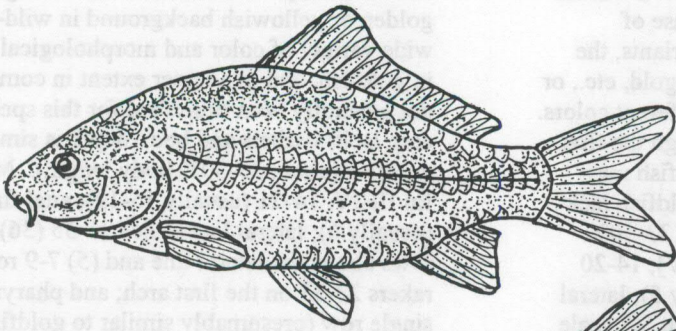
Common Carp *Cyprinus carpio*
wild type (typical scaled form)



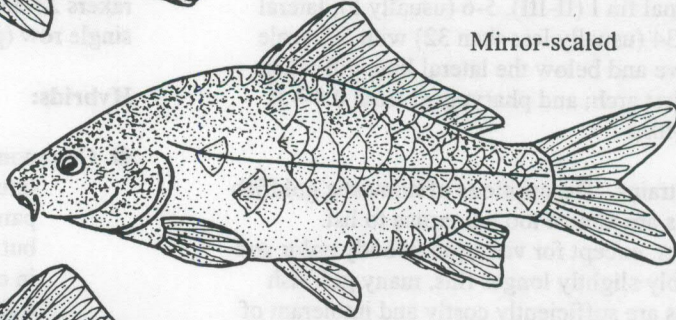
FORMS OF COMMON CARP

Cyprinus carpio

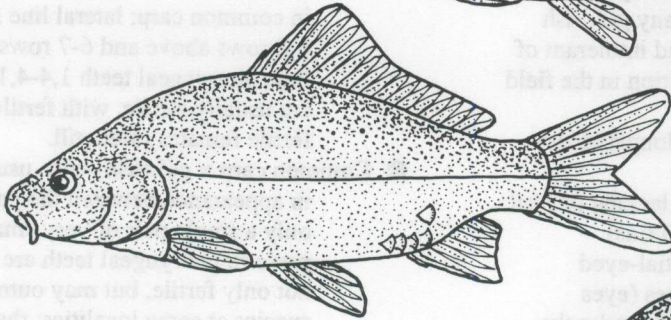
Line-scaled



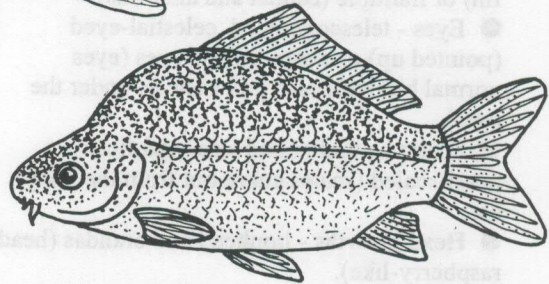
Mirror-scaled



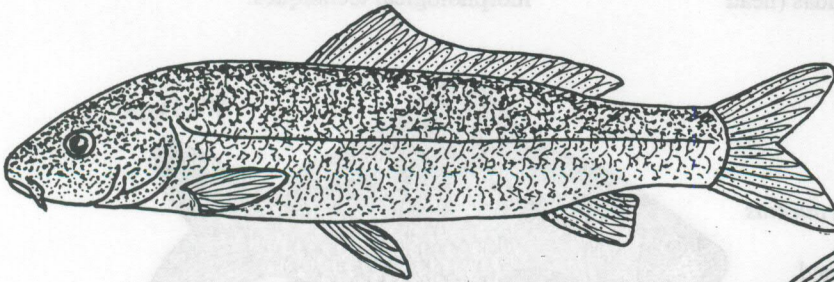
Leather



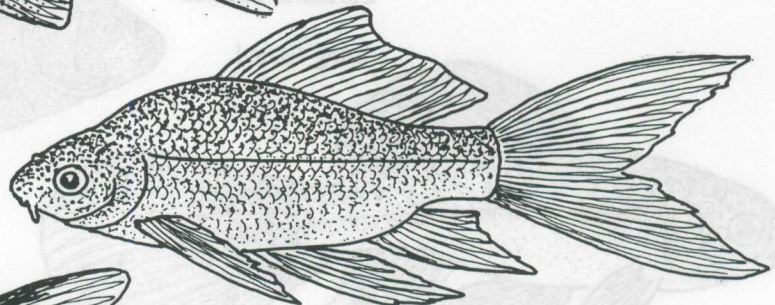
Deep-bodied



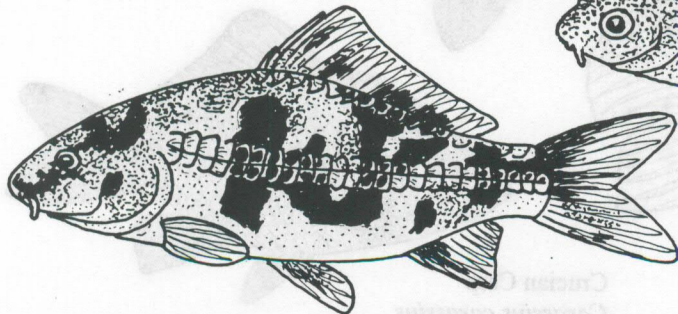
Elongated Body



Long-finned



Koi (Color Variant)



Goldfish - Coloration is an olive-green over a whitish background in wild-types; however, because of numerous domestically produced color variants, the background color may be bronze, yellow, gold, etc., or specimens may show a combination of different colors. Goldfish may change color with age through the first few years of life such that wild-type olive fish may eventually become gold or vice versa. Goldfish lack barbels and body depth ranges from about 33-50% body length. Meristics: dorsal fin I (III-IV), 14-20 (usually 17); anal fin I (II-III), 5-6 (usually 5); lateral line scales 25-34 (usually less than 32) with 5-7 scale rows both above and below the lateral line; gill rakers 35-50 on the first arch; and pharyngeal teeth 0,4-4,0 and not molar-like.

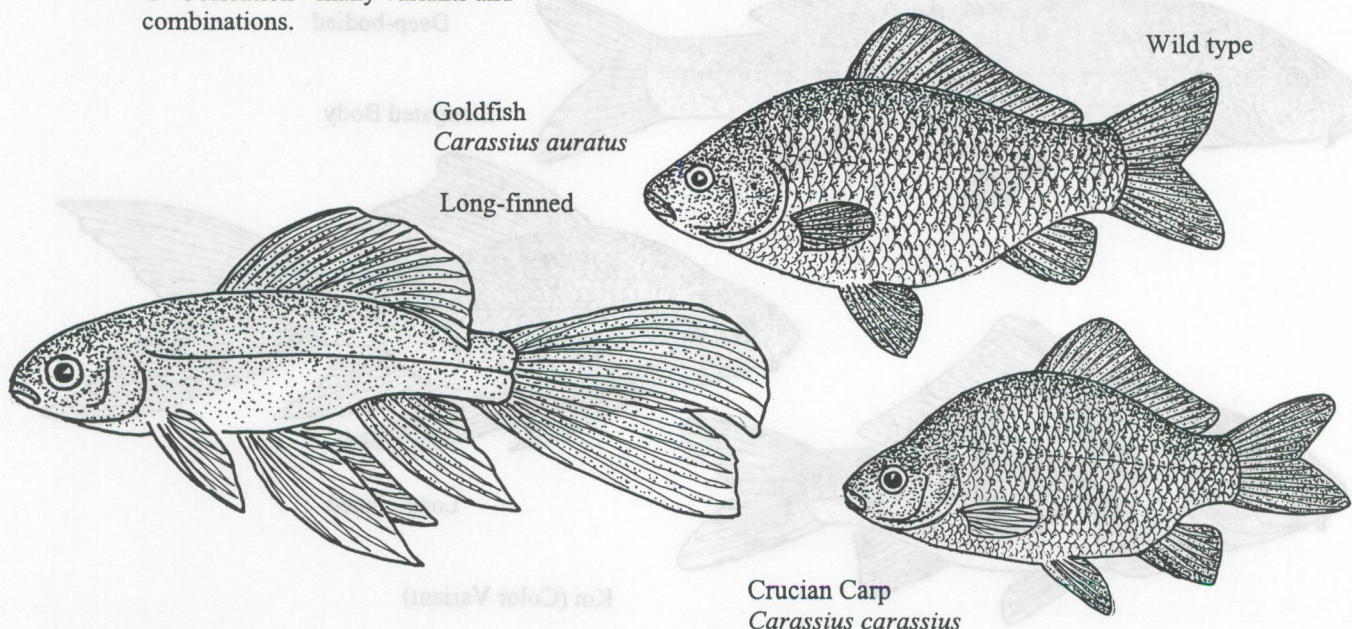
- Domestic strains - Descriptions of domestic goldfish strains are almost too numerous to list. Further, except for variation in body color and possibly slightly longer fins, many goldfish strains are sufficiently costly and intolerant of stress that sale for bait or collection in the field is unlikely.

- Body form - deep-bodied, elongated and egg-shaped to nearly spherical.
- Fins - elongated, shortened, lacking (dorsal fin) or multiple (caudal and anal fins).
- Eyes - telescope-eyed, celestial-eyed (pointed up) or water-bubble eyes (eyes normal but with enlarged vesicles under the eyes).
- Scales - number and size modifications, pearl-scaled (scales curve out from the body), etc.
- Head growths - lionhead and orandas (head raspberry-like).
- Coloration - many variants and combinations.

Crucian carp - Coloration is an olive-green but over a golden or yellowish background in wild-types. The wide variety of color and morphological variants seen in goldfish, and to a lesser extent in common carp, have not generally been described for this species. Crucian carp lacks barbels and body depth is similar to that of goldfish (about 33-50% body length). Meristics: dorsal fin III-IV, 14-21 (usually 15-19); anal fin II-III, (5) 6-8 (usually 6); lateral line scales 31-35 (36) with 6-8 scale rows above the lateral line and (5) 7-9 rows below; gill rakers 23-33 on the first arch; and pharyngeal teeth in a single row (presumably similar to goldfish).

Hybrids:

- Common carp x Crucian carp - generally intermediate in appearance between the parents; two pair of barbels are usually present but barbels are much less well developed than in common carp; lateral line scales 34-39 with 6-8 rows above and 6-7 rows below the lateral line; pharyngeal teeth 1,4-4,1; these hybrids are usually sterile, with fertile males rare, and fertile females rarer still.
- Common carp x goldfish - also usually intermediate in appearance between the parents; usually only a single pair of very small barbels is present; pharyngeal teeth are 1,4-4,1 or 4-4; not only fertile, but may outnumber parental species at some localities; the only hybrid common in nature.
- Goldfish x Crucian carp - reported but poorly described and probably very difficult to accurately identify with standard meristic and morphological techniques.



Common Names:

Aischgrunder carp - *Cyprinus carpio*; see German Aischgrunder carp.
Amur carp - *Cyprinus carpio haematopterus* (subspecies of questionable validity); not white Amur carp which is a synonym for grass carp *Ctenopharyngodon idella*.
Asagi carp - *Cyprinus carpio*.
Asian common carp - *Cyprinus carpio haematopterus*; see Amur carp.
Bigbelly carp - *Cyprinus carpio*.
Blue carp - *Cyprinus carpio*; also called the cerula strain or race, developed in Poland.
Bohemian carp - *Cyprinus carpio*; often leather carp.
Cerula carp - *Cyprinus carpio*; see blue carp.
Chinese carp(s) - loosely applied to many carp-like cyprinids from China, not just *Cyprinus carpio*.
Chinese common carp - *Cyprinus carpio*.
Chinese goldfish - *Carassius auratus auratus*.
Common carp - the formal common name for *Cyprinus carpio* adopted by the American Fisheries Society in 1970.
Cultured carp - *Cyprinus carpio*.
Dinnyes carp - *Cyprinus carpio*.
Eastern carp - *Cyprinus carpio haematopterus*; see Amur carp.
Egyptian carp - mirror and line-scale forms of *Cyprinus carpio* were being offered for sale as live bait in Texas under this name in 1998.
European carp - *Cyprinus carpio*.
European goldfish - *Carassius auratus gibelio* (if the subspecies is valid); infrequently, *Carassius carassius*.
Galician carp - *Cyprinus carpio*; often mirror-scaled carp.
German carp - *Cyprinus carpio* in general or any with scale pattern variations.
German Aischgrunder carp - a deep-bodied strain of *Cyprinus carpio*.
Gibele carp - *Carassius auratus gibelio* (subspecies validity questionable).
Golden carp - (1) leather or unscaled *Cyprinus carpio*, (2) goldfish *Carassius auratus*.
Golden Crucian carp - *Carassius carassius*.
Hungarian carp - *Cyprinus carpio*; especially a domestic strain with an elongated body.
Israeli carp - *Cyprinus carpio*, often with reference to the mirror-scaled types; however, common carp were first imported to Israel from Yugoslavia, and later from numerous other locations, hence many domestic strains are cultured in Israel.
Kajera Domas carp - *Cyprinus carpio*.
King carp - line-scaled *Cyprinus carpio*.
Koi or koi carp - (1) colored variants of *Cyprinus*

carpio; (2) koi has also been applied to common carp x goldfish and goldfish x Crucian carp hybrids, but this use is atypical.
Kopsha carp - *Cyprinus carpio*; domestic strain from fish ponds near Leningrad (U.S.S.R.); also called northern carp.
Krusk carp - (1) grass carp (*Ctenopharyngodon idella*) x *Cyprinus carpio haematopterus* hybrid (domestic) or (2) a cross between domestic Galician *Cyprinus carpio* and Eastern (Asian, Amur) carp *C. c. haematopterus*; sometimes called the "northern breed."
Lausitzer carp - *Cyprinus carpio*.
Leather carp - scaleless or nearly scaleless *Cyprinus carpio*.
Line or lined carp - line-scaled *Cyprinus carpio*.
Majalayan carp - *Cyprinus carpio*.
Mirror carp - mirror-scaled *Cyprinus carpio*.
Mongrel cultured carp - mixed domestic strains of *Cyprinus carpio*.
Nasice carp - *Cyprinus carpio*.
Northern carp - *Cyprinus carpio*; see Kopsha carp.
Pond carp - *Cyprinus carpio*.
Punten carp - *Cyprinus carpio*.
Prussian carp - usually *Carassius auratus gibelio*, occasionally *Carassius carassius*.
Sauinsk silver carp - the hybrid of *Carassius auratus gibelio* x *Cyprinus carpio* (domestic).
Silver Prussian carp - *Carassius auratus gibelio* (subspecies validity questionable).
Sinyonya carp - *Cyprinus carpio*.
Ukrainian carp - *Cyprinus carpio*; includes both normal-scaled and line-scaled (frame-scaled) forms.
Wild carp - *Cyprinus carpio*; specifically, not of a defined domestic strain.
Yamato carp - *Cyprinus carpio*.

Differentiation of common carp, goldfish, and Crucian carp:

Common carp:

- Barbels - two pairs present.
- Dorsal fin usually has ≥ 18 rays.
- Pharyngeal teeth molar-like, in three rows.
- Lateral line scales usually > 32 .
- Usually more elongated than goldfish or Crucian carp, but with deep-bodied exceptions.

Goldfish:

- Barbels absent.
- Dorsal fin usually has < 18 rays.
- Pharyngeal teeth not molar-like, in one row.
- Lateral line scales usually < 32 .
- Gill rakers 35-50.
- Usually deeper-bodied than common carp.

Crucian carp:

- Barbels absent.
- Dorsal fin usually has 15-19 rays.
- Pharyngeal teeth not molar-like, in one row.
- Lateral line scales 31-35.
- Gill rakers 23-33.
- Usually deeper-bodied than common carp.

ELECTROPHORETIC IDENTIFICATION OF KOI

Because koi or koi carp are only a domestic color variant of common carp, most technical scientific literature rarely directly discusses them. Although most current aquacultural and aquarium references also recognize them as common carp, some grey literature sources have in the past listed koi as another species or as a hybrid. Subsequently, some confusion and suspicion still remains as to the taxonomic identity of koi. In an effort to clarify this situation, tissue samples were obtained from goldfish, koi and wild-type common carp and subjected to electrophoretic analysis at Heart of the Hills Research Station (HOH), Ingram, Texas in 1987 and 1989.

A total of 21 specimens were examined including six goldfish obtained from HOH ponds, seven koi obtained from the San Antonio Zoo and from HOH ponds, and eight common carp collected from Victor Braunig Reservoir, Bexar County, Texas and Flat Rock Dam, Kerr County, Texas. Muscle and liver samples were removed, prepared and subjected to horizontal starch gel electrophoresis as described by Research Staff (1989. Electrophoretic technique guide: techniques used at Heart of the Hills Research Station with emphasis on largemouth bass and bluegill. TPWD, Austin.). A variety of enzyme systems were examined; however, isocitrate dehydrogenase (IDH), lactate dehydrogenase (LDH) and superoxide dismutase (SOD) provided some of the more definitive results.

Although these data are based on a small number of loci and specimens, and because both common carp and goldfish are natural tetraploids, results should be viewed cautiously. None the less, this preliminary information indicates no alleles present in koi and goldfish but absent in common carp. All alleles found in koi specimens examined were also present in common carp. These allele scores support the conclusion the koi is simply a color variant of common carp.

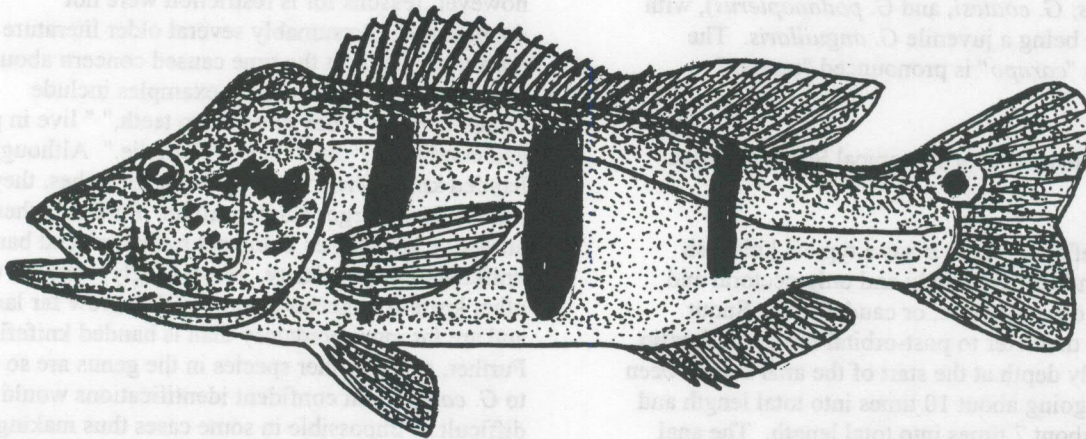
Enzyme	Tissue	Allele	Allele Occurrence		
			Common	Carp	Koi Goldfish
IDH	liver	100	*	*	
		90			*
IDH	muscle	120			*
		115			*
		110			*
		105			*
		100	*	*	
LDH-2	liver	100	*	*	
		95	*		
		90			*
		80?	*	*	*
LDH-1	liver	100	*	*	
		90			*
LDH-3	muscle	100			*
		90	*	*	
SOD	liver/ muscle	100	*		
		90	*	*	
		80			*

APPENDIX IV

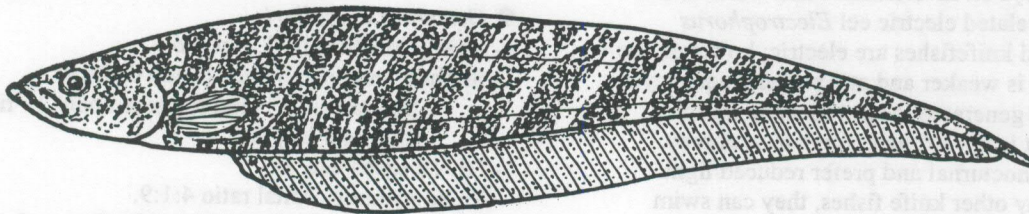
SPECIES REMOVED FROM THE LIST OF PROHIBITED HARMFUL AND POTENTIALLY HARMFUL FISHES, SHELLFISHES, AND AQUATIC PLANTS IN TEXAS

Over the years since the first prohibited list was established, reasons have arisen to delete certain species from the list and again allow possess, sale, or distribution of these organisms. Although it has been more common-place to see species added, some (like water fern *Azolla caroliniana*, peacock cichlid *Cichla ocellaris*, egeria *Egeria densa*, and Asian clams

Corbicula spp.) have been removed. However, previous species accounts for egeria and Asian clams from the earlier edition of this book have been retained and a discussion of peacock cichlids has been added in an effort to provide continued information on these organisms. Water fern can be found discussed under other small, floating plant descriptions.



Speckled Pavon
Cichla temensis



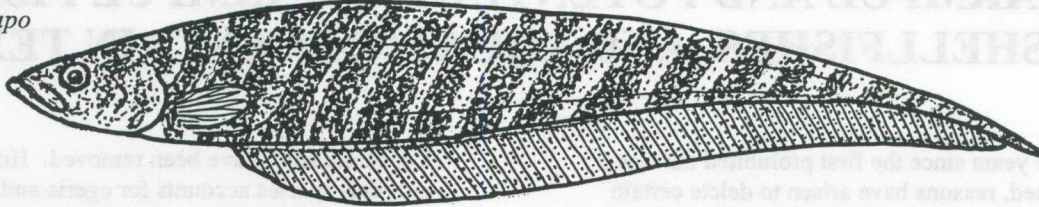
Banded Knifefish
Gymnotus carapo

BANDED KNIFEFISH

Family: Gymnotidae

Gymnotus carapo

Banded Knifefish
Gymnotus carapo



Other Names:
None.

Specifics:

This genus and several related genera represent a group of taxonomically problematic fishes. Generally, three or four species of *Gymnotus* are recognized (*G. carapo*, *G. anguillaris*, *G. coatesi*, and *G. podanopterus*), with *G. coropinae* being a juvenile *G. anguillaris*. The species name "*carapo*" is pronounced "sarapo."

Range:

Banded knifefishes occur in tropical South America.

Description:

Banded knifefish *G. carapo* has a typical knifefish shape with an elongate body and only pectoral and anal fins (no dorsal, pelvic, or caudal fins). Snout length to eye diameter to post-orbital head length ratio is 5:1:8. Body depth at the start of the anal fin has been described as going about 10 times into total length and head length about 7 times into total length. The anal fin has over 200 rays in adults (fewer in juveniles). Size is usually 12-18 inches (305-457 mm), questionably to 24 inches (610 mm). Coloration is brown or tan with about 20 forward sloping bars which continue to the back of the head.

Biology:

This knifefish preys on invertebrates and small fishes. Like the closely related electric eel *Electrophorus electricus*, banded knifefishes are electric; however, the current produced is weaker and at a higher frequency. The electric field generated is used to navigate and locate food, but it is not strong enough to stun prey. They are largely nocturnal and prefer reduced light levels. Like many other knife fishes, they can swim backwards.

Commercial Importance:

Limited numbers of banded knifefishes are imported

and sold in the pet trade where legal; however, other South American, Asian, and African knifefishes are far more popular and economically significant.

Reasons for Removal From Restriction:

Banded knifefish *G. carapo* was included on the original list of species prohibited in Texas in the 1960s; however, reasons for its restriction were not documented. Presumably several older literature reports available at the time caused concern about its aggressiveness and tenacity; examples include "cannibalistic," "they have sharp teeth," "live in pretty bad conditions," and "they seldom die." Although banded knifefishes do prey on smaller fishes, they usually leave larger animals alone. Further, other more attractive knifefishes in the pet trade replaced banded knifefishes in popularity. Interestingly, some of these other knifefish species now available grow far larger and are far more predatory than is banded knifefish. Further, several other species in the genus are so similar to *G. carapo* that confident identifications would be difficult or impossible in some cases thus making the regulation largely unenforceable.

Similar Species:

There are several families of knifefishes sold in the pet trade including other species of *Gymnotus*.

Other banded knifefishes (Family Gymnotidae):

- *Gymnotus anguillaris*
 - Nearly identical to *G. carapo*.
 - Slightly less deep bodied (body depth at the start of the anal fin goes about 15 times into total length).
 - HL 10 times into TL
 - Snout:eye:postorbital ratio 4:1:9.
 - Bars often less distinct and confined to the tail above the anal fin.

- *Gymnotus podanopterus*
 - Nearly identical to *G. carapo*.
 - Bars sometimes less distinct.
 - Diagnostic character descriptions unavailable.

- *Gymnotus coatesi*
 - description unavailable.

Featherback knifefishes (Family Notopteridae) with three genera:

- *Notopterus* with three species.
 - India and Southeast Asia.
 - Large (to 3 feet/1 m); heavy bodied.
 - Dorsal fin present (absent in *Gymnotus*)
 - Some species with bold ocellus marks on sides; others and even charcoal gray or variable pattern. Clown knifefish *N. chitala*, now popular in the pet trade, may show bold ocellus marks or may be unmarked.

- *Papyrocranus afer*.
 - Africa.
 - Considered *Notopterus* by some.
 - To about 2 feet (0.6 m) in length.
 - Dorsal fin present.
 - Color pattern variable; often dark markings on a light background.

- *Xenomystus nigri*
 - Africa.
 - To about 8 inches (203 mm) in length.
 - Gray-brown in color.
 - Dorsal fin absent.
 - Deeper bodied than banded knifefish.

Green knifefishes (Family Rhamphichthyidae) with 4-8 genera.

- Includes: *Sternopygus*, *Eigenmannia*, *Hypopomus*, and *Rhamphichthys*, and possibly others.
- Most similar to banded knifefishes.
- Usually less than 16 inches (406 mm) in length.
- Dorsal fins are lacking.
- Most are greenish-brown and rather transparent; species that do possess bar patterns have fewer than banded knifefishes and bars are usually thinner (broader in a few species).

Black ghost knifefishes (Family Aptereronotidae or Sternarchidae) with about 10 genera.

- South America.
- Differ from other South American knifefishes by the presence of a long, narrow dorsal fin and small caudal fin (the dorsal is often held against the body and not seen).
- Black ghost knifefish *Sternarchus albifrons* is common in the pet trade, jet black with white bands on the peduncle; other less common species may be mottled in brown and tan.

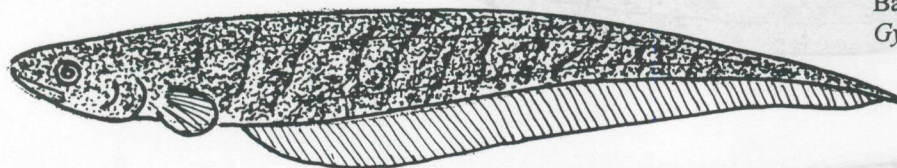
Aba aba *Gymnarchus niloticus* (Family Gymnarchidae)

- One African species.
- Not a knifefish, but similar in form.
- Long dorsal fin present but no anal, caudal, or pelvic fins.
- To about 3 feet (1 m) in length.
- Rare in the pet trade.

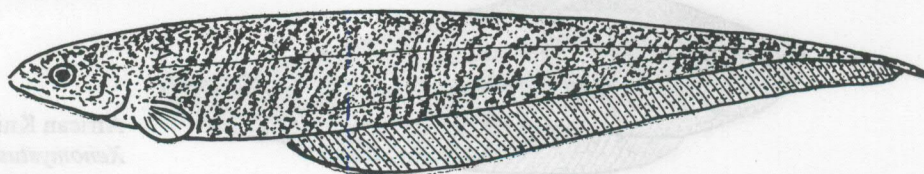
References:

Axelrod et al. 1976, 1989; Axelrod and Schultz 1971; Gunther 1866; Hoedeman 1962, 1975; Howells 1985; Innes 1966, 1979; Sterba 1967.

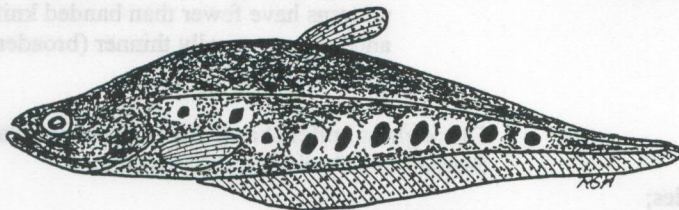
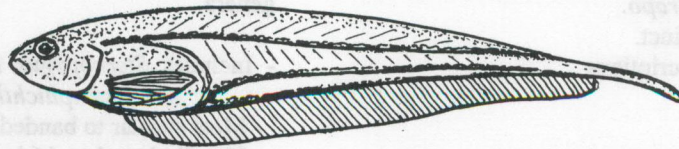
Banded Knifefish
Gymnotus anguillaris



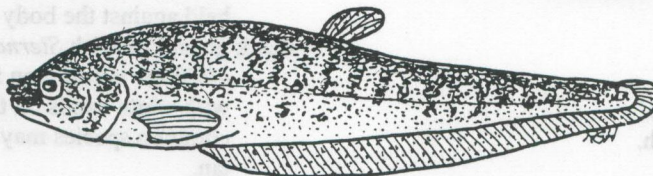
Banded Knifefish
Gymnotus podanopterus



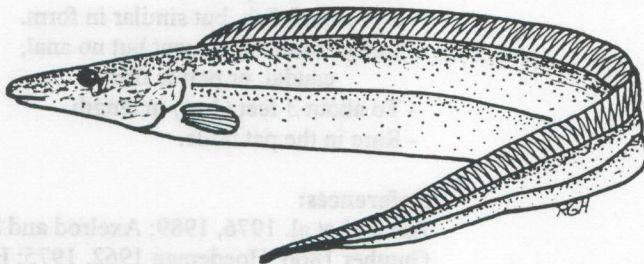
Green Knifefish
Eigenmannia virescens



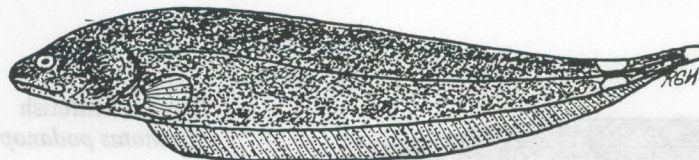
Clown Knifefish
Notopterus chitala



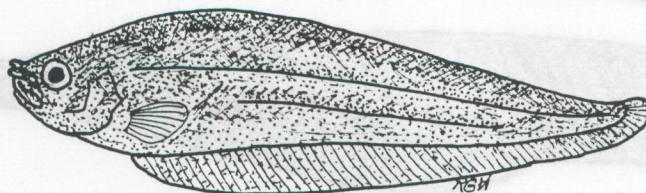
Featherfin Knifefish
Papyrocranus afer



Aba Aba
Gymnarchus niloticus



Black Ghost Knifefish
Sternarchus albifrons

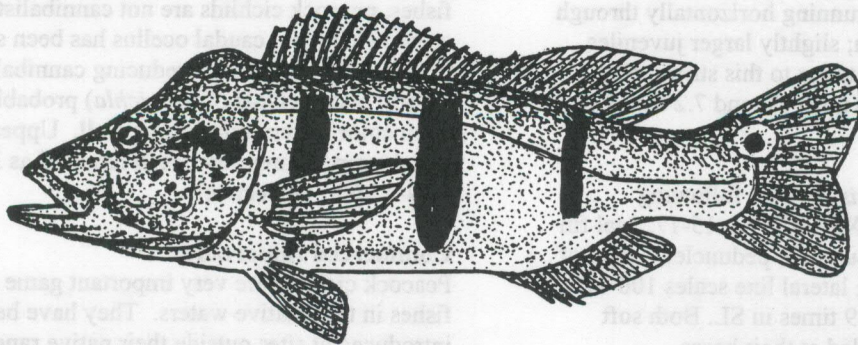


African Knifefish
Xenomystus nigri

PEACOCK CICHLIDS

Family: Cichlidae

Cichla spp.



Speckled Pavon
Cichla temensis

Other Names:

Peacock bass, peacocks, peacock pavon, tuncunare, speckled pavon, black-striped pavon, butterfly pavon. The American Fisheries Society indicates peacock cichlid should be used for *Cichla ocellaris* and speckled pavon for *C. temensis*. The plural use of peacock cichlids here in refers to all members of the genus collectively.

Specifics:

The genus *Cichla* reportedly contains about four species: *C. ocellaris*, *C. temensis*, *C. intermedia*, and *C. chacoensis*; however, the validity of *C. chacoensis* has been questioned by some and at least one recent paper considered it valid, but belonging in another genus. *Cichla intermedia* was described in 1971 as differing only slightly from *C. ocellaris*. Other authorities recognize *C. orinocoensis* and *C. monoculus* as valid. The *C. multifasciata* described by Castelnau in 1862 and discussed by Regan in 1905 is now believed to be a pike cichlid (*Crenicichla*). The black-striped pavon *C. nigrolineata* reported by Oglvie in 1966 is generally believed to be a synonym of *C. ocellaris*; others include *C. monoculus*, *C. nigromaculata*, *C. trifasciata*, *C. toucunnarai*, *C. orinocoensis*, *C. bilineatus*, and *C. atabapensis*. Synonyms of *C. temensis* include *C. tuncunare*, *C. flavo-maculata*, *C. brasiliensis*, *C. flavomaculata*, and *C. conibos*. The actual status of species in this genus is far from resolved.

Range:

Both *C. ocellaris* and *C. temensis* occur throughout the Amazon and Orinoco basins; *C. intermedia* has been reported from southeastern Venezuela. *Cichla chacoensis* has been described from Paraguay; however, this is otherwise outside the range of the genus and again, it may belong in another genus. Peacock cichlids have been introduced into a number of

locations outside their native range. An introduction in Lake Gatun, Panama, has been reported responsible for the elimination of several native fishes, but more-recent reviews suggest the initial impact assessment may have been excessively critical. Successful introductions have occurred on Guam, Hawaii, Dominican Republic, and Puerto Rico. They have also been stocked with some success in Florida. Experimental stockings in Texas were terminated and none are currently known to survive in the state. The results of a reported stocking in Kenya are unknown.

Description:

All peacock cichlids are relatively similar in appearance with elongate bodies compressed from side to side. The mouth is relatively large and upper lip extends back to the mid-eye. The preoperculum is smooth edged. The lateral line is broken as in most cichlids, but may be complete or nearly so in some cases. Lateral line scales (80-120) are similar in size to other adjacent body scales. The spiny (XII-XVI) and soft (I, 15-18) dorsal fins are connected but very deeply indented in between. The soft dorsal fin has 2-4 scale rows at its base; the anal fin (III, 10-11) is also scaled at the base. The caudal fin is slightly indented and typically has a bold ocellus (eye spot), rarely more than one.

Peacock cichlid (*C. ocellaris*) has the following meristic counts: dorsal fin XII-XVI + I, 16-18; anal fin III, 10-11; 38-40 scales around the peduncle; 4 rows of scales in the soft dorsal fin; lateral line scales 80-95; body depth goes 3.0-3.5 times in SL; and eye diameter 4.0-4.5 times into HL. Coloration in larger juveniles and adults is usually olive to olive brown dorsally and white ventrally, often with a yellowish tint; 3 black spots or bars laterally on the body, often with gold or white edges; and a bold, black-centered ocellus in the

upper caudal lobe. Pectoral fins are transparent or slightly dusky; anal and pelvic fins are red-orange; the lower caudal lobe is dusky blue and sometime marked with white; the lower head and throat are yellow to orange but often turn red at spawning; the iris is red. Juveniles under about 1 inch (25 mm) TL are pale yellow with a black stripe running horizontally through the peduncle and caudal fin; slightly larger juveniles develop three black bars anterior to this stripe. Size reaches to 27.6 inches (700 mm) TL and 7.2 lbs (3.25 kg), and probably larger.

Speckled pavon (*C. temensis*) has the following meristic counts: dorsal fin XIV-XV + I, 15-17; anal fin III, 10-11; 48-50 scales around the peduncle; 4 rows of scales in the soft dorsal fin; lateral line scales 100-120; and body depth goes 3.6-3.9 times in SL. Both soft dorsal and anal fins are scaled at their bases. Coloration is usually grayish-brown with 3 vertical bars, 3-4 horizontal rows of yellowish dots or dashes, and an ocellus in the front of the upper caudal lobe. Pelvic fins and the lower half of the caudal fin are red; the anal fin is red near the body but shades to bluish-gray at its margin; pectoral fins are clear; irregular black spots or blotches may be present on the head below the eye; the eye is red; the dorsal fins and upper caudal fins are usually brownish with yellow dots. Juveniles are yellowish in color and similar to peacock cichlid. Speckled pavon is reported to grow slightly larger than peacock cichlid; to at least 27 lbs (12.2 kg).

The third species (*C. intermedia*) has the following meristic counts: dorsal fin XII-XIV + I, 16-17; anal fin III, 10-11; 38-40 scales around the peduncle; 4 rows of scales in the soft dorsal fin; lateral line scales 80-95; and body depth goes 3.0-4.25 times in SL. Coloration is usually bluish-green with white ventrally and orange highlights on the sides. The dorsal fins and upper caudal lobe are bluish-gray with pale spots, pelvic and anal fins are bright orange to red; the lower caudal lobe is brick red; pectoral fins are clear; the iris is red; and the head has yellow or yellowish-green tints laterally. Juveniles have a bold lateral stripe and 8-9 less-vivid vertical bars. Maximum size is probably similar to that reported for peacock cichlid.

Biology:

Peacock cichlids are extremely predatory and feed on other fishes and aquatic invertebrates; some sources consider them strictly piscivorous. They have been described as non-selective predators which take those food items present in greatest abundance. Specimens in Texas fed almost exclusively on sunfishes (*Lepomis*). They reach maturity in their native waters in about 11-12 months at lengths of about 11.1 inches (280 mm) TL (*C. ocellaris*) and 13.4 inches (340 mm) TL (*C. temensis*). Adults pair off and spawn on solid

substrates where possible. Both sexes guard the eggs and the female may transfer the young to a previously-dug hole; free-swimming juveniles are guarded for a time as well. There are reports of pairs spawning a second time while still guarding a previous spawn. It has also been reported that, unlike most predatory fishes, peacock cichlids are not cannibalistic. The bold color pattern and caudal ocellus has been suggested as a major recognition factor reducing cannibalism. If true, several pike cichlids (*Crenicichla*) probably benefit from color pattern mimicry as well. Upper and lower lethal temperatures have been reported as 37.9 C and 14.4-15.6 C, respectively.

Commercial Importance:

Peacock cichlids are very important game and food fishes in their native waters. They have been introduced at sites outside their native range as game fishes or for control of overpopulation and stunting in other fishes. Juveniles are occasionally imported for sale in the pet trade, but usually in very limited numbers.

Reasons For Removal From Restriction:

Texas originally prohibited only peacock cichlid *C. ocellaris* but not other species in the genus. Research with both *C. ocellaris* and *C. temensis* at TPWD's Heart of the Hills Research Station found cold tolerances to be too limited to allow survival in Texas. Even power-plant reservoir populations were lost on occasion when plant shut-downs eliminate warm-water inputs in winter. Possible negative interactions between peacock cichlids and native largemouth bass *Micropterus salmoides* were also an initial concern as well. Inability to survive Texas winters ultimately resulted in elimination from the state prohibited list thus allowing pet trade and aquacultural access to these species again.

Similar Species: Peacock cichlids are probably most likely to be confused with other similarly patterned cichlids; however, most lack the caudal ocellus typical of peacock cichlids.

- Festas Cichlid *Cichlasoma festae* from South America is sometimes yellow or orange with black bars and a caudal ocellus; however, it has more numerous bars and more anal spines (5 or more), is deeper bodied, and has spiny and soft dorsals which are not deeply indented or divided. This species only occasionally appears in the pet trade.
- Red Snook Cichlid *Petenia splendida* from Central America is gray or yellowish-gray with dark bars and an ocellus, but has more bars, 5 or more anal spines, and spiny and soft dorsals which are not deeply indented or

divided. It too is only rarely imported for sale in the pet trade.

- Halfbanded Cichlid *Chaetobranchius semifasciatus* from South America and two species of the genus from Central America (redeye cichlid *C. flavescens* and two-stripe cichlid *C. orbicularis*) are closely related to *Cichla*, with 3 anal spines and sometimes a caudal ocellus. However, all are less boldly patterned in silvery-gray with obscure bars and do not have deeply indented or divided dorsal fins. All are relatively uncommon in the pet trade.
- Daemon's eartheater *Geophagus daemon* from South America may most closely resemble peacock cichlids in fin and body color patterns, but it has a more elongate snout and less concave forehead outline, has very long pelvic fins which reach beyond the vent and insertion of the anal fin, and spiny and soft dorsal fins which are not deeply indented. Although members of this genus have been popular in the pet trade, this particular species appears not to have been readily available to date.
- Pike cichlids (*Crenicichla* and *Batrachops*) include some species which are similar to peacock cichlids, but are much more elongate with spiny and soft dorsal fins which are only slightly indented. See discussion under pike cichlids.

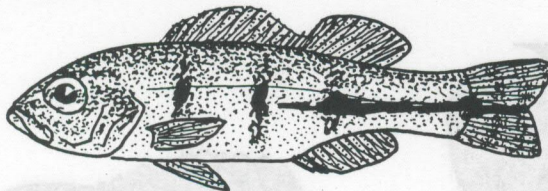
- African giant cichlid *Boulengerochromis microlepis* from Lake Tanganyika is yellow in color with either black bars or spots (depending upon sex), but has a crescent-shaped caudal fin and no indentation between spiny and soft dorsal fins. Although many species of rift lake cichlids are collected at this location for the pet trade, African giant cichlids do not appear to be imported for sale in the U.S. Additionally, this species has been proposed for federal listing as a prohibited species because of large size and predatory habits.

Technical Note:

A group of African cichlids in the genus *Aulonocara* have been imported and sold in the pet trade for many years as peacock cichlids (also as emperor cichlids). They have three anal spines but otherwise are usually similar to *Cichla* in name only. Females and juveniles are typically barred in brown and tan, but males may be brilliant blue, orange, or yellow (usually blue in most species). A recent revision of the genus listed 17 valid species with others yet to be described. *Aulonocara nyassae* (sold frequently in the pet trade) has apparently been most recently listed as *A. stuartgranti*.

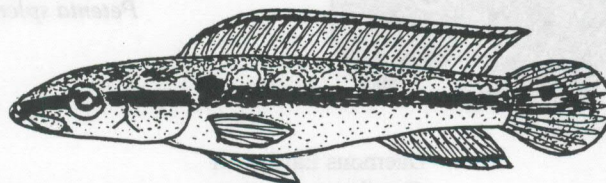
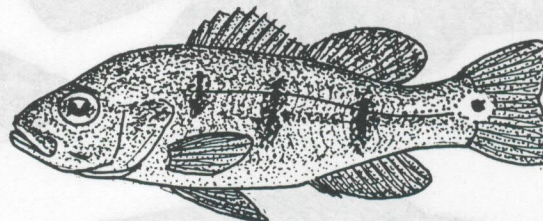
References:

Axelrod and Burgess 1978; Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Brichard 1978; Garrett 1982; Gilliland 1983; Guest and Lyons 1980; Guest et al. 1979; Howells 1985, 1992; Howells and Garrett 1992; Konings 1989; Machado-Allison 1971; Ogilvie 1966.

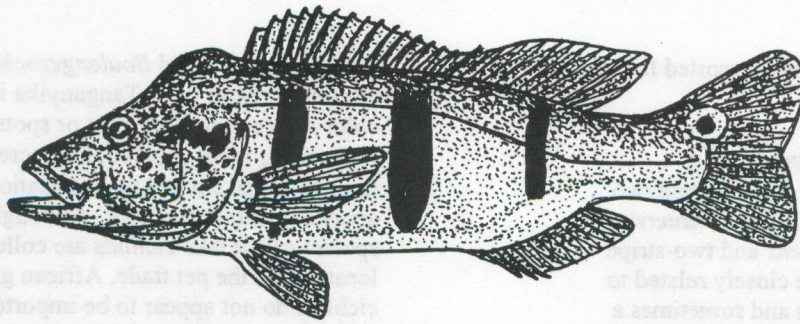


Peacock Cichlid
Cichla ocellaris
Juvenile

Peacock Cichlid
Cichla ocellaris
Juvenile

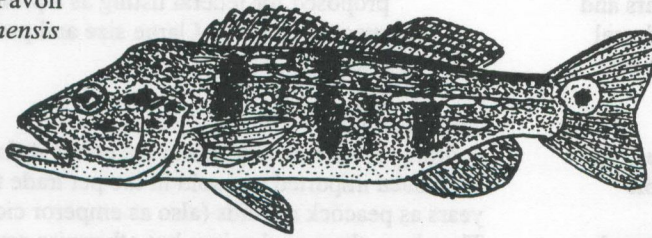


Pike Cichlid
Crenicichla lepidota

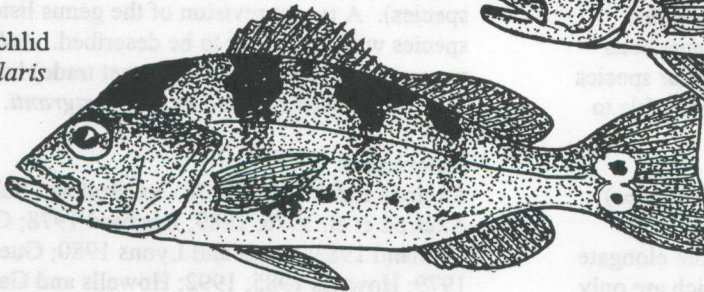


Speckled Pavon
Cichla temensis

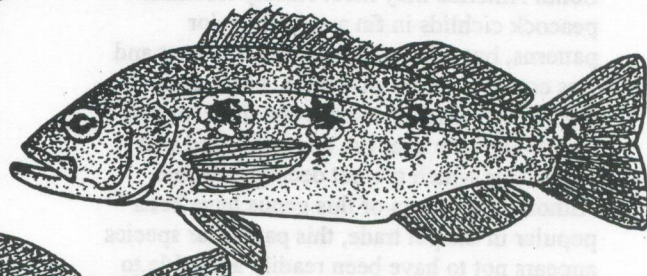
Speckled Pavon
Cichla temensis



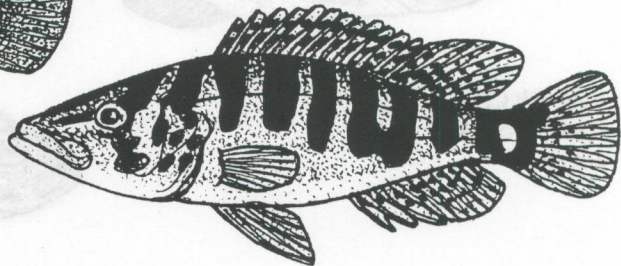
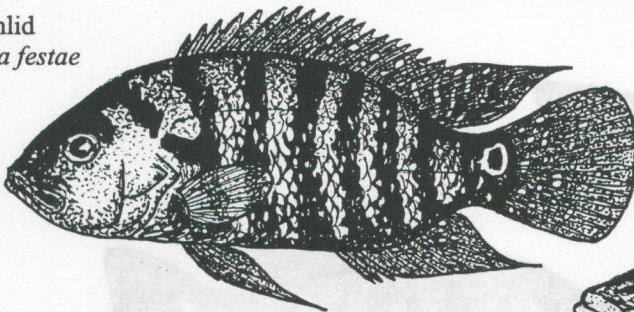
Peacock Cichlid
Cichla ocellaris



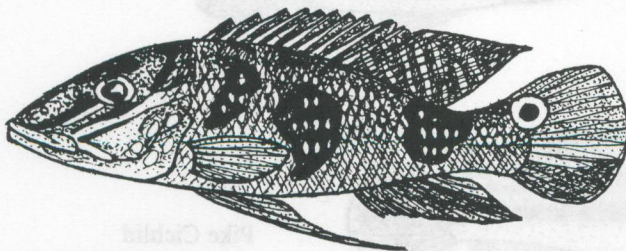
Peacock Cichlid
Cichla ocellaris



Festas Cichlid
Cichlasoma festae

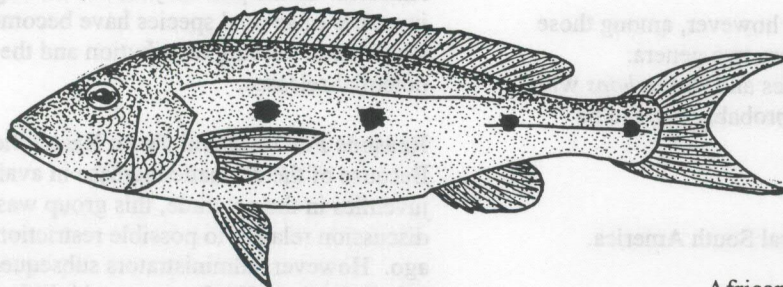
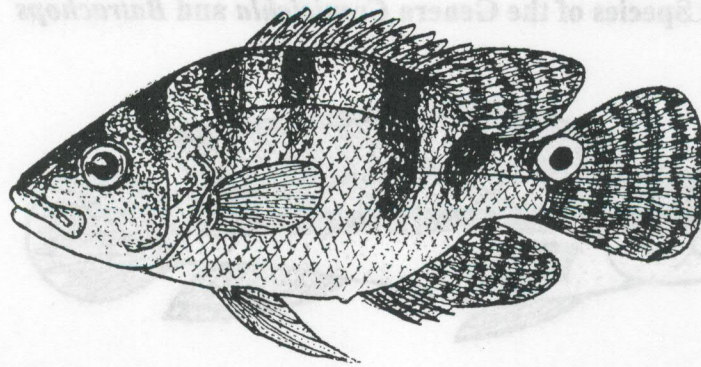


Red Snook Cichlid
Petenia splendida

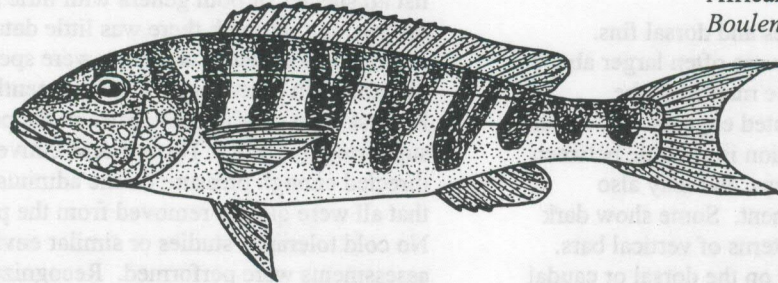


Daemons Eartheater
Geophagus daemon

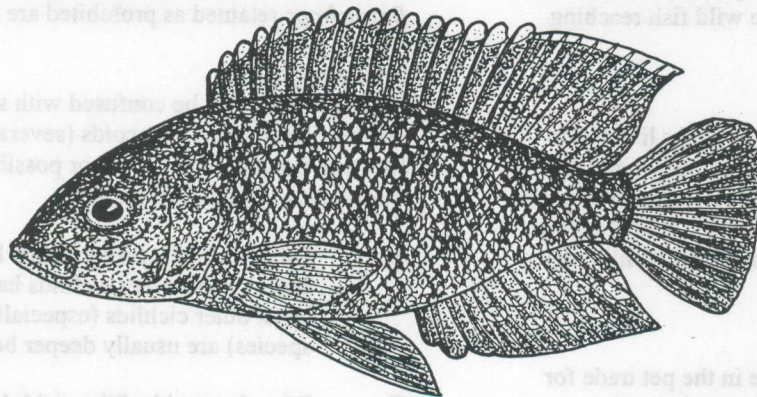
Halfbanded Cichlid
Chaetobranchius semifasciatus



African Giant Cichlid
Boulengerochromis microlepis



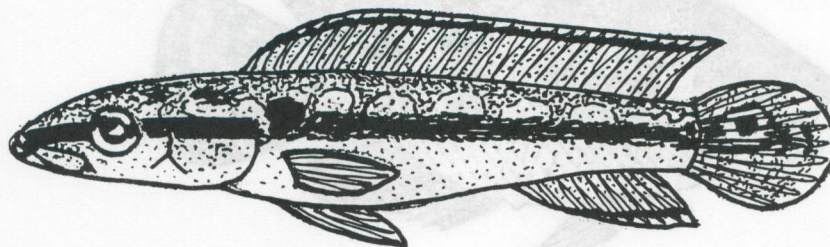
African Peacock Cichlid
Aulonocara "nyassae"



PIKE CICHLIDS

Family: Cichlidae

All Species of the Genera *Crenicichla* and *Batrachops*



Pike Cichlid
Crenicichla lepidota

Other Names:

None.

Specifics:

The family is large and diverse; however, among those commonly called pike cichlids are two genera:

Crenicichla with about 30 species and *Batrachops* with about 7 species. Many species probably need to be redefined.

Range:

Pike cichlids are native to tropical South America.

Description:

All species have elongated bodies and dorsal fins. Many have large mouths. Scales are often larger above the lateral line than below it. The margin of the preoperculum usually has a serrated edge and the lower jaw typically protrudes. Coloration is variable between species, juveniles and adults, sexes, and may also change with mood and environment. Some show dark lateral stripes; others display patterns of vertical bars. Eye spots are sometimes present on the dorsal or caudal fins. Fins may be boldly striped in some species but clear in others. Length in captivity often reaches 5-12 inches, (127-345 mm) with some wild fish reaching twice that length.

Biology:

All pike cichlids are predatory and prefer live food. They occupy an ecological niche in South America similar to that of pickerel (*Esox* spp.) in North America. Captive specimens tolerate other fishes which are too large to be eaten. They spawn in typical cichlid style and guard the eggs and young.

Commercial Importance:

Pike cichlids have been available in the pet trade for many decades; however, due to large size and aggressive behavior, they have not historically been in

high demand. In the past, specimens available for sale usually included only a few random adults which occasionally appeared in shipments from South America. In the past 10 years or so, large numbers of juveniles of several species have become widely available increasing distribution and the possibility of potential releases.

Reasons For Removal From Restriction:

Because of the dramatic increase in availability of juveniles in the pet trade, this group was proposed for discussion relative to possible restriction about a decade ago. However, administrators subsequently moved to list all species of both genera with little subsequent discussion (although there was little data available on ecological tolerances and none were specifically prohibited in other states). More recently, intense interest from cichlid enthusiasts in the pet trade supported by staff at Texas A&M University ultimately directed enough pressure on the administrative staff that all were quietly removed from the prohibited list. No cold tolerance studies or similar environmental assessments were performed. Recognized tropical origins and public demand was sufficient to change their status. Rumors that *Crenicichla* was legalized but *Batrachops* retained as prohibited are incorrect.

Similar Species:

Pike cichlids could be confused with some other cichlids, some pike characoids (several families and species), bowfin *Amia calva*, or possibly some snakeheads (Family Channidae).

- Other cichlids: pike cichlids have three anal spines, most other cichlids have higher counts. Most other cichlids (especially pet trade species) are usually deeper bodied.
- Pike characoids: Pike cichlids never have the adipose fin present in pike characoids and

possess a long dorsal fin with spines (dorsal spines are lacking in pike characoids and their dorsal fins are short).

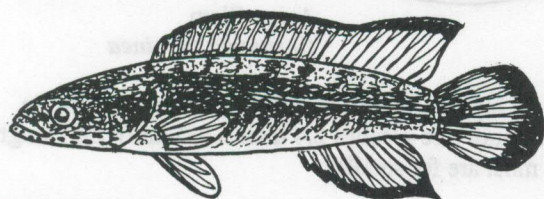
- Bowfin: Pike cichlids lack the bony gular plates present in bowfin, and have dorsal and anal spines which are lacking in bowfins.
- Snakeheads: Pike cichlids have much shorter anal fins than snakeheads, and one snakehead, *Channa asiatica*, lacks pelvic fins (present in pike cichlids); snakeheads also lack fin spines.

Technical Note:

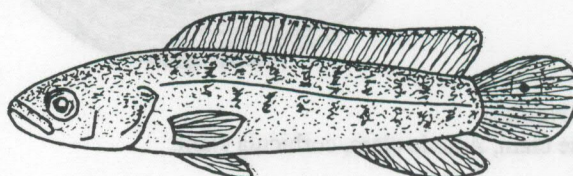
Batrachops has non-depressible teeth (all) and higher dorsal spine counts (18-24, typically 22-24) than *Crenicichla* which has some teeth which are depressible and dorsal spine counts of about 16-15 (but often 22 or less).

References:

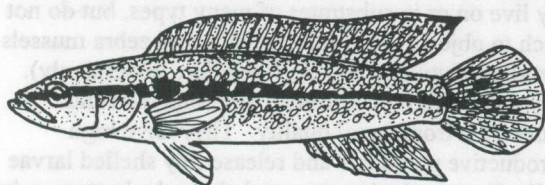
Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Goldstein 1973; Sterba 1967; Swing and Ramsey 1989; Werner 1982a, b.



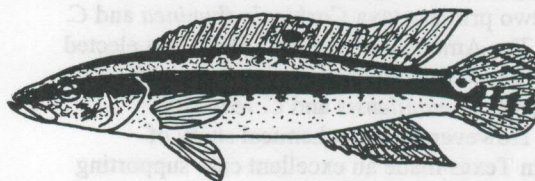
Pike Cichlid
Crenicichla lenticulata



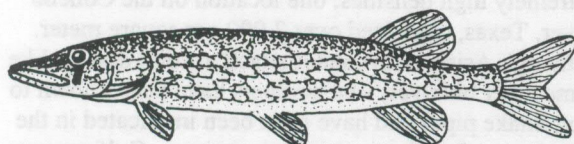
Pike Cichlid
Batrachops semifasciatus



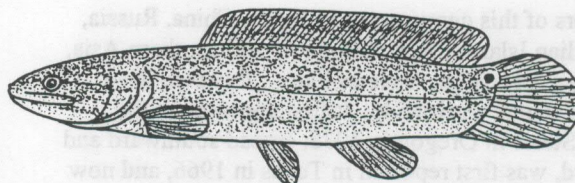
Pike Cichlid
Crenicichla saxatilis



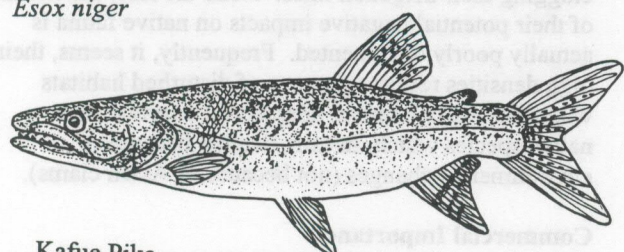
Pike Cichlid
Crenicichla dorsiocellata



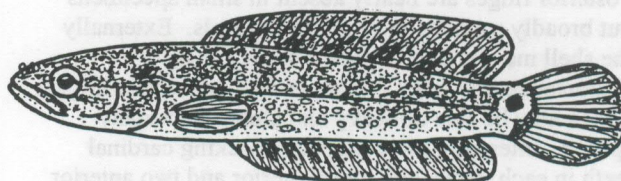
Chain Pickerel
Esox niger



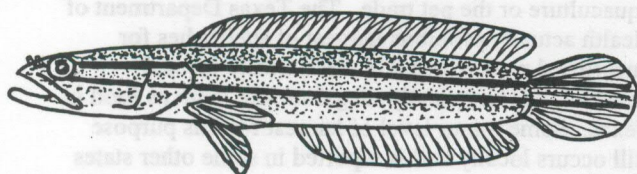
Bowfin
Amia calva



Kafue Pike
Hepsetus odoe



Snakehead
Channa asiatica

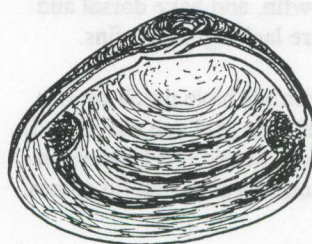
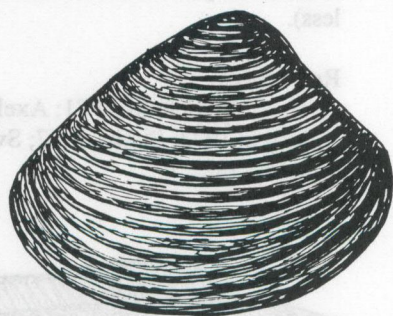


Snakehead
Ophiocephalus micropeltes

ASIAN CLAM

Family: Corbiculidae

All species of the genus *Corbicula*



Asian Clam
Corbicula fluminea

Other Names:

Chinese clam, Asiatic clam, corbicula clam.

Specifics:

At least 150 species have been described in this genus. Most recently the vast majority of these have been reduced to two primary taxa *Corbicula fluminea* and *C. fluminalis*. The American Fisheries Society has elected to designate the American form *C. fluminea*, with previously used *C. manilensis* and *C. leana* as synonyms. However, one biochemical study of specimens in Texas made an excellent case supporting the presence of two species locally.

Range:

Members of this genus occur in Japan, China, Russia, East Indian Islands, Australia, India and southern Asia, and into East Africa. Species like *C. fluminea* have invaded waters worldwide. It first appeared in the United States in Oregon in 1938, spread southward and eastward, was first reported in Texas in 1966, and now occurs in all major river systems in the state.

Description:

Shell shape may be nearly triangular to oval. Shells are strong and solid. Beaks may be low or moderately elevated above the hinge line. Beak cavities are deep. Posterior ridges are nearly absent in small specimens but broadly rounded in larger individuals. Externally the shell may be dull to glossy but is always characterized by bold, 3-dimensional concentric ridges which may be fine or heavy and closely or widely spaced. Internally there are 3 interlocking cardinal teeth in each valve, and two posterior and two anterior lateral teeth in the left valve and one posterior and one anterior lateral tooth in the right valve; lateral teeth also have fine, file-like striations. External color may range from yellowish-green, tan, light brown, dark brown, to black and may display concentric bands of color; juveniles may have one or more greenish rays on their beaks. Internally, coloration may be white, white with

purple highlights, or completely dark or light purple. Maximum size reaches 2.4 inches (60 mm) shell length, but most are far smaller.

Biology:

Asian clams inhabit fresh and brackish waters where they live on or in substrates of many types, but do not attach to objects as do some marine and zebra mussels (Families Mytilidae and Dreissenidae, respectively). They are tolerant of disturbed environments and reduced environmental quality. They have high reproductive potentials and release tiny shelled larvae (pediveligers) which may crawl about the bottom or be swept into the water column by currents. General life expectancy is only about three years. They often reach extremely high densities; one location on the Concho River, Texas, contained over 2,000 per square meter. Although Asian clam cannot attach to solid objects like some other bivalves, vast numbers have been known to clog intake pipes and have even been implicated in the shut down of nuclear generating stations. Golf courses in Texas have reported problems with Asian clams clogging their irrigation lines. None the less, the extent of their potential negative impacts on native fauna is actually poorly documented. Frequently, it seems, their high densities reflect tolerance of disturbed habitats where they may be more adapted for survival than native species which, in turn, decline because of environmental changes (not because of Asian clams).

Commercial Importance:

Asian clams are harvested for human consumption in their native waters, but generally see no commercial harvest in the United States and are of little interest to aquaculture or the pet trade. The Texas Department of Health actually prohibits harvest of shellfishes for uncertified waters; because fresh waters are not certified, it is technically illegal to take them as food in Texas. Some minor level of harvest for this purpose still occurs locally and is reported in some other states as well.

Reasons For Removal From Restriction:

Although initially labeled as having the most cost liability of any exotic mollusk in North America (a statement made before zebra mussels invaded), the actual threat from Asian clams is much less problematic. This species was deleted from the prohibited list in Texas because (1) it already occurred statewide, (2) invasion of new waters was usually not due to direct human activity which could be regulated, and (3) extended time periods and cost associated with scientific permits needed to allow academic or private research with Asian clams was actually confounding or preventing scientific work with it.

Similar Species:

There are over 50 species of freshwater mussels (Family Unionidae), a number of species of fingernail clams (Family Sphaeriidae), and several brackish water bivalves which could be confused with Asian clams. None have the concentric ridges found externally on Asian clam shells.

- Freshwater mussels (Unionidae) are often significantly larger. Those with hinge teeth usually have two pseudocardinal teeth and two posterior lateral in the left valve and one of each in the right valve; none have anterior lateral teeth (lateral teeth positioned ahead of the beak). Several unionid species lack hinge teeth completely.

- Fingernail clams (Sphaeriidae) also have anterior and posterior lateral teeth, but these teeth lack the fine, file-like striations present in Asian clams. Fingernail clams usually have 2 small, cardinal teeth in each valve (occasionally only 1). All are small and thin shelled and none have heavy external ridges.
- Atlantic rangia *Rangia cuneata* (Mactridae) occurs in fresh and low-salinity waters in coastal areas. It has highly elevated hooked beaks and both anterior and posterior lateral teeth but has a chondrophore rather than cardinal or pseudocardinal teeth.
- Carolina marshclam *Polymesoda caroliniana* (Corbiculidae) is a coastal estuarine species in the same family as Asian clam. It lacks the concentric ridges present in Asian clam and has become relatively uncommon along coastal Texas.

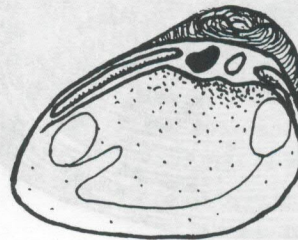
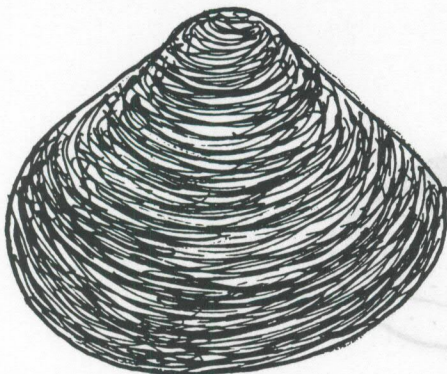
Technical Note:

The terms cardinal teeth and pseudocardinal teeth have sometimes been used interchangeably but they actually do differ in embryonic origins. Unionids have pseudocardinal teeth and fingernail and Asian clams have cardinal teeth (as do other marine bivalves).

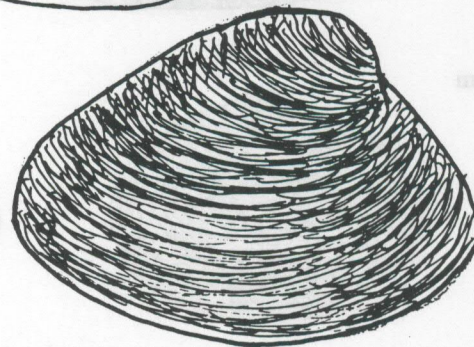
References:

Anderson et al. 1976; Diaz 1974; Fontainier 1982; Gruver 1968; Hirase 1951; Howells 1992; Howells et al. 1996; Morton 1979; Nitzel et al. 1984; Rinne 1974; Sinclair and Isom 1963.

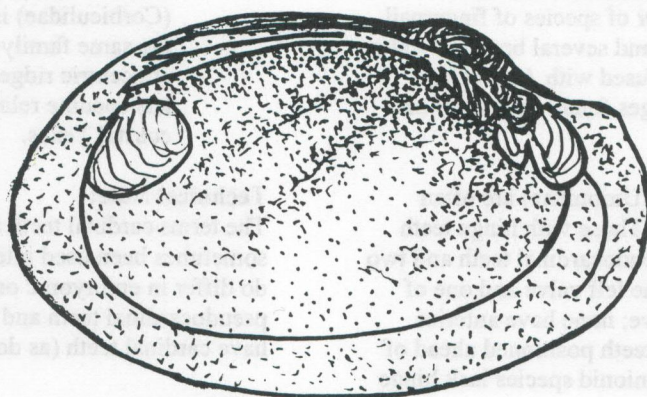
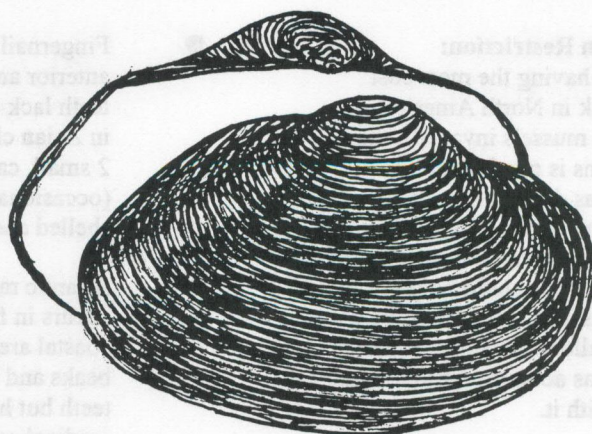
Carolina Marshclam
Polymesoda caroliniana



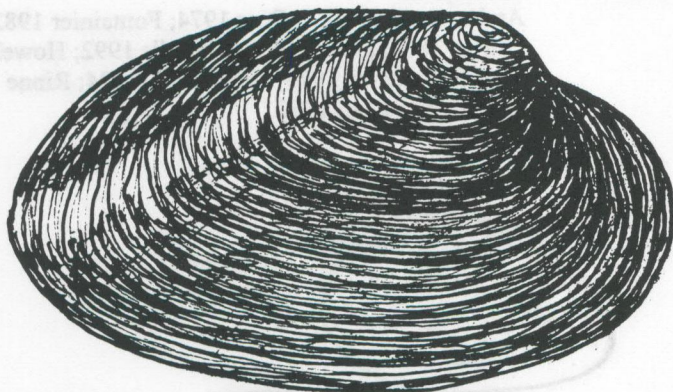
Atlantic Rangia
Rangia cuneata



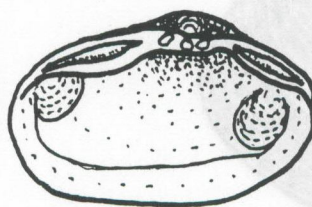
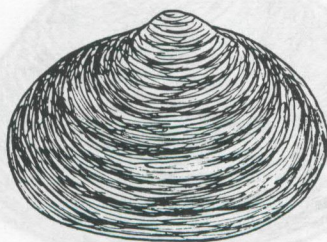
Native Freshwater Mussel
Giant Floater
Pyganodon (Anodonta) grandis
without hinge teeth



Native Freshwater Mussel
Tampico Pearlymussel
Cyrtonaias tampicoensis
with pseudocardinal teeth
and posterior lateral teeth



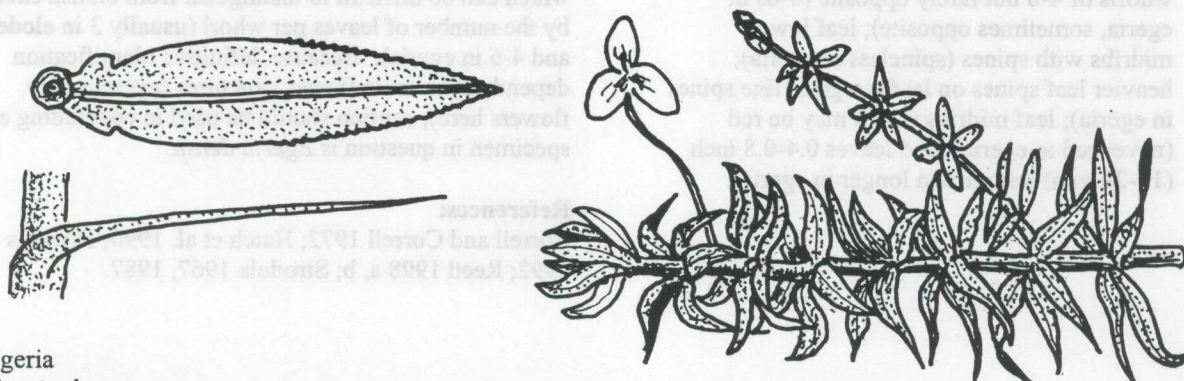
Fingernail Clam
Sphaeriidae



EGERIA (AFRICAN ELODEA)

Family: Hydrocharitaceae

Egeria densa



Egeria
Egeria densa

Other names:

Anacharis, Brazilian elodea.

Specifics:

Egeria was long considered a species of *Elodea* until reclassified in 1961 based upon differences in flowers. It is commonly called *Anacharis densa* in some older and aquarium literature; it is still regularly sold under this name. The number of species in the genus is unclear.

Range:

Egeria is native to Central and South America but has been widely introduced in the United States and elsewhere. In Texas, it is common in the San Marcos and Comal rivers, but is usually not as abundant elsewhere in the state.

Description:

Egeria has stout, elongate stems to 10-12 feet (3.0-3.7 m) which are usually sparsely branched. Leaves are somewhat lance-shaped (linear-lanceolate) with finely toothed edges (usually 25-35 teeth per side), especially on the outer two thirds of the leaf. Leaves are 0.6-1.2 inches (15-30 mm) long and 0.2-0.3 inches (5-8 mm) wide; in the middle an upper stem, they grow in whorls of 4-8 (but can be opposite); leaf color is green with a green midvein. Male flowers occur at the surface in clusters of 2-8, have 3 white petals to 0.5 inches (12 mm) long, 1-3 stamens; female flowers are 0.4-0.8 inches (10-20 mm) long and are pollinated by insects.

Biology:

This species often grows in dense beds both in still-water lakes and in flowing rivers; it may root solidly to the bottom or grow in floating mats. *Egeria* produces large amounts of oxygen and is utilized as food and

cover by a variety of fish and wildlife. Reproduction in U.S. waters is done vegetatively through fragmentation; plants here either rarely flower or do not produce viable seed. Aquarium plants almost never flower.

Commercial Importance:

Egeria has historically been one of the most commonly sold plants in the aquarium trade; it has often been sold in dime stores with goldfish *Carassius auratus* under the name anacharis. It is also sold extensively in biological supply catalogues for use in class room studies and also appears in the ornamental pond plant trade. It is often sold by the bunch (a group of stems held together with a rubber band).

Reasons for Removal From Restriction:

Original restriction reflected fast growth and production of dense beds which can preclude more-desirable native plants. However, although the species has been established in Texas for many years, it is abundant only in the headwaters of the San Marcos and Comal rivers and has shown no inclination to overpopulate elsewhere in Texas. This, in conjunction with demand for class room use, prompted deletion from the prohibited list.

Similar Species:

Egeria is most likely to be confused with American elodea or waterweed *Elodea* spp. and introduced and prohibited hydrilla *Hydrilla verticillata*.

- *Elodea* differs in having small male flowers with small (<0.06 inch; 1.5 mm) petals that are colorless, and have 3-9 stamens (as opposed to 0.3-inch/7.6 mm white flowers with 1-3 stamens in *egeria*); leaf whorls usually in 3s (4-5s in *egeria*); and leaves usually less than 0.8 inch (20 mm) long (often longer in *egeria*).

Despite reports to the contrary, elodea apparently does not occur in Texas.

Hydrilla has flowers in sets of 3 which are 0.2 inch (5 mm) wide (larger than egeria); leaf whorls of 4-8 but rarely opposite (4-6s in egeria, sometimes opposite); leaf lower midribs with spines (spineless in egeria); heavier leaf spines on leaf margins (fine spines in egeria); leaf midribs which may be red (never red in egeria); and leaves 0.4-0.8 inch (10-20 mm) long (often longer in egeria).

Technical Note:

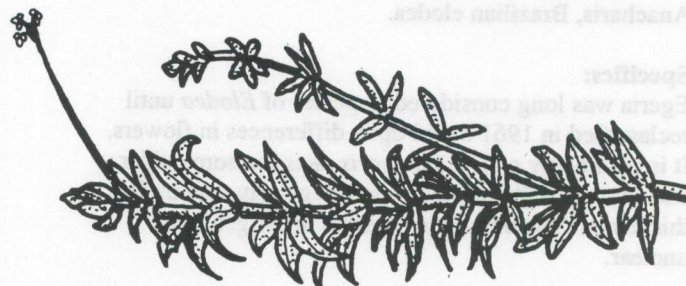
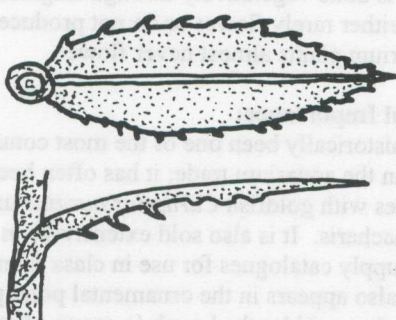
Egeria can readily be differentiated from elodea when growing in a lush, bushy form (it is much larger and more robust); however, side branches and plants in aquaria often develop thinner stems and shorter leaves which can be difficult to distinguish from elodea except by the number of leaves per whorl (usually 3 in elodea and 4-6 in egeria). Because definitive identification depends upon male flower structures (egeria rarely flowers here), caution should be used in concluding a specimen in question is *Egeria densa*.

References:

Correll and Correll 1972; Hatch et al. 1990; Howells 1992; Reed 1998 a, b; Strodola 1967, 1987.

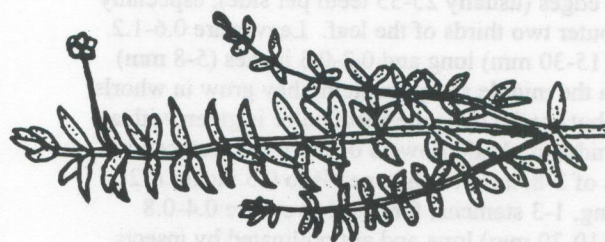
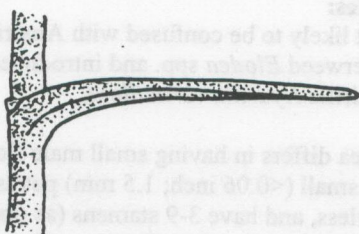
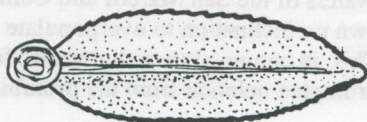
Hydrilla

Hydrilla verticillata



Waterweed

Elodea canadensis

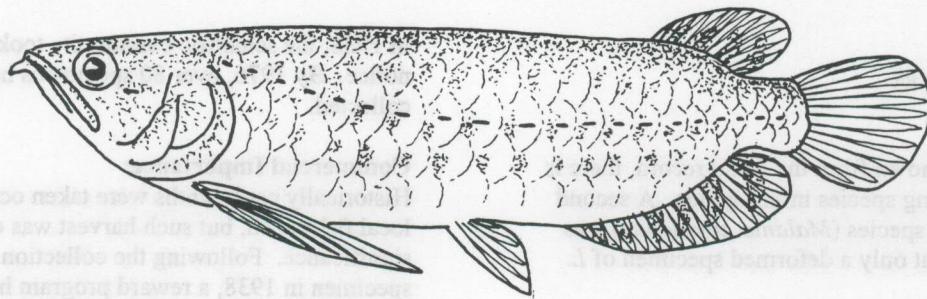


APPENDIX V

EXOTIC SPECIES COVERED UNDER FEDERAL REGULATIONS AND INTERNATIONAL TREATIES

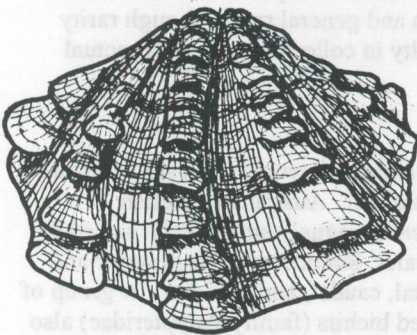
A number of exotic organisms are listed as threatened or endangered by the U.S. Fish and Wildlife Service (USFWS). These generally arise from similar lists prepared by the Convention on International Trade in Endangered Species (CITES) and subsequently adopted by USFWS. Although a number of the following species would rarely, if ever, be encountered outside their native ranges, others may appear from time to time in the pet trade, seashell shops, or elsewhere.

Therefore, the same state and federal biologists and law enforcement personnel handling state-listed species may see these protected exotics as well. Unless a species was also included on the Texas list of prohibited harmful or potentially harmful fishes, shellfishes, and aquatic plants previously (e.g., arapaima *Arapaima gigas*), it was otherwise not included in the first edition of this book.

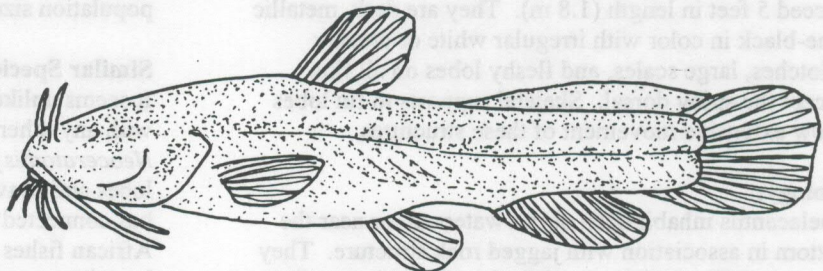


Asian Arowana
Scleropages formosus

Fluted Giant Clam
Tridacna squamosa



Mexican Blind Catfish
Prietella phreatophila

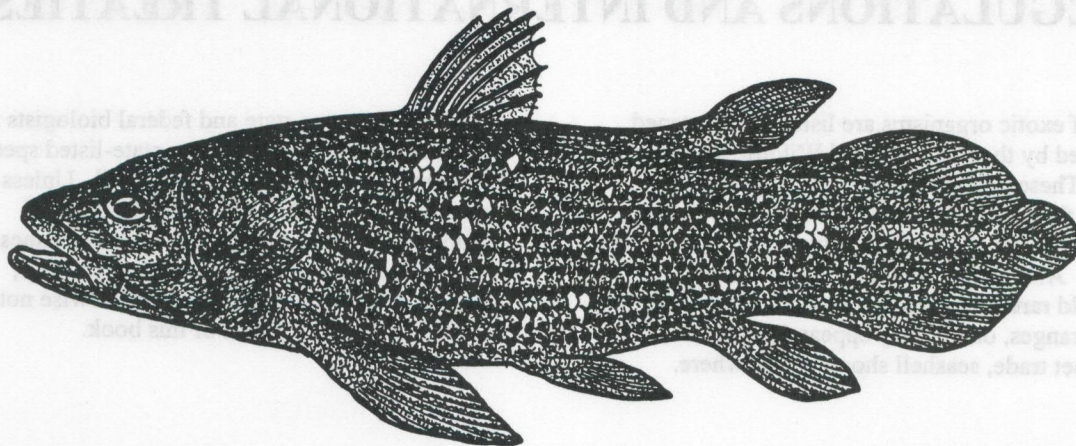


COELACANTH

Family: Latimeriidae

Latimeria chalumnae

CITES-listed



Coelacanth
Latimeria chalumnae

Other Names:

Latimeria, four-legs.

Specifics:

Although well known from the fossil record, there is only a single living species in this genus. A second living genus and species (*Malania anjouanae*) was found to represent only a deformed specimen of *L. chalumnae*.

Range:

East London, South Africa, and the Comoro Islands northwest of Madagascar. A second population was reported discovered in Indonesia in 1998.

Description:

Coelacanth is a large, heavy-bodied fish which can exceed 5 feet in length (1.8 m). They are dark, metallic blue-black in color with irregular white or creamy splotches, large scales, and fleshy lobes on all fins except the spiny dorsal. Skeletal supports to fin lobes allow extensive movement of these structures.

Biology:

Coelacanths inhabit deep ocean waters on or near the bottom in association with jagged rock structure. They are reportedly predatory and feed exclusively on other fishes. Coelacanths give birth to live young; they do not lay eggs. Lobe-finned fishes were known from the Devonian to the Cretaceous periods but were believed to have become extinct over 70 million years ago. When a living specimen was trawled off South Africa

in 1938, the scientific community took immediate notice. By 1976, over 80 specimens had been collected.

Commercial Importance:

Historically coelacanths were taken occasionally by local fishermen, but such harvest was of limited significance. Following the collection of the first living specimen in 1938, a reward program has since prompted local fishermen to report catches of this species. None the less, this fish is of far more scientific interest than commercially valuable.

Reasons For Restriction:

CITES presumably listed this species because of its limited distribution and general rarity (though rarity may reflect difficulty in collection more than actual population size).

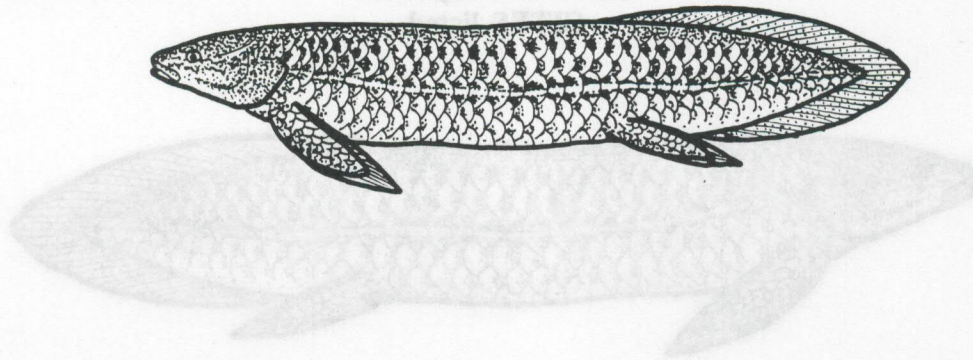
Similar Species:

It seems unlikely coelacanth would be easily confused with any other living fish. Australian lungfish *Neoceratodus fosteri* is vaguely similar with scaled fin lobes and heavy scales, but occurs in fresh water and has connected dorsal, caudal, and anal fins. A group of African fishes called bichirs (family Polypteridae) also have heavy scales and some of their fins are lobed; however, all have elongate bodies, live in freshwaters, and have longer divided dorsal fins.

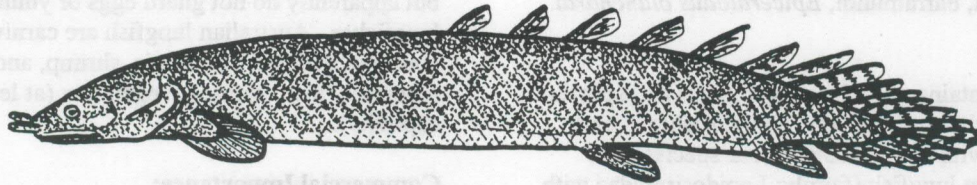
References:

Atz 1976; Hoedeman 1974; Nelson 1976.

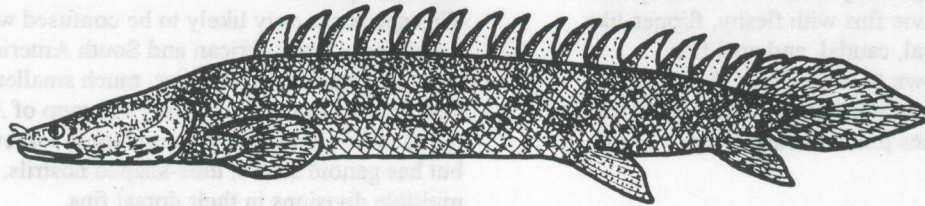
Australian Lungfish
Neoceratodus fosteri



Green Polypterus or
Marbled Bichir
Polypterus palmas



Bichir
Polypterus lapradii

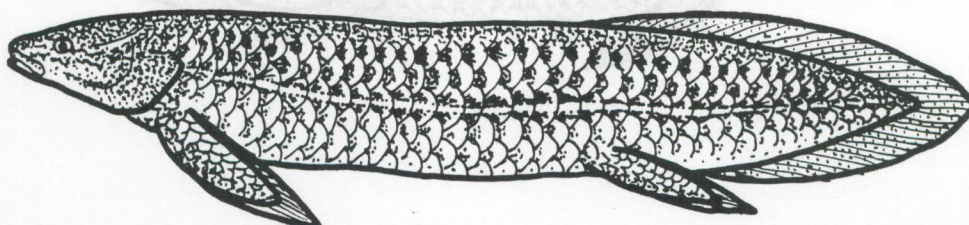


AUSTRALIAN LUNGFISH

Family: Ceratodontidae

Neoceratodus fosteri

CITES-listed



Australian Lungfish
Neoceratodus fosteri

Other Names:

Burnett salmon, barramundi, *Epiceratodus blanchardi*.

Specifics:

This family contains only this single genus and species. Related lungfishes include African lungfishes (family Protopteridae with one genus and four species) and South American lungfish (family: Lepidosirenidae with a single genus and species).

Range:

Originally restricted to the Burnett and Mary Rivers, Queensland, Australia, but with more-recent introductions into other adjacent waters.

Description:

Australian lungfish has an elongate body which exceeds 5 feet (1.5 m) and may weigh over 88.2 lbs (40 kg). It has large, heavy, bony scales on the body and head; pectoral and pelvic fins with fleshy, flipper-like bases; and joined dorsal, caudal, and anal fins. Coloration is dark brown to olive-green dorsally and laterally with irregular black blotches and a belly which is more pale (sometimes pink or orange in juveniles).

Biology:

They usually inhabit still or slow-flowing pools which experience seasonal dewatering. Australian lungfish usually breathes with well developed gills but can gulp air and breathe through an accessory "lung." Spawning

adults scatter eggs which adhere to aquatic vegetation but apparently do not guard eggs or young as do other lungfishes. Australian lungfish are carnivorous and consume fishes, frogs, snails, shrimp, and worms; some reportedly also consume vegetation (at least in captivity).

Commercial Importance:

Australian lungfishes are recognized as an important living fossil and are protected fully in Australia. Unlike other lungfishes, this species never appears in the pet trade and is only likely to be encountered at large, public aquaria under appropriate permits.

Reasons For Restriction:

Very limited range and general rarity have prompted full legal protection in Australia.

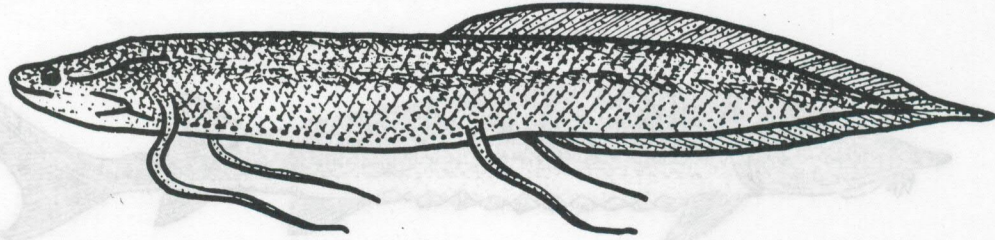
Similar Species:

This species is only likely to be confused with other lungfishes. Both African and South American species have far more slender bodies, much smaller scales, and thin filament-like pelvic fins. A group of African fishes called bichirs (Polypteridae) is somewhat similar but has ganoid scales, tube-shaped nostrils, and multiple divisions in their dorsal fins.

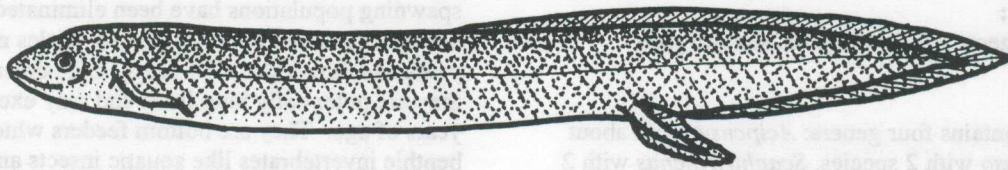
References:

Merrick and Schmida 1984; Nelson 1976; Sterba 1967.

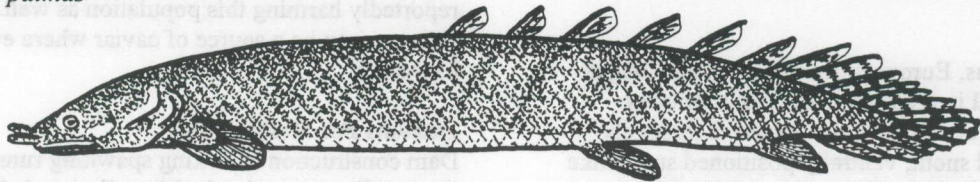
African Lungfish
Protopterus aethiopicus



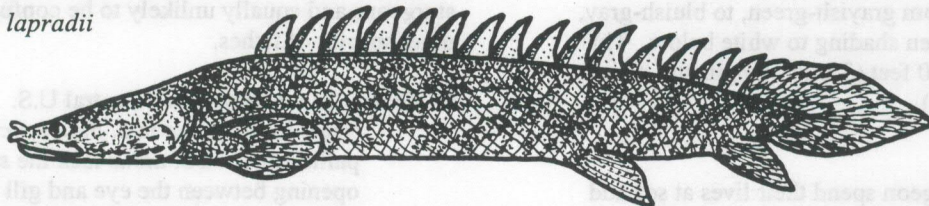
South American Lungfish
Lepidosiren paradoxus



Green Polypterid or
Marbled Bichir
Polypterus palmas



Bichir
Polypterus lapradii

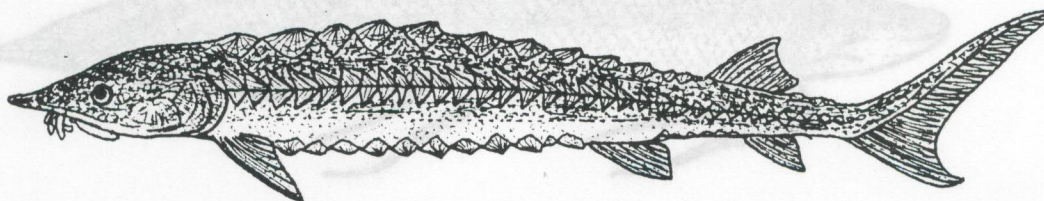


EUROPEAN STURGEON

Family: Acipenseridae

Acipenser sturio

CITES-listed



European Sturgeon
Acipenser sturio

Other Names:

Common sturgeon, Baltic sturgeon, sea sturgeon.

Specifics:

This family contains four genera: *Acipenser* with about 16 species, *Huso* with 2 species, *Scaphirhynchus* with 2 species, and *Pseudoscaphirhynchus* with 3 species. North American Atlantic sturgeon *A. oxyrinchus* and European sturgeon were long considered synonyms.

Range:

This species ranges along the entire coast of Europe including the Baltic, Mediterranean, and Black seas.

Description:

Like all sturgeons, European sturgeon has an elongate body, pentagonal in cross section, 5 rows of bony scutes or plates (dorsal, lateral, ventral), a relatively long and pointed snout, ventrally positioned suckerlike mouth, and four barbels which are not branched or featherlike. Its lower lip is not interrupted and it has a spiracle (small hole) positioned between the eye and upper gill cover margin. It has 31-43 dorsal fin rays, 22-26 anal fin rays, 24-33 (35) scutes in the lateral row, 18-25 gill rakers, 10-12 rhombic plates positioned between the dorsal and lateral rows of scutes. Coloration ranges from grayish-green, to bluish-gray, brown, and olive green shading to white below. This species can exceed 10 feet (3 m) in length and weights over 469 lbs (213 kg).

Biology:

Adult European sturgeon spend their lives at sea and migrate up rivers to spawn. Juveniles live in fresh water for a time before migrating down river to salt water. Because of human development and environmental impacts throughout Europe, many

spawning populations have been eliminated and this has become an extremely rare fish. Males mature at 7-9 years and females at 8-14 years. Like other sturgeons, they are potentially long lived and may exceed 100 years of age. They are bottom feeders which consume benthic invertebrates like aquatic insects and shellfishes. Caviar is produced from its roe.

Commercial Importance:

In recent decades, the only significant remaining population (supporting a fishery) was in the Black Sea; however, with the breakup of the Soviet Union and its control over the local fishery, excess harvest is reportedly harming this population as well. European sturgeon can be a source of caviar where ever it can be harvested.

Reasons For Restriction:

Dam construction (blocking spawning runs and impounding spawning beds), pollution, habitat modification, over harvest, and general human impacts have eliminated this species from much of its former range.

Similar Species:

European sturgeon is obviously most like other sturgeons and equally unlikely to be confused with other species of fishes.

● Genus: *Scaphirhynchus* - Central U.S.

Shovelnose sturgeon *S. platyrhynchus* and pallid sturgeon *S. albus* lack the spiracle opening between the eye and gill cover, have branched (featherlike) barbels, flattened snouts, and filament-like extensions on the tail.

- Genus: *Pseudoscaphirhynchus* - Syn-Darya and Amu-Darya regions of Eurasia. Three species in this genus are similar to American *Scaphirhynchus*; they have wedged shaped heads and flattened snouts. At least one species has apparently been produced commercially and actually imported for sale in the U.S. pet trade.

- Genus: *Huso* - Aral-Caspian Sea area and eastern Asia. Beluga sturgeon *H. huso* and Asian beluga *H. dauricus* differ from European sturgeon and other *Acipenser* by having very large, crescent-shaped mouths (smaller and more transverse in *Acipenser*) and branchiostegals which join across the isthmus to form a fold (branchiostegals attach to the isthmus in *Acipenser*). Beluga sturgeon grows extremely large and is reported to reach 25 feet (7.6 m) in length and weights of 3,300 lbs (1,500 kg).

- Genus: *Acipenser* - Europe, Asia, U.S.
Among the 16 or so species in this genus, many closely resemble European sturgeon.

Atlantic sturgeon *A. oxyrhynchus* from the Atlantic coast of Canada and the U.S. and northeastern Gulf of Mexico is most like European sturgeon and both have been considered the same species by some authorities in the past. Atlantic sturgeon reportedly has a smaller mouth and the small plates found between the dorsal and lateral rows of scutes are much less developed and irregularly shaped (not well developed and rhombic).

Other Old World *Acipenser*:

- Persian sturgeon *A. gueldenstaedti* (Black, Caspian, Aral seas) - snout shorter and more rounded.
- Siberian sturgeon *A. baeri* (Siberia) - has fan-shaped gill rakers (not so in European sturgeon).
- European sterlet *A. ruthenus* (Black and Caspian seas) - has more than 50 scutes in the lateral series (24-36 in European sturgeon).
- Ship sturgeon (*A. nudiiventris*) - has the lower lip interrupted (uninterrupted in European sturgeon).
- Stellate sturgeon *A. stellatus* (Black, Caspian, and Azov seas) - snout longer, more narrow, and bent upward.

- Eastern Asian sturgeons (Amur sturgeon *A. schrencki*, green sturgeon *A. medirostris*) - lack the dense array of rhombic plates between the dorsal and lateral rows of scutes.

Other North American *Acipenser*:

- Shortnose sturgeon *A. brevirostris* (Atlantic drainage) - has a shorter snout, fewer anal rays (19-22), and is brown in color.
- White sturgeon *A. transmontanus* (Pacific drainage) - has more dorsal rays (44-48) and more anal rays (28-31).
- Lake sturgeon *A. fulvescens* (Central U.S. freshwater) - has more gill rakers (25-40, usually 32-35).

Technical Notes:

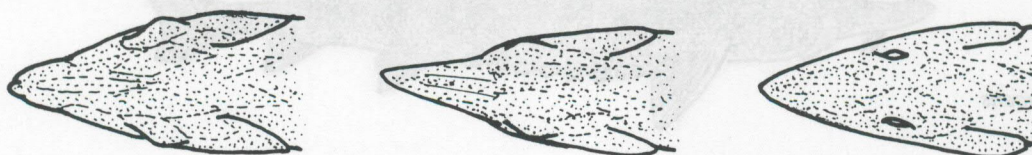
(1) European sterlet is being commercially produced in Europe and imported for sale in the aquarium trade in the U.S. Additionally, sturgeon culture has been ongoing in the former U.S.S.R. for decades and has included not only restocking natural habitats but the production of hybrids between a number of species. It is likely some of the sturgeon-caviar fishery there has been supported as much or more by stocking as naturally-produced fishes in some areas. With the breakup of the old Soviet Union and fisheries now falling into multiple political jurisdictions, dramatic declines have been reported in sturgeon stocks and fisheries.

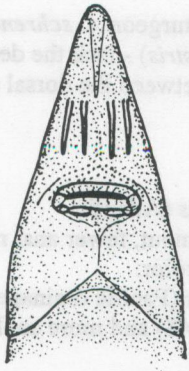
(2) Unlike many other endangered species discussed herein, international trade in this case more frequently involves sturgeon products (i.e., caviar) rather than the fish themselves (except for limited numbers of commercially-produced sterlets and the like).

References:

Axelrod et al 1989; Berg 1948; Bardach et al. 1972; Blanc et al. 1971; Burtsev 1969; Dees 1961; Frank 1971; Jones et al. 1978; Kozlov 1969; Masuda et al. 1984; Muus 1967; Pflieger 1975; Riehl and Baensch 1986; Scott and Crossman 1973; Nichols 1943; Vladykov and Greeley 1963.

Variation in head shape in
Atlantic Sturgeon *Acipenser oxyrhynchus*





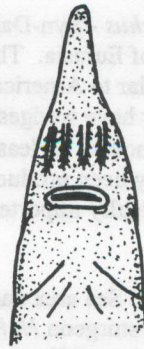
Atlantic Sturgeon
Acipenser oxyrinchus



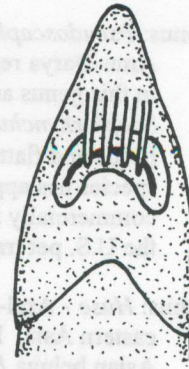
Whiptail Sturgeon
Pseudoscaphirhynchus sp.



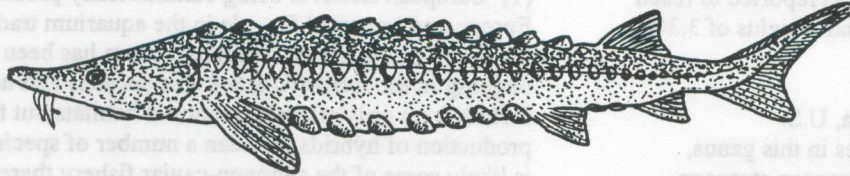
Shovelnose Sturgeon
Scaphirhynchus
platyrhynchus



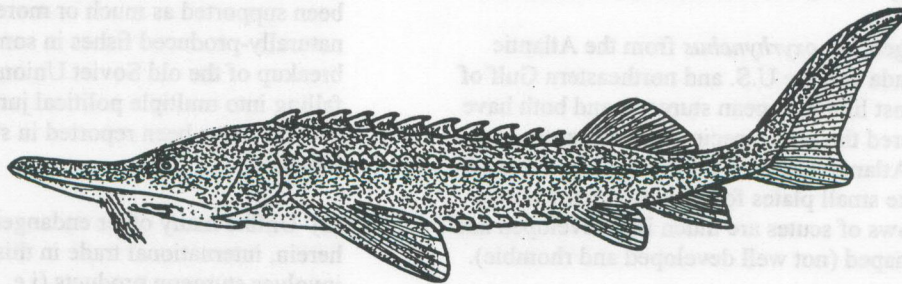
European Sterlet
Acipenser
ruthenus



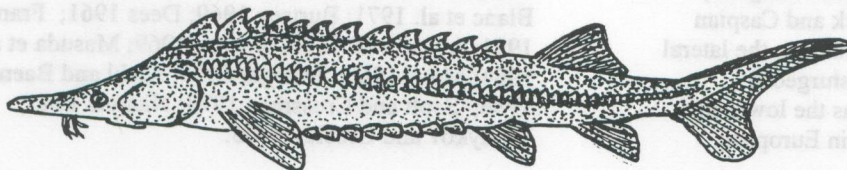
Beluga Sturgeon
Huso huso



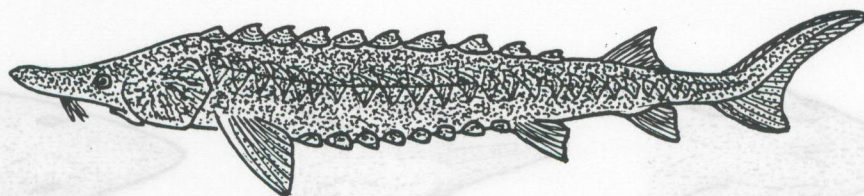
Atlantic Sturgeon
Acipenser oxyrinchus



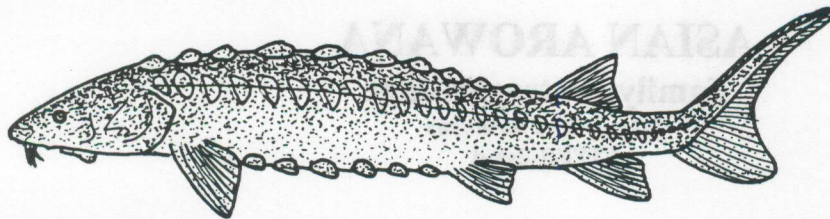
European Sterlet
Acipenser ruthenus



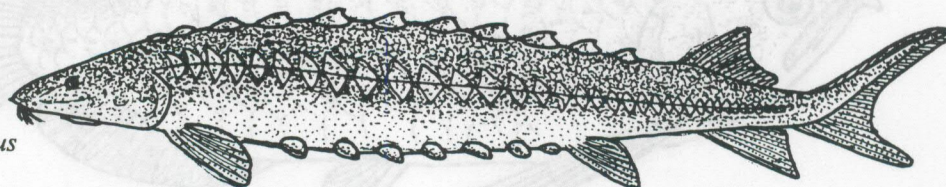
Ship Sturgeon
Acipenser nudiiventris



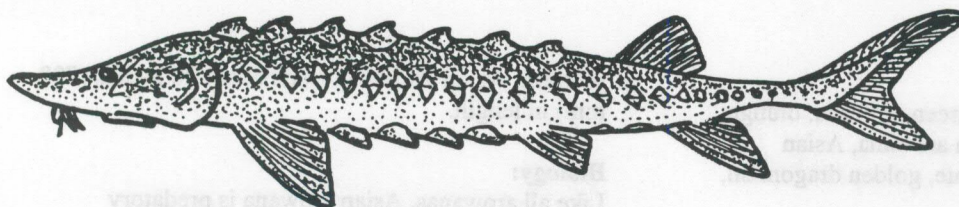
Lake Sturgeon
Acipenser fulvescens



Shortnose Sturgeon
Acipenser brevirostris

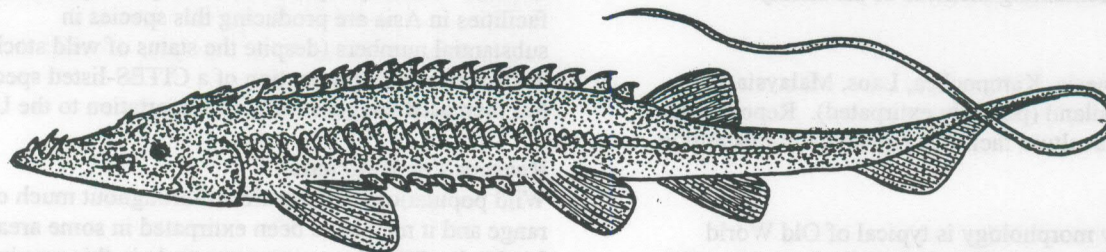
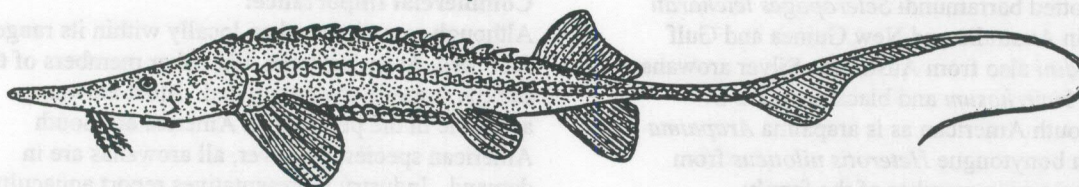


White Sturgeon
Acipenser transmontanus

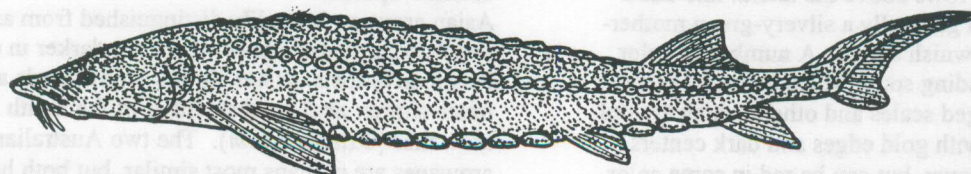


Green Sturgeon
Acipenser medirostris

Shovelnose Sturgeon
Scaphirhynchus platyrhynchus



Whiptail Sturgeon
Pseudoscaphirhynchus kaufmannii



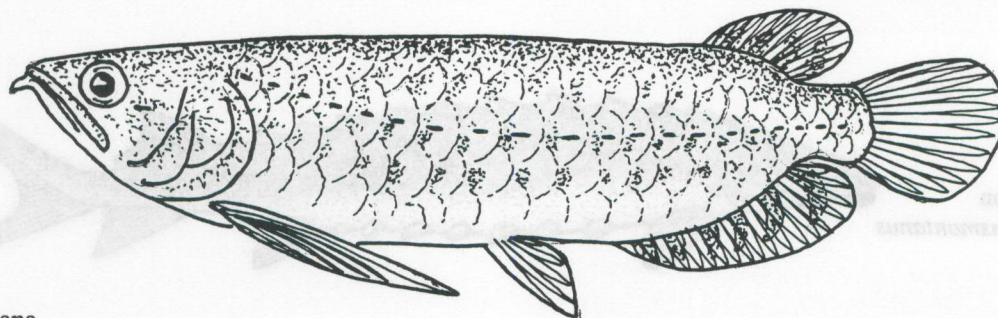
Beluga Sturgeon
Huso huso

ASIAN AROWANA

Family: Osteoglossidae

Scleropages formosus

CITES-listed



Asian Arowana
Scleropages formosus

Other Names:

Asiatic arowana, red arowana, green arowana, orange arowana, silver arowana, golden arowana, Asian bonytongue, Malayan bonytongue, golden dragonfish, Emperor fish, barramundi.

Specifics:

Asian arowana is the only bonytongue in its native range. Two other Old World arowanas include saratoga or spotted barramundi *Scleropages leichardti* which occurs in Australia and New Guinea and Gulf saratoga *S. jardini* also from Australia. Silver arowana *Osteoglossum bicirrhosum* and black arowana *O. ferreirai* are South American as is arapaima *Arapaima gigas*. African bonytongue *Heterotis niloticus* from Africa is the remaining member of the family.

Range:

Burma, Indonesia, Kampuchea, Laos, Malaysia, Vietnam, Thailand (possibly extirpated). Reportedly reared in aquaculture facilities elsewhere in this region.

Description:

General body morphology is typical of Old World arowanas with a somewhat elongate body, large scales, two short chin barbels, and a large, oblique mouth. The dorsal fin is short with 18-20 rays, the anal fin is relatively short with 26-27 rays, there are 15 branchiostegal rays, and the lateral line has 21-24 scales with 2.5 scale rows above the lateral line and 2 below. Coloration is generally a silvery-green mother-of-pearl hue and brownish above. A number of color variations exist including some which are more olive-brown with dark-edged scales and others which are red or gold with scales with gold edges and dark centers. The iris is usually brown, but can be red in some color

morphs. Asian arowanas reach about 28 inches (700 mm) in length.

Biology:

Like all arowanas, Asian arowana is predatory (primarily piscivorous). They are noted jumpers and capable of rapid fright responses. They prefer neutral to slightly acidic waters which are relatively warm.

Commercial Importance:

Although sometimes taken locally within its range as a food fish, Asian arowana, like other members of the family, is easily over exploited. Most arowanas available in the pet trade in America are South American species; however, all arowanas are in demand. Industry representatives report aquaculture facilities in Asia are producing this species in substantial numbers (despite the status of wild stock). This commercial production of a CITES-listed species has increased the possibility of importation to the U.S.

Reasons For Restriction:

Wild populations have declined throughout much of its range and it may have been extirpated in some areas. Listing by CITES now prevents trade in this species among countries which have signed this treaty (including the U.S.), without appropriate government approval.

Similar Species:

Asian arowana is readily distinguished from arapaima and African bonytongues which are darker in color and lack chin barbels. It has shorter chin barbels and a much shorter anal fin than either of the South American arowanas (*Osteoglossum*). The two Australian arowanas are perhaps most similar, but both have more

elongate bodies and therefore more lateral line scales with counts over 30 (21-24 in Asian arowana).

Technical Notes:

(1) Arapaima is also listed by CITES and USFWS as well as in some U.S. states. Brazil legally protects it, but reportedly Peru and Venezuela do not (hence some exports continue). Australia prohibits export of both species native there; however, occasional specimens still appear in the pet trade.

(2) Problems have arisen with some species in this family which are listed by a variety of regulatory agencies. For example, arapaimas have been imported with appropriate federal permits into states with local

restrictions only to have local authorities seize the specimens because of a lack of appropriate state permits (federal permits do not inherently allow possession under state regulations). Similarly, some states which prohibit South American silver arowana (and which list it specifically) may attempt to restrict importation and distribution of the nearly identical black arowana even though the local regulations do not actually list it.

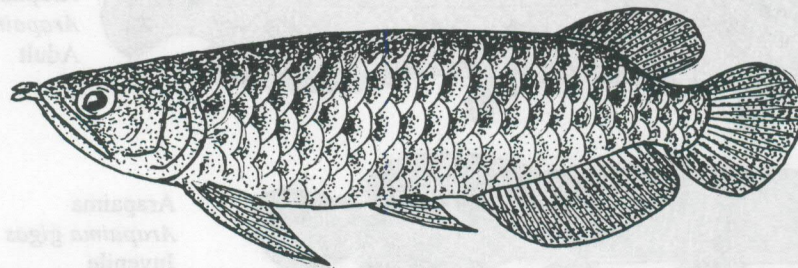
References:

Axelrod and Schultz 1971; Axelrod et al 1974, 1989; Dow 1982; Frank 1971; Frey 1961; Gunther 1868; Kanazawa 1966; Merrick and Schmida 1984; Sakurai et al. 1993; Smith 1945.

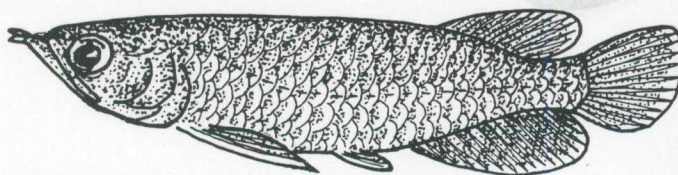
Fin ray counts, scale numbers, and barbels (present or absent) among the bonytongue family.

Species	Dorsal rays	Anal rays	Lateral line scales	Scale rows above/below LL	Chin barbels
Asian arowana					
<i>S. formosus</i>	18-20	26-27	21-24	2.5/2	short
Saratoga					
<i>S. leichardti</i>	15-19	25-27	35	3/4	short
Gulf saratoga					
<i>S. jardini</i>	20-24	28-32	ca 33	4/5/2.5	short
Silver arowana					
<i>O. bicirrhosum</i>	42-50	49-58	30-37	3.5/3.5	long
Black arowana					
<i>O. ferreirai</i>	52-57	61-66	37-40	4/2.5	long
African bonytongue					
<i>H. niloticus</i>	32-37	34-39	32-38	4.5/5.5	none
Arapaima					
<i>A. gigas</i>	34-37	30-32	56	6.5/6	none

Asian Arowana
Scleropages formosus

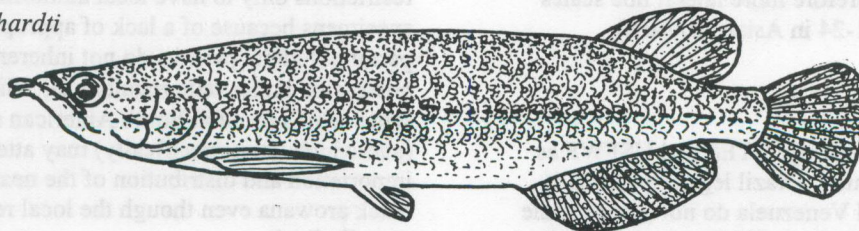


Black-gold Morph

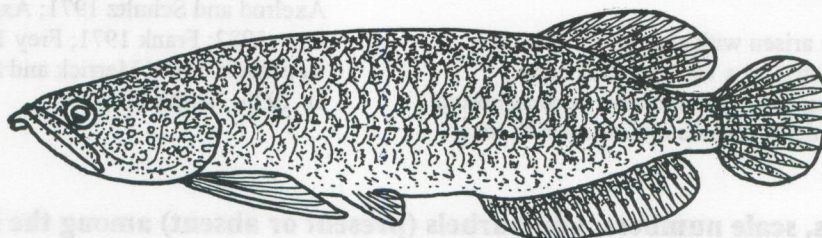


Juvenile

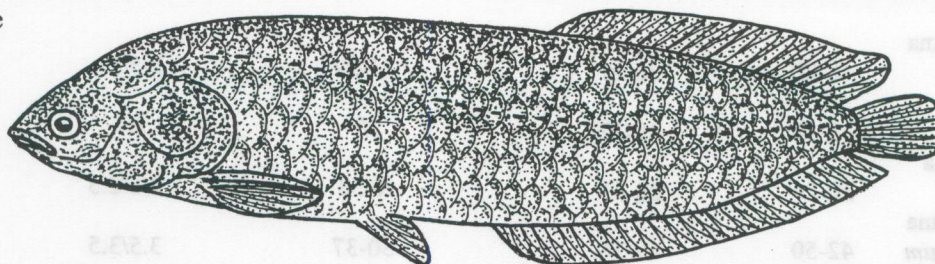
Saratoga
Scleropages leichardti



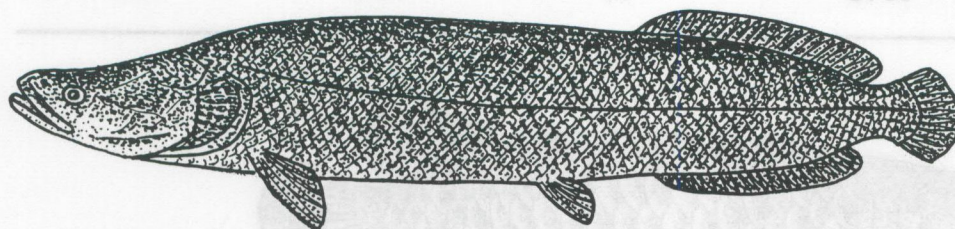
Gulf Saratoga
Scleropages jardini



African Bony-tongue
Heterotis niloticus



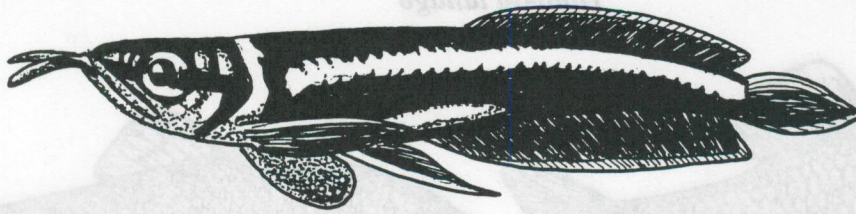
Arapaima
Arapaima gigas
Adult



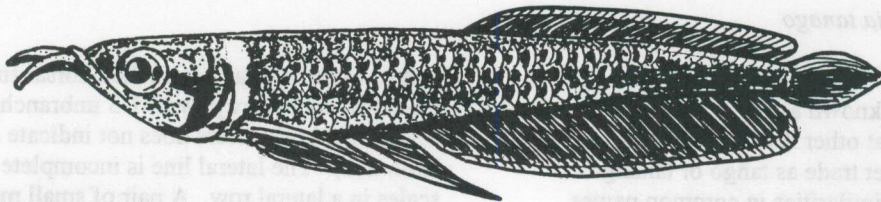
Arapaima
Arapaima gigas
Juvenile



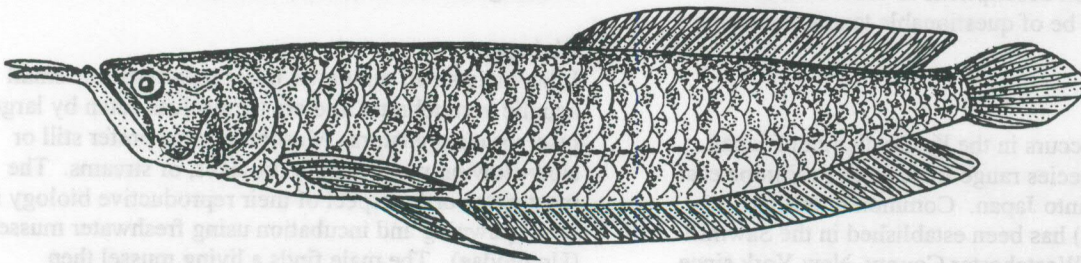
Black Arowana
Osteoglossum ferreirai
 Yolk-sac Juvenile



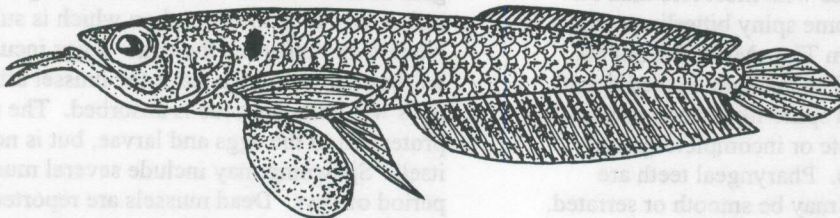
Black Arowana
Osteoglossum ferreirai
 Juvenile



Silver Arowana
Osteoglossum bicirrhosum
 Adult



Silver Arowana
Osteoglossum bicirrhosum
 Yolk-sac Juvenile

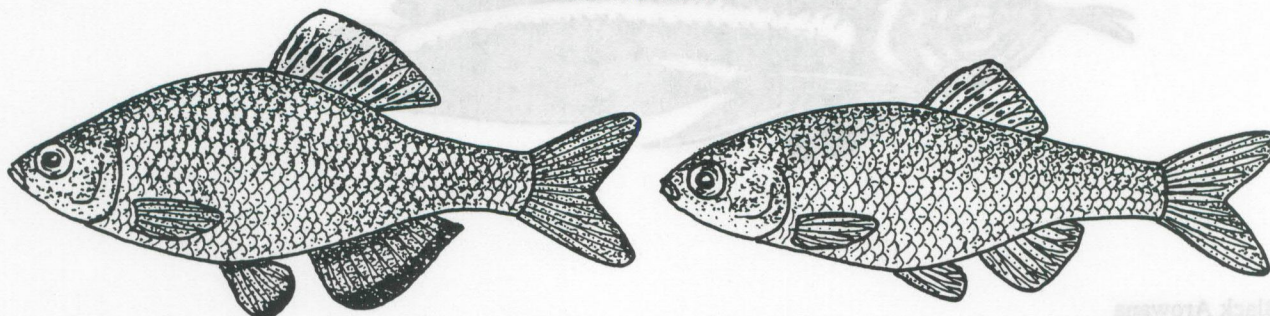


TOKYO BITTERLING (MIYAKO BITTERLING)

Family: Cyprinidae

Tanakia tanago

USFWS-listed



Tokyo Bitterling *Tanakia tanago*

Other Names:

Tokyo bitterling is also known as Miyako bitterling and miyakotanago. Note that other Asian bitterlings are sometimes sold in the pet trade as tango or tanago bitterlings, but despite similarities in common names, are not listed by USFWS as endangered.

Specifics:

Bitterlings are small, minnow-like fishes which include six genera: *Tanakia* (with one species), *Rhodeus* (seven species), *Acanthorhodeus* (11 species), *Acheilognathus* (12 species), *Paracheilognathus* (four species), and *Pseudoperilampus* (three species). Some of these species are based on descriptions in older scientific literature and may be of questionable taxonomic value today.

Range:

Tokyo bitterling occurs in the Kanto district of Japan. Other bitterling species range from western Europe east through Asia and into Japan. Common bitterling (*Rhodeus sericeus*) has been established in the Sawmill and Bronx rivers, Westchester County, New York since the 1920s.

Description:

Bitterlings are small cyprinids with most less than 3.9 inches TL (100 mm TL); (some spiny bitterlings may reach 7.1 inches TL (180 mm TL)). Most, but not all, are relatively deep bodied. The last unbranched dorsal and anal ray is hardened and spine-like in some species. Lateral lines may be complete or incomplete (pored only on the first 4-10 scales). Pharyngeal teeth are typically uniserial (5-5) and may be smooth or serrated. During breeding season, females develop a long ovipositor which may exceed 3.9 inches (100 mm) in length.

Tokyo bitterling has 9 branched dorsal fin rays and 9 branched anal fin rays with 1-3 unbranched rays in each fin (available literature does not indicate if any are hardened). The lateral line is incomplete with about 36 scales in a lateral row. A pair of small maxillary barbels is present. Females and non-spawning males are silvery-tan, sometimes with an orange tint.

Spawning males have bolder orange or peach highlights, a dark shoulder patch, a white slash on the front top edge of the dorsal fin, and the anal fin has a broad black edge with a central red band and a dusky band near the body. Both sexes lack a dark lateral stripe, but have black spindle-shaped markings in the webbing between the dorsal fin rays.

Biology:

Like many small minnows, bitterlings consume small aquatic invertebrates and are themselves eaten by larger piscivorous predators. Most bitterlings prefer still or slow-flowing waters in ponds, lakes, or streams. The most noteworthy aspect of their reproductive biology is their spawning and incubation using freshwater mussels (Unionidae). The male finds a living mussel then drives the female to it. The female inserts her long ovipositor into the incurrent siphon of the mussel and lays one or more eggs which become lodged on the gills of the mussel. The male bitterling then releases milt over the incurrent siphon which is subsequently inhaled and fertilizes the eggs. Eggs incubate for 2-4 weeks and hatchlings leave the mussel after about two days when the yolk sac is absorbed. The mussel offers protection to the eggs and larvae, but is not harmed itself. Spawning may include several mussels over a period of days. Dead mussels are reportedly rejected even in the absence of living mussels. In their native waters, bitterlings are reported to used unionids of the genera *Unio* and *Cristaria*. Common bitterling introductions in New York have been found to adapt to

the local mussels *Elliptio complanata* and *Anodonta cataraacta*.

Commercial Importance:

Tokyo bitterling, though attractive, has been largely unknown in the American pet trade. However, at least one aquarium fish reference book does provide a photograph of it. Several other bitterlings from Europe and eastern Asia do appear in the pet trade, but usually to a limited extent. Some have been used as bait fishes in their native waters, but usually to limited extent. Most are too small to be taken for human consumption; however, the name bitterling apparently reflects an extremely bitter taste to their flesh.

Reasons For Restriction:

Tokyo bitterling is listed by USFWS as an endangered species, probably reflecting limited historical distribution in its native waters in association with the expanding population of Japan and subsequent impacts on local flora and fauna. Additionally, freshwater mussels are among the fastest declining groups of animals worldwide for a variety of reasons. As unionid populations are lost, negative impacts on bitterling populations will be unavoidable.

Similar Species:

This species is most likely to be confused with other bitterlings and other morphologically similar cyprinids.

A bitterling is not endangered Tokyo bitterling *Tanakia tanago* if:

- Barbels are absent or minute.
- Branched dorsal fin rays are 10 or more.
- Branched anal fin rays are 10 or more.
- Lateral line is complete.
- Dorsal fin membranes are without black spindle-shaped markings. Except in the Japanese bitterling *Acheilognathus lanceolatus* which does have black spindle-shaped markings in the dorsal fin but which has a complete lateral line and lacks the dark shoulder blotch in spawning males.

A number of other Asian cyprinids sold in the pet trade as barbs (*Barbus*, *Puntius*, *Capoeta*, and *Barbodes*) are somewhat similar to some bitterlings. Most have distinctive color patterns which readily distinguish them; however, a few like rosy barb *B. conchius* may be confusing. In general, southern and southeastern Asian barbs seen in the pet trade usually have:

- Branched dorsal fin rays usually 8 (higher in nearly all bitterlings).
- Branched anal fin rays usually 5-6 (higher in all bitterlings).
- Barbels may be absent or in 1-2 pairs (bitterlings never have nasal barbels present in some

barbs).

- Lateral lines may be complete or broken, but if broken, only a few scales lack pores (bitterlings with broken or incomplete lateral lines never have more than 10 pored scales).
- Lateral line or lateral scale counts are usually 17-33 (typically higher in bitterlings).
- Females never have long ovipositors.

Some deeper-bodied native cyprinids may also be somewhat similar to bitterlings. Native minnows typically have:

- Far fewer branched dorsal and anal rays than most bitterlings.
- Complete, broken, or interrupted lateral lines, but usually only have a few unpored scales (bitterlings with broken lateral lines never have more than 10 pored scales).
- Females never have extremely long ovipositors.

Technical Notes:

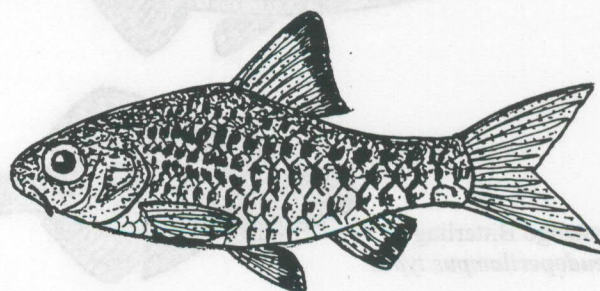
(1) *Acheilognathus* is sometimes spelled without the "e". *Acanthorhodeus* typically has serrated pharyngeal teeth and *Acheilognathus* usually has smooth pharyngeal teeth, but are otherwise often similar. Hybrids between *Rhodeus* and *Acanthorhodeus* are believed to occur.

(2) Although release and subsequent establishment of temperate European and Asian cyprinids in North America has occurred and is a cause for concern, small size and complex reproductive behavior suggest minimal risk from bitterlings. Indeed, the common bitterling established in New York has been able to use native unionids but appears not to have become numerically over-abundant or ecologically problematic. Asian rosy bitterlings (*Rhodeus ocellatus*) in aquaria have rejected local Texas unionids including southern mapleleaf (*Quadrula apiculata*) and Tampico pearlymussel (*Cyrtonaias tampicoensis*) as spawning sites.

References:

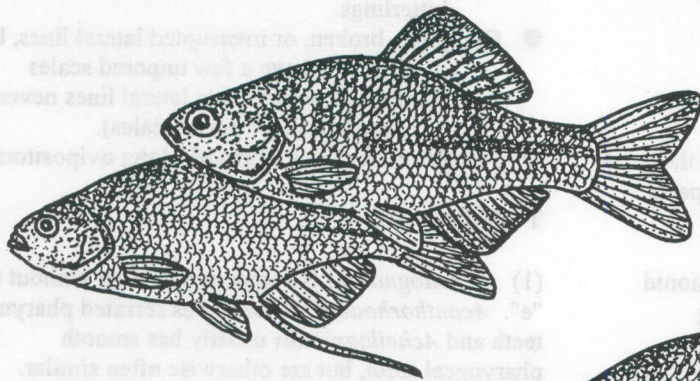
Axelrod et al. 1989; Berg 1949a; Masuda et al. 1984; Nichols 1943; Schmidt et al. 1981.

Checkered Barb *Capoeta oligolepis*

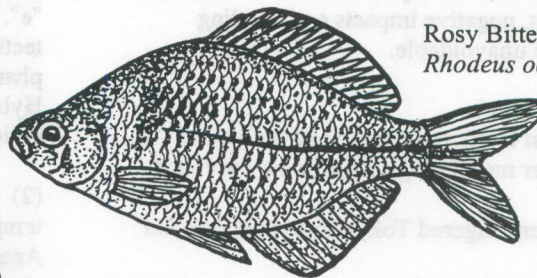


Summary of bitterling meristic traits.

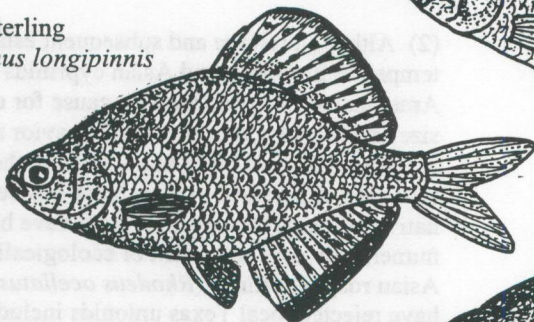
Species	Lateral line	Lateral scales	Barbels	Rays		D/A spines
				dorsal	anal	
<i>Tanakia</i>	incomplete	ca. 36	1 pair	ii, 9	ii, 9	-
<i>Rhodeus</i>	incomplete	32-40	none	iii, 8-12	iii, 8-12	none
<i>Pseudoperilampus</i>	incomplete	32-34	none	11-14	11-14	-
<i>Acheilognathus</i>	complete	34-40	optional	ii, 9-18	ii, 8-16	optional
<i>Acanthorhodeus</i>	complete	34-40	1 pair	ii-iii, 10-18	ii-iii, 8-14	yes
<i>Paracheilognathus</i>	complete	35-37	minute or none	11-16	11-16	none



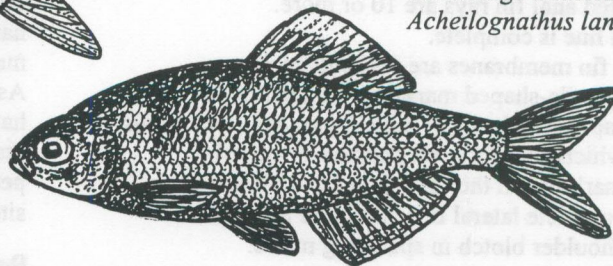
Common Bitterling
Rhodeus sericeus



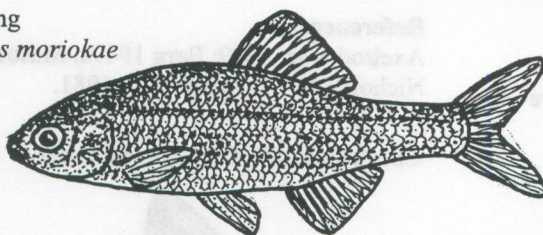
Rosy Bitterling
Rhodeus ocellatus



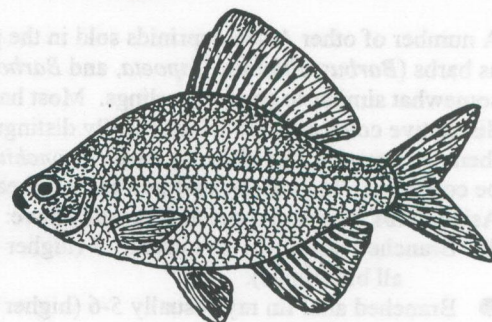
Blushing Bitterling
Acheilognathus longipinnis



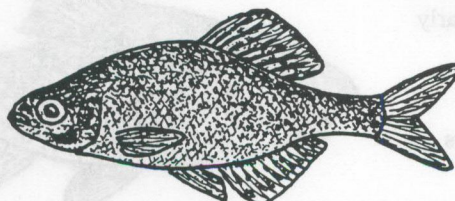
Yaritanago Bitterling
Acheilognathus lanceolatus



Tango Bitterling
Acheilognathus moriokae



Russian Spiny Bitterling
Acanthorhodeus asmussi



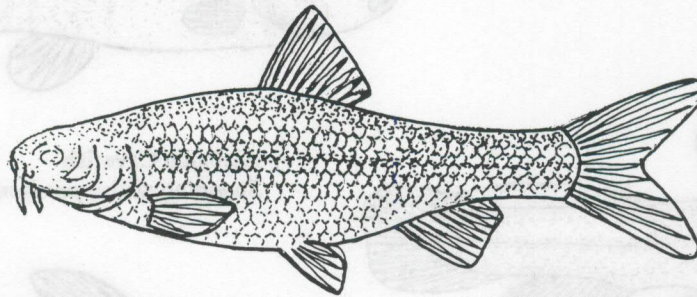
Zenitango Bitterling
Pseudoperilampus typus

AFRICAN BLIND BARB

Family: Cyprinidae

Caecobarbus geertsii

CITES-listed



African Blind Barb
Caecobarbus geertsii

Other Names:

Congo blind barb, blind barb.

Specifics:

This is apparently a monotypic genus.

Range:

Lower Congo; caves near Thysville.

Description:

Blind barbs have typical minnow-like torpedo-shaped bodies with short, centrally-located dorsal fins with 3 unbranched and 7-8 branched rays; anal fins with 3 unbranched and 5 branched rays; and 28-29 lateral line scales. There is a small, but readily apparent, barbel at each corner of the upper lip. Eyes are completely lacking. Coloration is pale pink (colorless but appearing pink due to circulating blood).

Biology:

This species inhabits caves in the vicinity of Thysville in the Congo. They have been described as constantly in motion and locate food with their tactile barbels. Captives consume both live and prepared foods. Aquarium literature sources recommend temperatures no lower than 70°F (21°C) and no warmer than 85°F (29°C).

Commercial Importance:

Although this species is regularly listed in aquarium literature from both the U.S. and Europe, it is apparently still not produced commercially and virtually never seen in the pet trade. Although protected in its native waters, some specimens are occasionally reported smuggled out of the country and ultimately sold at rather high prices.

Reasons For Restriction:

Blind barb has a very limited distribution and probably

limited population size. Because of its rarity it is protected in the Congo.

Similar Species: A number of other blind fishes might be confused with this species; however, among these, only one ever appears regularly in the pet trade or elsewhere.

- Mexican blind cave tetra *Astyanax mexicanus* (the blind form of Mexican tetra) is produced commercially and readily available in the pet trade. It lacks barbels present in blind barb and has an adipose fin which blind barb does not.

- Several ictalurid catfishes including widemouth blind catfish *Satan eurystomus* and toothless blind catfish *Trogloglanis pattersoni* from San Antonio, Texas, and Mexican blind catfish *Prietella phreatophila* and Tamaulipan blind catfish *P. lindbergi* from northeastern Mexico all have nasal and chin barbels (only maxillary barbels in blind barb) and adipose fins (absent in blind barb) and none appear in the pet trade.

- Native American cavefishes (family Amblyopsidae) like Ozark cavefish *Amblyopsis rosae*, northern cavefish *A. spelaea*, Alabama cavefish *Speoplatyrhinus poulsoni*, and southern cavefish *Typhlichthys subterraneus*, have body shapes similar to blind barb, but all lack barbels, have more posteriorly-positioned dorsal fins, and may lack pelvic fins. All are rare, protected, local species which never appear in the pet trade.

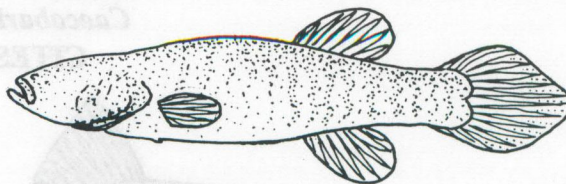
- Other blind catfishes (several families), blind loaches (family Cobitidae), and possibly other cave-dwelling fishes only superficially resemble blind barb and can be readily distinguished by body shape or size, number, and position of barbels (if any).

number, and position of barbels (if any).

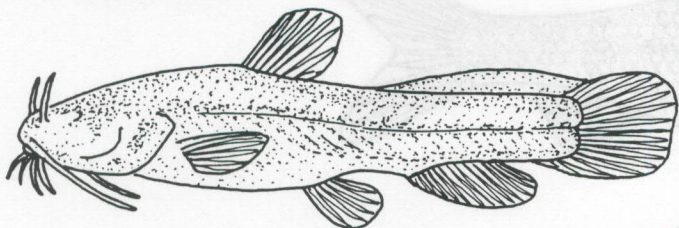
References:

Axelrod and Schultz 1971, Axelrod et al. 1974;
Hoedeman 1974; Pflieger 1975.

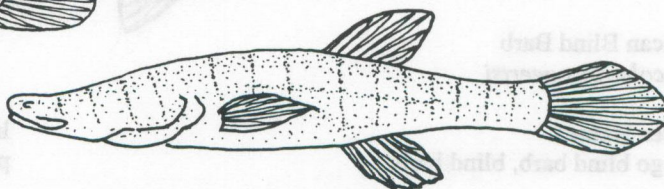
Southern Cavefish
Typhlichthys subterraneus



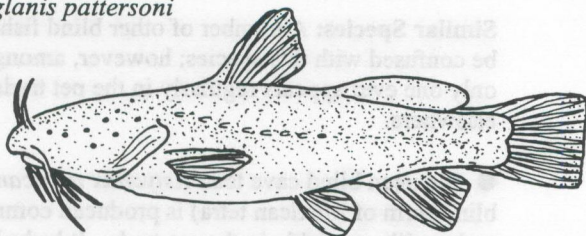
Mexican Blind Catfish
Prietella phreatophila



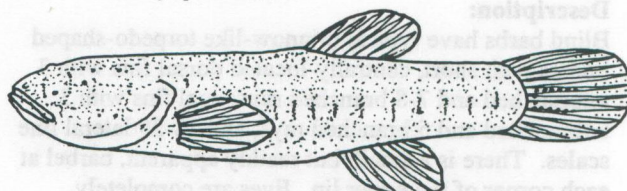
Alabama Cavefish
Speoplatyrhinus poulsoni



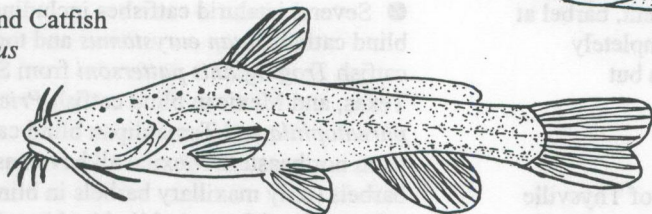
Toothless Blind Catfish
Trogloglanis pattersoni



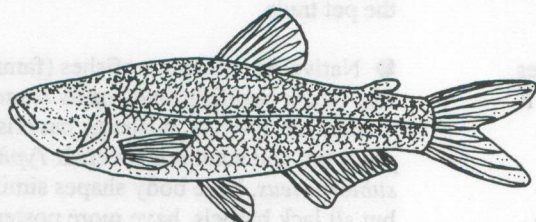
Ozark Cavefish
Amblyopsis rosae



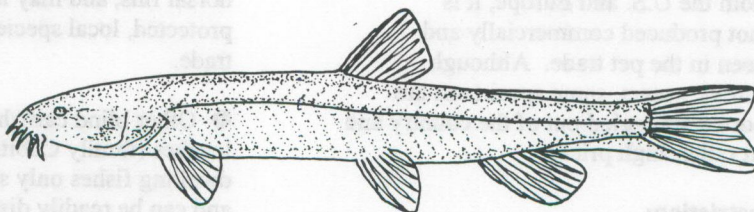
Widemouth Blind Catfish
Satan eurystomus



Blind Cavefish
(Blind Mexican Tetra)
Astyanax mexicanus



Turkmanian Blind Loach
Neomacheilus starsotini

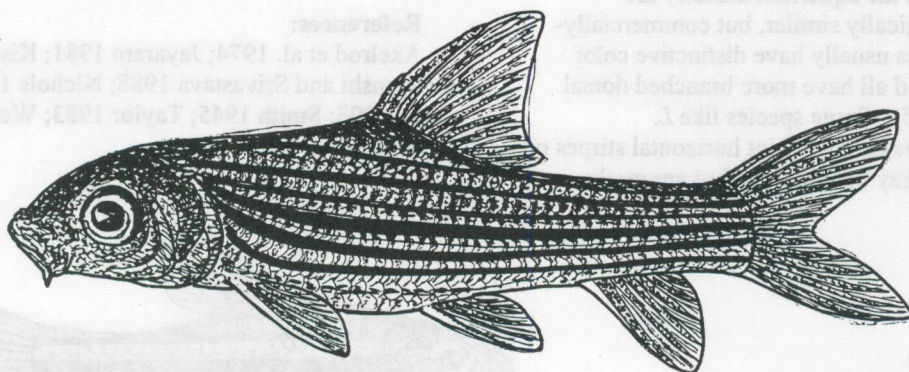


SEVENLINE BARB (TEMPLIK)

Family: Cyprinidae

Probarbus jullieni

USFWS, CITES



Sevenline Barb
Probarbus jullieni

Other Names:

Pla eesok in Thailand; ikan temoleh; ikan temeahan; seven-striped barb. Also, called *Cirrhinus lineata*.

Specifics:

One of the more obscure genera and species of cyprinids collectively known as barbs.

Range:

Thailand, Vietnam, Laos, and the Malay Peninsula.

Description:

This is a generally minnow-like fish which reaches a length of about 3 feet (1 m), but is usually about half that. It has somewhat enlarged eyes in juveniles. It has a pair of short maxillary barbels. The centrally located dorsal fin has 9 branched rays and the last unbranched ray is ossified (bony) but not toothed. The mouth is down-turned and somewhat sucker-like. Pharyngeal teeth are uniserial 4-4. General coloration is a silvery-to creamy-yellow with 7 dark (often black) horizontal stripes; head is greenish; the iris is red; fins may have pinkish rays and black membranes with the caudal fin particularly dark.

Biology:

Sevenline barbs are found near river mouths but apparently do not enter salt water. They are reported to feed chiefly on vegetation but are also taken by anglers using worms.

Commercial Importance:

Locally, they are highly regarded as a food fish, but harvest is limited by rarity. Juveniles occasionally

appear in pet trade shipments from Southeast Asia, but this is probably more by accident than intent and the species has never been significant in the aquarium trade.

Reasons For Restriction:

Presumably, general rarity was cause for concern.

Similar Species:

Sevenline barb is most likely to be confused with other cyprinids with lateral stripes, particularly those species which appear in the pet trade.

- *Osteochilus hasseltii* (one of several bonylip barbs) appears occasionally in the pet trade. It is silvery to yellow with 6-8 lateral stripes (rows of dark spots) and reaches 12 inches (305 mm) in length. However, it has a much longer dorsal fin with 11-18 rays.
- *Cyclocheilichthys apogon* (another bonylip barb) also appears occasionally in the pet trade. It too is silvery to golden (at spawning) with 7 or more dark bars, but it is much deeper bodied and has an uninterrupted groove on the posterior side of the lower lip.
- Sailfin barb *Labiobarbus festiva* is similar to the bonylip barbs and likewise has a very long dorsal fin.
- Some of the mud carps (genus *Cirrhinus*) may be somewhat similar and some may show suggestions of lateral stripes, but all have

pharyngeal teeth in three rows, a lower lip thin or absent, and occasionally more branched dorsal rays (7-12); these are rarely, if ever, imported.

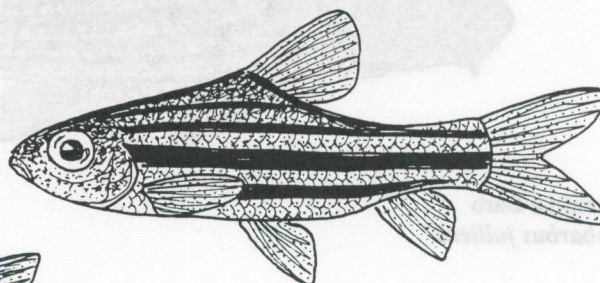
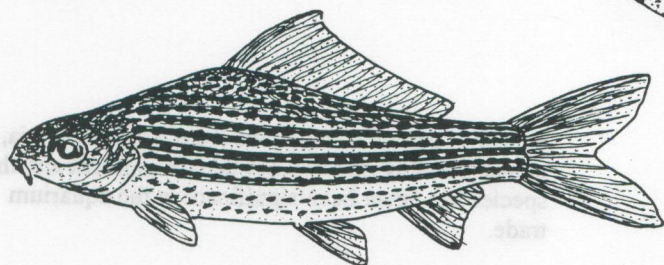
- Some of the cyprinid sharks (genus *Labeo*) imported and sold in the aquarium industry are morphologically similar, but commercially-sold species usually have distinctive color patterns and all have more branched dorsal rays (10-15). Some species like *L. indramontri* do have faint horizontal stripes on a silvery-gray background, but are rarely imported.

- Some of the more-typical pet trade barbs (genus *Puntius*, *Barbus*, *Barbodes*, *Capoeta*) include species like striped barbs *B. lineatus* (*fasciatus*) have horizontal stripes, but those which appear in the pet trade are smaller and have pharyngeal teeth in 3 rows.

References:

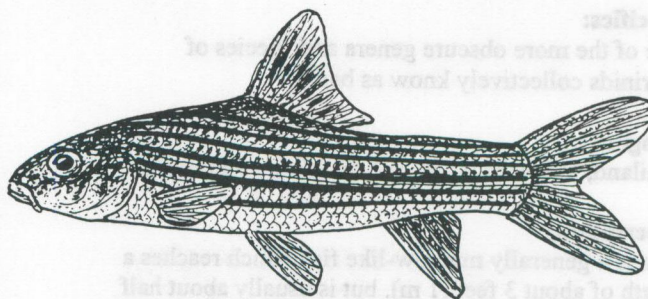
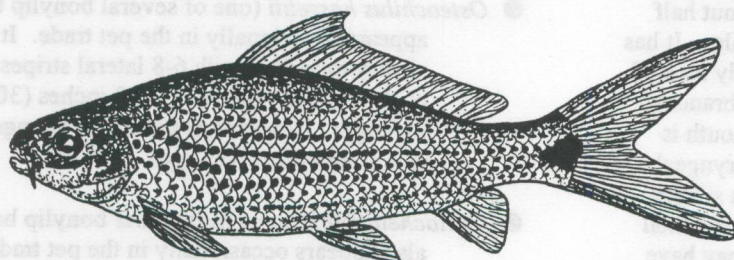
Axelrod et al. 1974; Jayaram 1981; Kiss et al. 1980; Munshi and Srivastava 1988; Nichols 1943; Sakurai et al. 1993; Smith 1945; Taylor 1983; Weber and De Beaufort 1916.

Sailfin Barb
Labio barb festiva



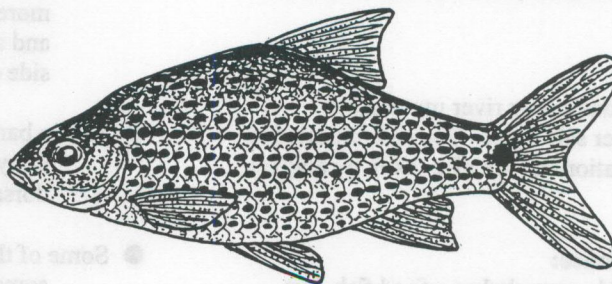
Striped Barb
Puntius fasciatus

Bonylip Barb
Osteochilus hasseltii



Lined Mud Carp
Cirrhinus lineatus

Bonylip Barb
Cyclocheilichthys apogon



CICEK (TURKISH SPINY ROACH)

Family: Cyprinidae

Acanthorutilus handlirschi

USFWS-listed

NO FIGURE AVAILABLE

Other Names:

Kavinne in Turkey.

Specifics:

One recent text on European freshwater fishes list this and three additional species in the genus including *A. anatolicus*, *A. crassus*, and *A. maeandricus*, all with limited distributions in Turkey.

Range:

Restricted to Southcentral Turkey. Apparently endemic to Lake Egirdir.

Description:

All are poorly known and descriptions largely unavailable. Even illustrations and photographs of *A. handlirschi* remain unavailable. *Acanthorutilus* species are classic minnow-like fishes, with scaled bodies, complete lateral lines, and sizes usually around 3.9 inches TL (100 mm TL) or less. The generic name suggests one or more of the unbranched dorsal fin rays is ossified (otherwise they are relatively similar to roach *Rutilus rutilus*).

Biology:

Unreported.

Commercial Importance:

None.

Reasons For Restriction:

This species appears to have been endemic to Lake Egirdir in southern Turkey where it was one of 10 fish species present (3 endemic). However, in 1955, European zander *Stizostedion lucioperca* was introduced and ultimately caused the extinction of 7 species.

Similar Species:

Turkish spiny roach is (or was) no doubt similar to countless other small cyprinids; but the unavailability of even basic descriptions or illustrations makes it difficult to elaborate.

Technical Note:

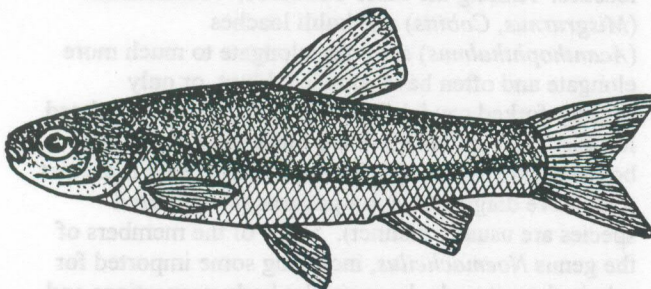
Although this species is listed by the USFWS, the difficulty in obtaining descriptions or figures of it makes legally protecting it based on this regulation almost unenforceable. Even information on other members of the genus is so limited as to preclude quick or easy identification.

References:

Blanc et al. 1971. Note: This species appears in some Internet references.

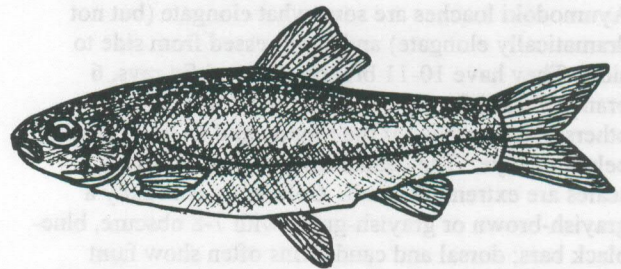
Spiny Roach

Acanthorutilus maeandricus



Spiny Roach

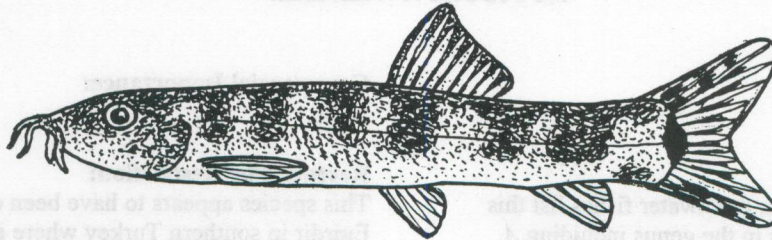
Acanthorutilus crassus



AYUMODOKI LOACH

Family: Cobitidae
Hymenophysa (Botia) curta
USFWS-listed

Ayumodoki Loach
Hymenophysa curta



Other Names:

Also known as *Leptobotia curta* and *Botia curta*; called ayu-modoki in Japanese.

Specifics:

Members family Cobitidae include loaches and weatherfishes. Subfamilies include Botinae (*Leptobotia*, *Botia*, *Hymenophysa*; about 10 species), Cobitinae (fifteen genera and 25 species), and Noemacheilinae (with four genera and over 100 species). Scales, if present, in members of this family are small, cycloid, and often obscure. Some authorities place *Noemaheilus* and its relatives in another family (Homalopterididae). Originally spelled *Hymenophysa*.

Range:

Ayumodoki loach is endemic to Japan and occurs in the Yodo River, Lake Biwa, and several rivers in the Okayama area. Other loaches range from Europe and North Africa through Asia to Japan and some of the Southeast Asian islands.

Description:

Ayumodoki loaches are somewhat elongate (but not dramatically elongate) and compressed from side to side. They have 10-11 branched dorsal fin rays, 6 branched anal fin rays, four nasal barbels and two others at the corners of the mouth, and an erectile spine below the eye. The caudal fin is forked and body scales are extremely small. Coloration is usually a grayish-brown or grayish-green with 7-8 obscure, blue-black bars; dorsal and caudal fins often show faint banding patterns as well. Size reaches about 5.9 inches SL (150 mm SL).

Biology:

Details of the biology of ayumodoki loaches are largely

lacking. Loaches in general are bottom feeders which consume small invertebrates and are often nocturnal. A spine positioned before or below the eye may offer some protection when digging into the substrate or be used for defensive purposes.

Commercial Importance:

Although a large number of species of loaches and weatherfishes is imported for sale in the pet trade and ayumodoki loaches are occasionally mentioned briefly in aquarium literature, this particular species is relatively unattractive compared to other species and has never been significant as an aquarium species.

Reasons For Restriction:

This species is listed as endangered by USFWS; presumably reflecting limited abundance and distribution in its native waters and problems associated with human growth and environmental impacts in Japan.

Similar Species:

This species is most likely to be confused with other loaches. Among the other Cobitidae, weatherfishes (*Misgrurnus*, *Cobitis*) and kuhli loaches (*Acanthopthalmus*) are more elongate to much more elongate and often have rounded, blunt, or only slightly-forked caudal fins. Most of the closely-related loaches in the genus *Botia* are more stout and deeper bodied; many of the species imported for sale in the pet trade have diagnostic color patterns (even barred species are usually distinct). Some of the members of the genus *Noemacheilus*, including some imported for sale in the pet trade, have similar body proportions and color patterns, but all lack the spine present near the eye in ayumodoki loaches.

Several other species of *Leptobotia* from China are similar but may display more vertical bars in the color pattern (9-12 bars in *L. mantschurica* and about 15 bars in *L. fasciata*) or fewer bars (6 in *L. elongata*). Species of *Leptobotia* rarely appear in the pet trade.

Additionally, a number of cyprinid fishes regularly sold in the pet trade (called *Labeo* or sharks) have barbels and may have sizes and body shapes similar to some loaches. However, all have much larger scales and lack the spine near the eye.

Members of the family Cobitidae differ from ayumokodi loaches by having:

More elongate bodies: *Leptidocephalus*, *Acanthopsis*, *Neoeucirrhichthys*, *Semileptes*, *Paralepidocephalus*, *Acanthopsoides*.

Much more elongate bodies: *Eucirrhichthys*, *Acanthophthalmus*, *Vaillantella*, *Niwaella*, *Cobitophis*.

Square (truncate), rounded, or very deeply-forked caudal fins: *Leptidocephalus*, *Vaillantella*, *Semileptes*, *Paramisgurnus*, *Lepturichthys*, *Lefua*, *Neocanthopsis*.

No spine below the eye: *Elxis*, *Nematocheilus*, *Aborichthys*, *Oreonectes*, *Paramisgurnus*, *Barbatula*, *Homaloptera*, *Praeformosiana*, *Crossostoma*.

No barbels: *Neoeucirrhichthys*.

Bulging eyes: *Semileptes*.

Large scales: *Gobiobotia*.

Bodies flattened top to bottom: *Hemimyzon*, *Gastromyzon*, *Sinogastromyzon*, *Pseudogastromyzon*.

Technical Note:

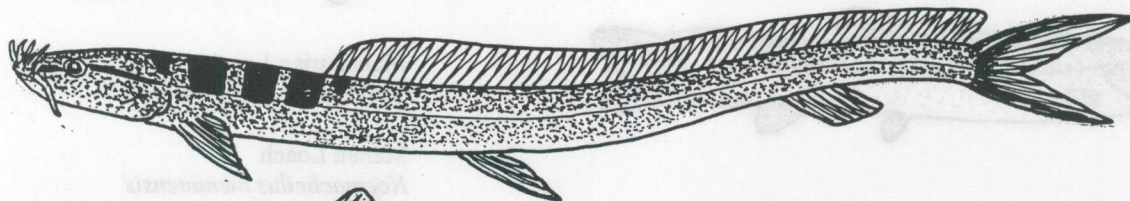
Domestic forms of several weatherfishes are produced and sold in gold-colored xanthic forms.

References:

Axelrod and Burgess 1982; Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Masuda et al 1984; Munshi and Srivastava 1988; Nichols 1943; Smith 1945; Sterba 1967; Taylor 1982; Weber and De Beaufort 1916.

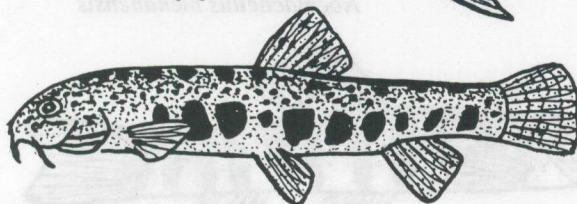
Longfinned Loach

Vaillantella euepipterus



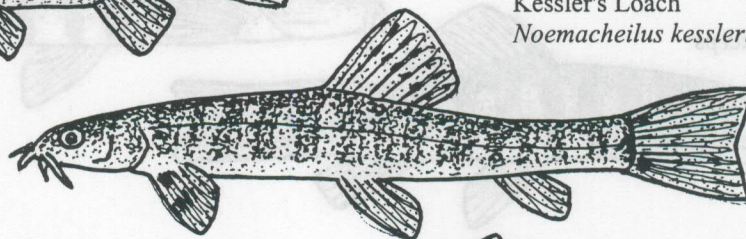
Golden Spined Loach

Cobitis aurata



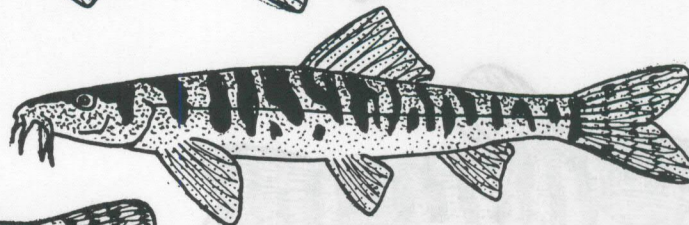
Kessler's Loach

Noemacheilus kessleri



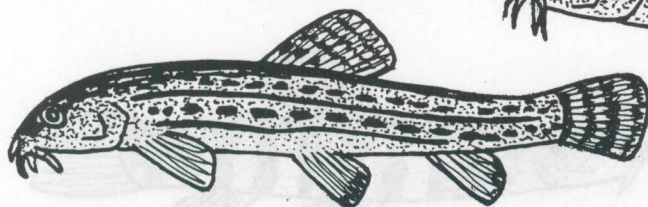
Spined Loach

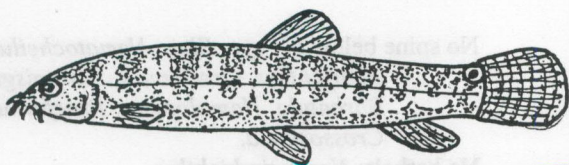
Cobitis taenia



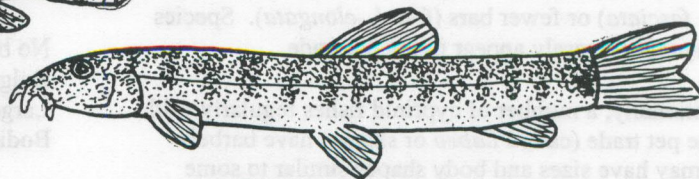
Brandt's Loach

Noemacheilus brandti

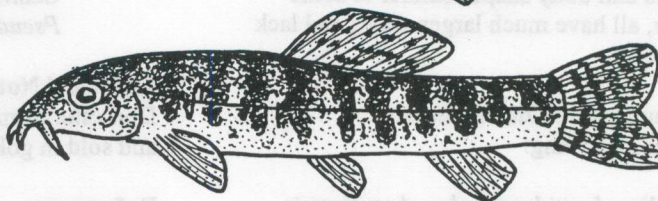




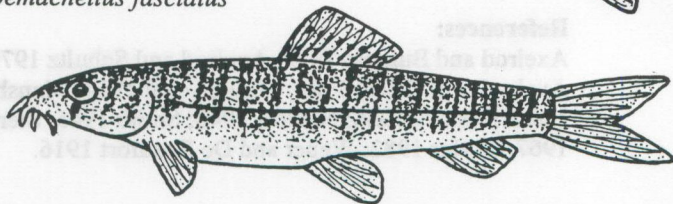
Barbeled Loach
Lepidocephalus guntae



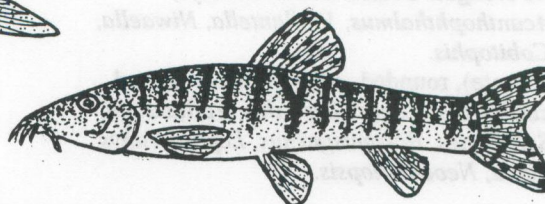
Spotback Loach
Noemacheilus notostrigma



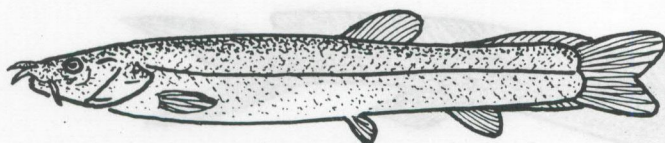
Barred Loach
Noemacheilus fasciatus



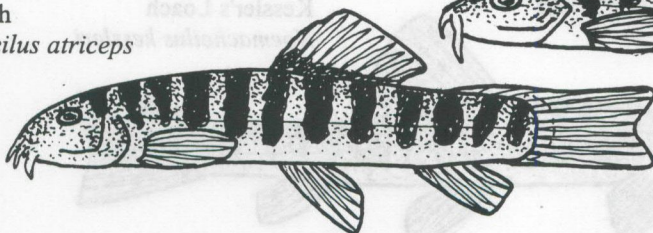
Flattail Loach
Botia compressicaudata



Mottled Loach
Noemacheilus botia



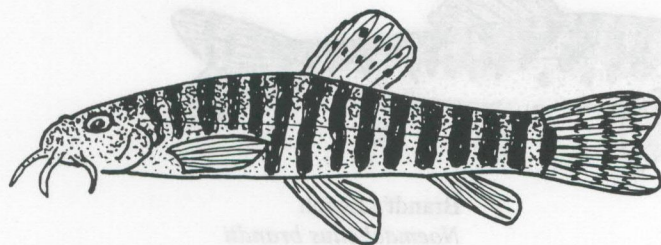
Manchurian Loach
Leptobotia mantschurica



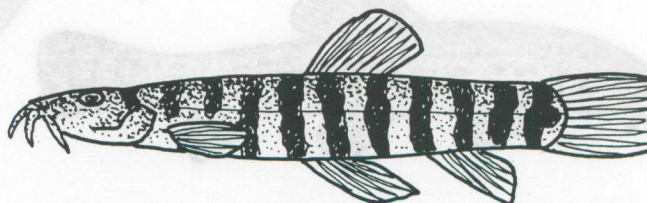
Thai Loach
Noemacheilus atriceps



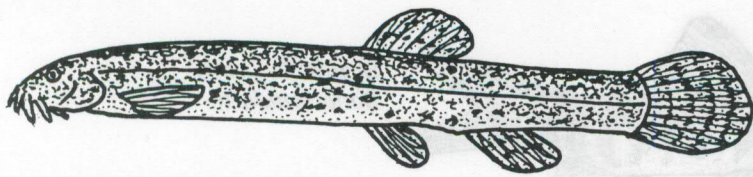
Menan Loach
Noemacheilus menanensis



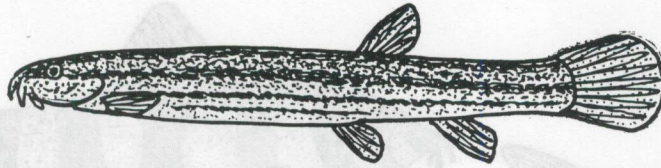
Deignan's Loach
Noemacheilus deignani



Reid's Loach
Noemacheilus reidi



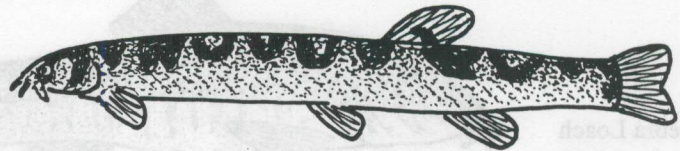
Oriental Weatherfish
Misgurnus anguillicaudatus



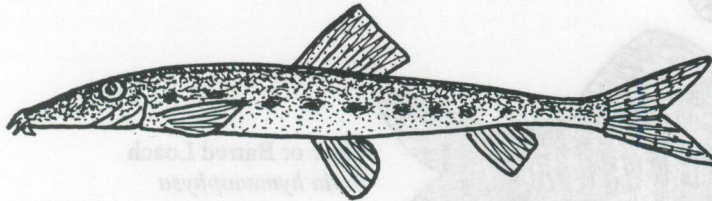
European Weatherfish
Misgurnus fossilis



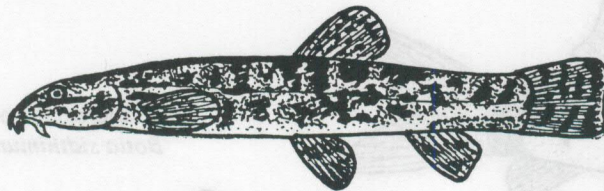
Kuhli or Coolie Loach
Acanthopthalmus kuhlii



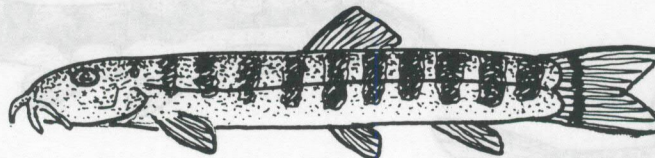
Halfbanded Loach (Pangio)
Acanthopthalmus semicinctus



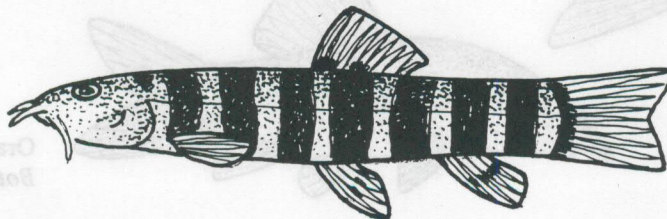
Horseface or Longnose Loach
Acanthopsis choirorhynchus



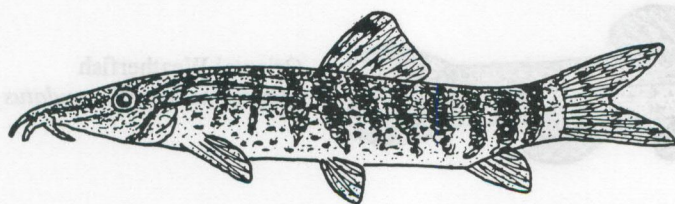
Stone Loach
Noemacheilus barbatulus



Chinese Loach
Barbatula fasciolata

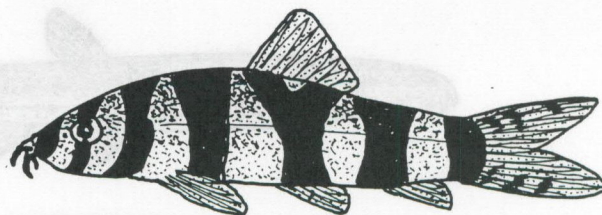
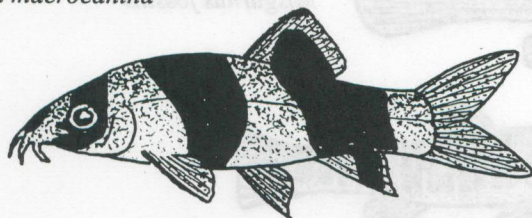


Nichol's Loach
Noemacheilus nicholsi



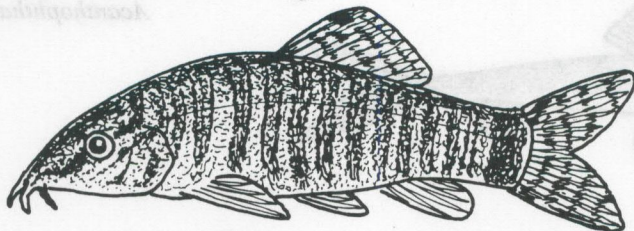
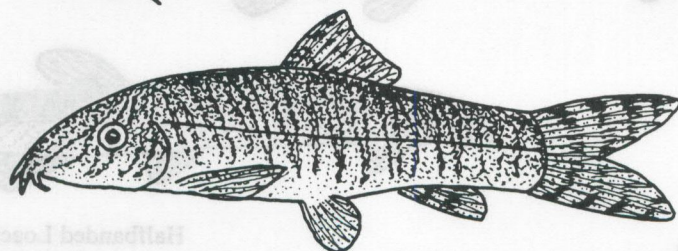
Beaufort's Loach
Botia beauforti

Clown Loach
Botia macrocantha



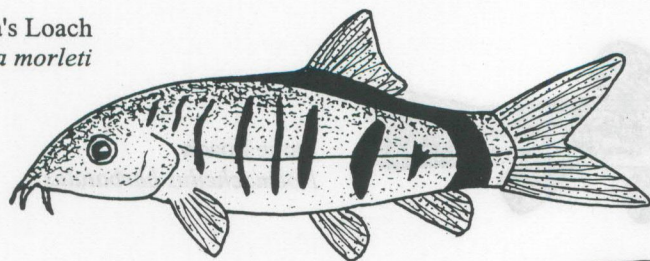
Bengal Loach
Botia dario

Zebra Loach
Botia striata

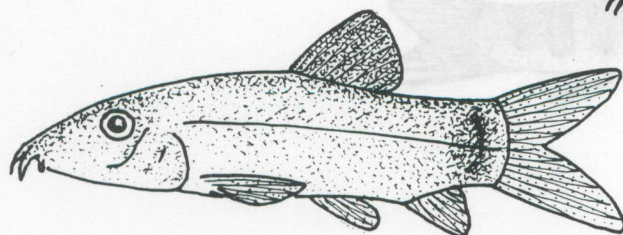
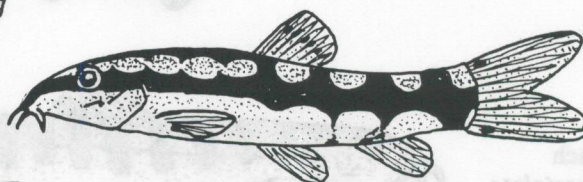


Tiger or Barred Loach
Botia hymenophysa

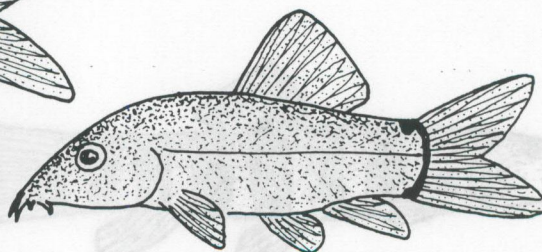
Hora's Loach
Botia morleti



Ladderback Loach
Botia sidhimunk



Leconte's Loach
Botia leconti



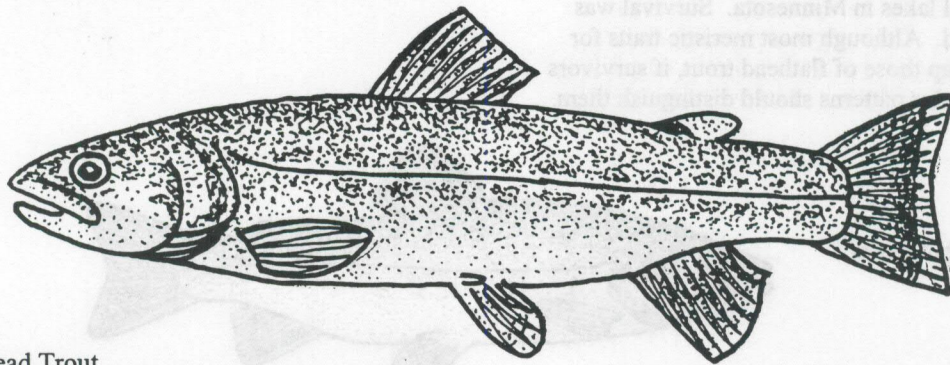
Orange-finned Loach
Botia modesta

TURKISH FLATHEAD TROUT (ALA BALIK)

Family: Salmonidae

Salmo platycephalus

USFWS-listed



Turkish Flathead Trout
Salmo platycephalus

Other Names:
Flathead trout.

Specifics:

Described as a new subgenus (*Platysalmo*) and species in 1968 from three specimens. This species appears most closely allied to brown trout *S. trutta* and its closest relatives including Atlantic salmon *S. salar*, Sevan trout *S. ischchan* (Armenia), and Ohrid trout *S. letnica* (Yugoslavia); less closely related to Pacific salmon *Oncorhynchus* and chars *Salvelinus*. It has been suggested these specimens may only represent morphologically atypical brown trout.

Range:

Known from a tributary of the Seyhan (or Sarus) River system in Southcentral Turkey which drains into the Mediterranean Sea.

Description:

General body shape and fin placement are typically trout-like, with the head somewhat flatter and wider than in most brown trout. There are 23-24 gill rakers on the first arch, 57-59 vertebrae, 15-16 pyloric caeca, 109-110 lateral line scales, iii and 10 dorsal fin rays, and iii and 8 anal fin rays. Coloration is a dusky brown, darker dorsally and more pale ventrally, but without dark or light spots or other distinctive markings; fins have pale margins. Total length of the three known specimens was 13.5-14.8 inches TL (342-376 mm TL). All three specimens were mature females.

Biology:

General biology is poorly known but probably very similar to brown trout. The three females taken in July had developing ovarian eggs suggesting a fall spawning

period (brown trout in Turkey spawn in spring). Their stomach contents were primarily gammaridian amphipods.

Commercial Importance:
None.

Reasons For Restriction:

Currently listed by USFWS as endangered; presumably reflecting on extreme rarity and very limited distribution. This further suggests chances of importations into the U.S. are probably quite remote. However, any such importations would also fall under Lacey Act requirements of disease-free certification for salmonids.

Similar Species:

Turkish flathead trout differs from brown trout and its immediate relatives by the absence of either dark or light spots. It has more gill rakers than brown trout (23-24 versus 17-22). It also has a lower number of pyloric caeca than any other salmonid thus far described, except in some Mexican golden trout *O. chrysogaster*. American Pacific salmon (*O. gorbuscha*, *O. keta*, *O. kisutch*, *O. nerka*, and *O. tshawytscha*) have more lateral line scales (112-205) and usually have black spots. Rainbow trout *O. mykiss* (previously *Salmo gairdneri*) and cutthroat trout *O. clarki* also have definite black spots and less than 23 gill rakers. Chars like brook trout *Salvelinus fontinalis*, Arctic char *S. alpinus*, and lake trout *S. namaycush* also usually display color patterns with dark or light spots. Some forms of Arctic char may lack both dark and light spots and were once considered unique species. These include Sunapee trout *Salvelinus aureolus*, aurora trout *S. timagamiensis*, Quebec red trout *S. marstoni*, and blueback trout *S. aquassa*. These chars often have

bolder, more-distinct color patterns, including light and dark leading fin edges, and far more lateral line scales.

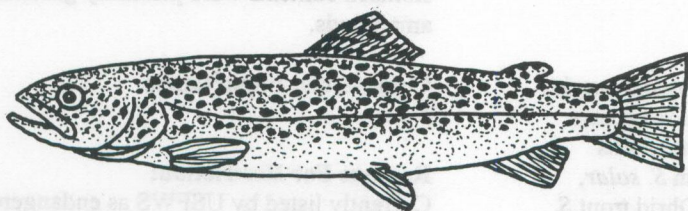
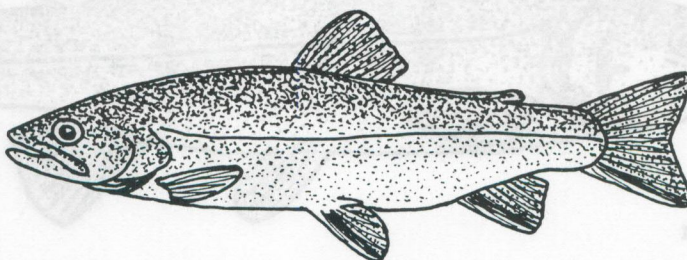
Technical Note:

Ohrid trout *Salmo letnica* eggs were obtained from Yugoslavia by USFWS in 1964-65, hatched, and stocked in several lakes in Minnesota. Survival was reportedly limited. Although most meristic traits for Ohrid trout overlap those of flathead trout, if survivors do still remain, color patterns should distinguish them.

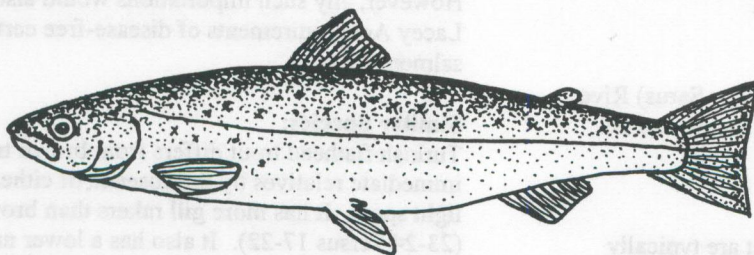
References:

Behnke 1968; Henn and Rinkenbach 1925 ; Qadri 1974; Radnoski et al. 1984; Robins et al. 1991; Sale 1967.

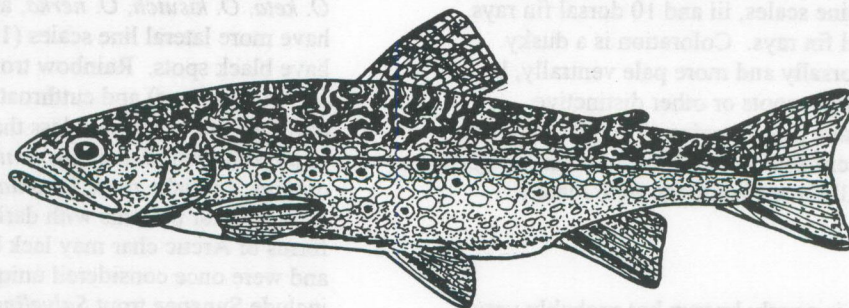
Aurora Trout
Salvelinus "timagamiensis"



Brown Trout
Salmo trutta

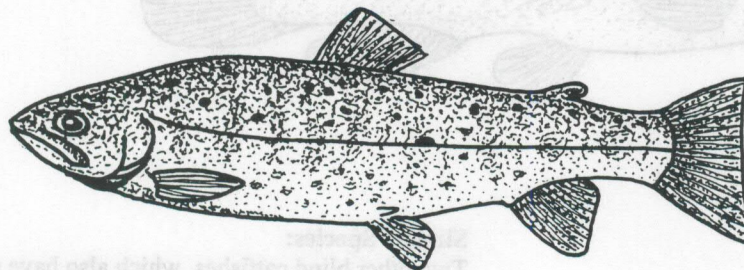
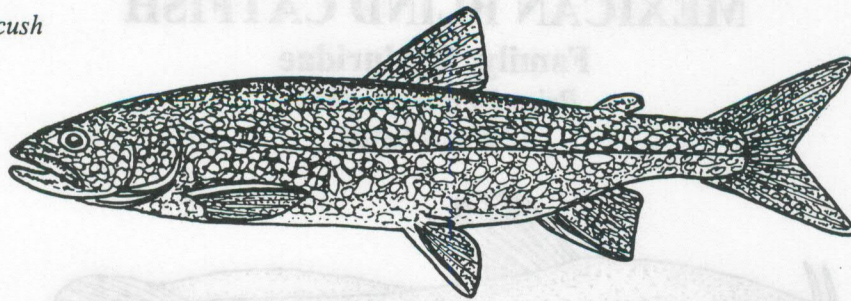


Atlantic Salmon
Salmo salar



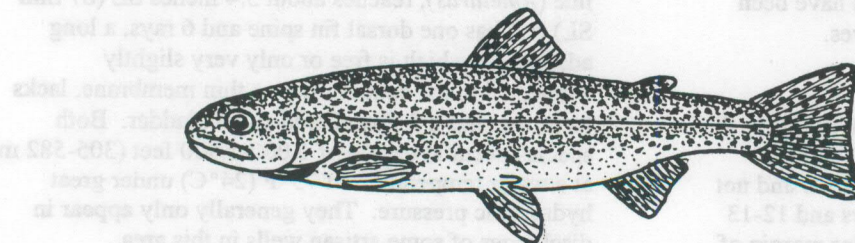
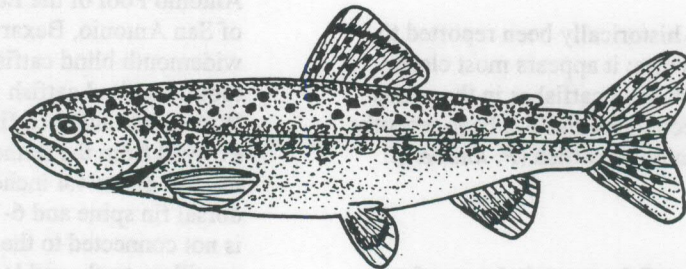
Brook Trout
Salvelinus fontinalis

Lake Trout
Salvelinus namaycush



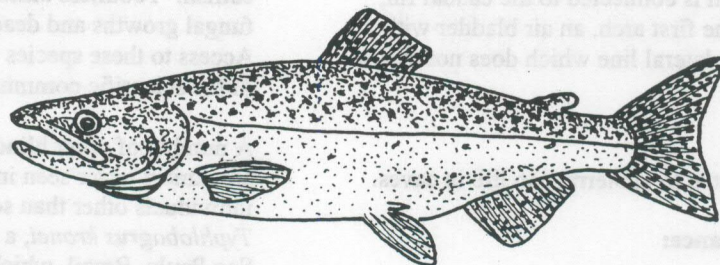
Cherry Salmon
Oncorhynchus masou

Golden Trout
Oncorhynchus aguabonita



Rainbow Trout
Oncorhynchus mikiss

Chinook Salmon
Oncorhynchus tshawytscha

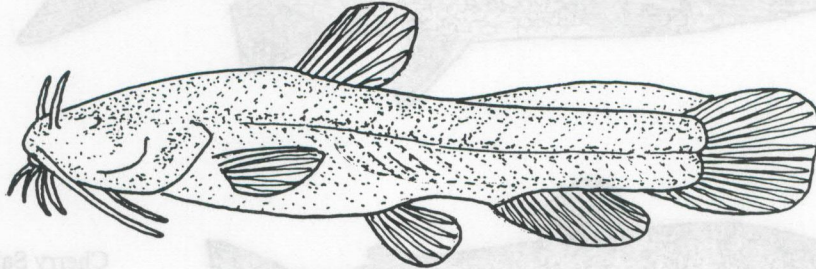


MEXICAN BLIND CATFISH

Family: Ictaluridae

Prietella phreatophila

USFWS-listed



Mexican Blind Catfish
Prietella phreatophila

Other Names:

Muzquiz catfish, Bagre de Muzquiz.

Specifics:

The genus *Prietella* has historically been reported to contain only a single species; it appears most closely related to the madtom ictalurid catfishes in the genus *Noturus*. However, a second species has been recently described as Tamaulipan blind catfish (*P. lindbergi* Welsh and Gilbert).

Range:

Initially Mexican blind catfish was only known from a single location in the Mexican drainage of the Rio Grande; however, additional populations have been discovered more recently in adjacent caves.

Description:

Mexican blind catfish lacks eyes and skin pigment; it also has the first unbranched ray in the dorsal fin (typical "spine" in other ictalurids) unossified and not spine-like. It usually has 7 dorsal fin rays and 12-13 branched caudal fin rays with the posterior margin of the caudal fin relatively blunt or only very slightly emarginate (indented). It possess a long and relatively high adipose fin which is connected to the caudal fin, 10-14 gill rakers on the first arch, an air bladder with 2 chambers, and a short lateral line which does not extend past the dorsal fin..

Biology:

Both species are adapted to subterranean life in caves.

Commercial Importance:

None.

Reasons For Restriction:

Rarity and extremely restricted distribution.

Similar Species:

Two other blind catfishes, which also have state and federal protection, occur in aquifer waters of the San Antonio Pool of the Edwards Aquifer beneath the city of San Antonio, Bexar County, Texas. This include widemouth blind catfish *Satan eurystomus* and toothless blind catfish *Trogloglanis pattersoni*. Widemouth blind catfish, which appears to have evolved from the flathead catfish line (*Pylodictus*), reaches about 4.4 inches SL (113 mm SL) and has a dorsal fin spine and 6-7 rays, a long adipose fin which is not connected to the caudal fin, has a patch of maxillary teeth, and lacks a swim bladder. Toothless blind catfish, which apparently evolved from a bullhead line (*Ameiurus*), reaches about 3.4 inches SL (87 mm SL) and has one dorsal fin spine and 6 rays, a long adipose fin which is free or only very slightly connected to the caudal fin by a thin membrane, lacks teeth, and has a 2-chambered swim bladder. Both species occur at depths of 1,000-1,900 feet (305-582 m) at a water temperature of 75°F (24°C) under great hydrostatic pressure. They generally only appear in discharges of some artisan wells in this area. Widemouth blind catfish consumes isopods, amphipods, small shrimps, and possibly toothless blind catfish. Toothless blind catfish appears to consume fungal growths and dead and decaying organisms. Access to these species is largely restricted to members of the scientific community.

A number of other blind catfishes occur elsewhere, but are almost never seen in the pet trade or encountered by individuals other than scientists. Examples include *Typhlobagrus kronei*, a Pimelodidae from caves near Sao Paulo, Brazil, which has a forked tail. Two blind walking catfishes (Clariidae) include *Uegitglanis zammaranoi* from subterranean waters in Somalia and *Horaglanis krishnai* from caves in Kerala, India; both

number of catfish species are domestically produced as albinos, including channel catfish *Ictalurus punctatus*; however, all possess eyes and retain morphological and meristic traits or normal specimens except for coloration.

One blind, cave species which is regularly available in the pet trade is sold as blind cave fish or blind cave tetra (originally under the name *Anoptichthys jordani*) which is now known to be only a form of Mexican tetra *Astyanax mexicanus* (previously *A. fasciatus*). This species has been commercially produced and distributed worldwide. Although it is similar in size, blind Mexican tetra are scaled, lack barbels and spines, and have forked caudal fins.

African blind barb *Caecobarbus geertsi* from caves near Thysville in the Congo Basin of Africa is protected by both local and international regulations but has been reported to appear in the pet trade occasionally. It possesses barbels (fewer than blind catfishes), has scales, lacks an adipose fin, and has a forked caudal fin. Several blind loaches (Cobitidae), including Turkmenan blind loach *Noemacheilus starostini* and Iranian blind loach *N. smithi*, are occasionally mentioned in aquarium literature, but

unlikely to be imported. Both loaches have barbels and lack scales, but are much elongated and lack adipose fins.

Finally, a number of species of American cavefishes (Family Amblyopsidae; genera *Amblyopsis*, *Speoplatyrhinus*, *Typhlichthys*) occur in the eastern U.S. Most lack pelvic fins and none have barbels or adipose fins. Most or all of these species usually fall under local regulations, federal protection, or both. None are handled in the pet trade.

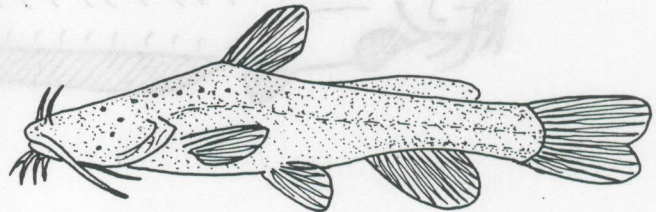
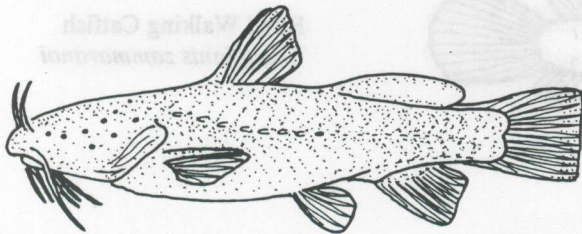
Technical Note:

The Asian pangasiid catfish sold in the pet trade as Siamese or iridescent shark *Pangasius sutchi* is now being produced in an albino form. At least one mutant eyeless albino has been observed in this strain. This is a schooling, pelagic species with large eyes used for visual location of prey (hardly traits suited for a troglomorphic species). Unlike any of the three blind American ictalurids, pangasiids have deeply-forked tails.

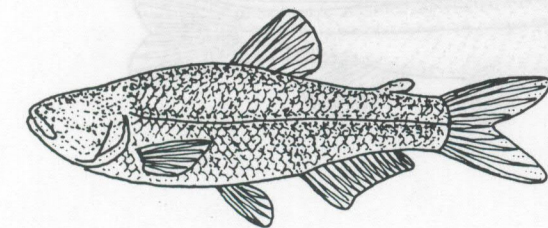
References:

Burgess 1989; Cooper and Longley 1979; Longley and Karnei 1978; Lundberg 1970; Taylor 1969.

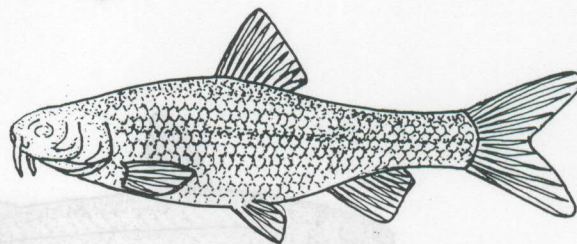
Toothless Blind Catfish
Trogloglanis pattersoni



Widemouth Blind Catfish
Satan eurystomus

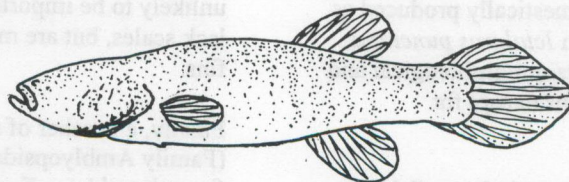


Blind Cavefish
(Blind Mexican Tetra)
Astyanax mexicanus

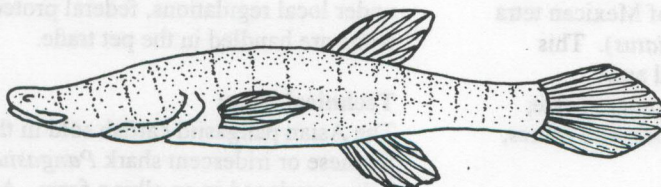


African Blind Barb
Caecobarbus geertsi

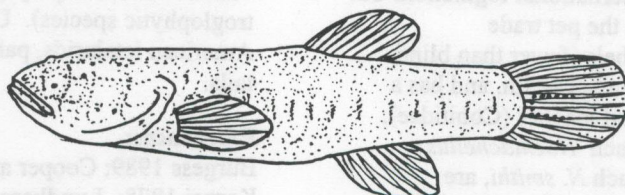
Southern Cavefish
Typhlichthys subterraneus



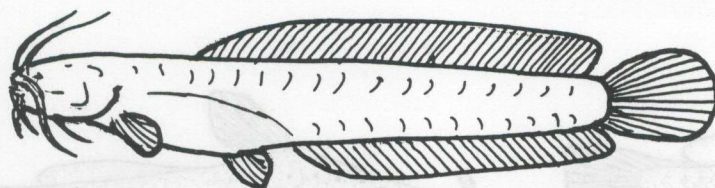
Alabama Cavefish
Speoplatyrhinus poulsoni



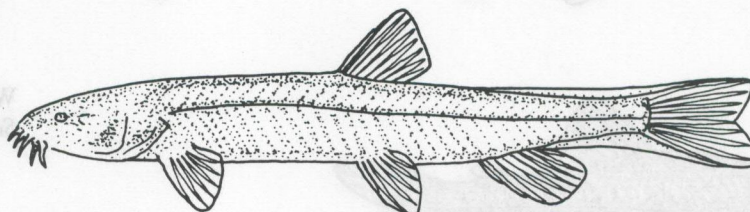
Ozark Cavefish
Amblyopsis rosae



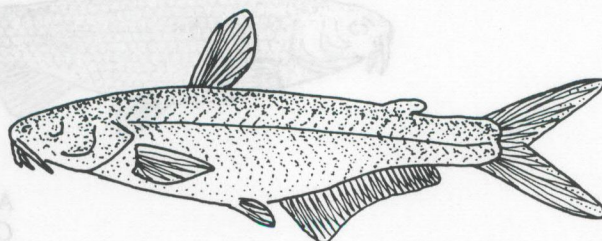
Blind Walking Catfish
Uegitglanis zammaranoi



Turkmenan Blind Loach
Neomacheilus starostrini



"Blind" Siamese Shark
Pangasius sutchi
(deformed albino)

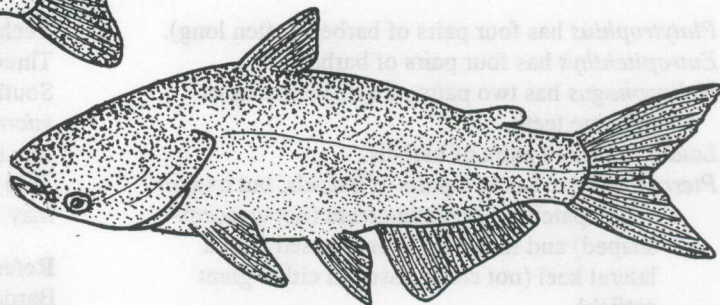
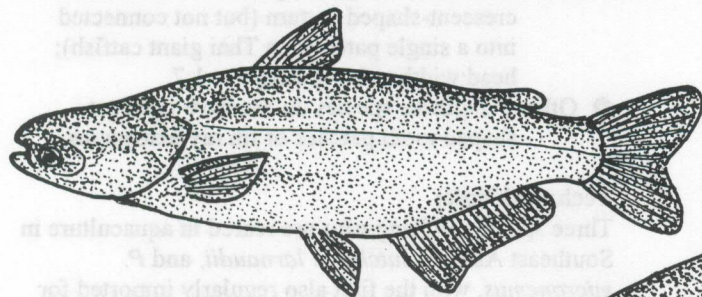


ASIAN GIANT CATFISHES

Family: Pangasiidae

Mekong Giant Catfish *Pangasius sanitwongsei* - USFWS-listed

Thai Giant Catfish *Pangasianodon gigas* - USFWS, CITES-listed



Thai Giant Catfish
Pangasianodon gigas

Other Names:

Thai giant catfish is called "pla thepa" and Mekong giant catfish is called "pla biik" in Thailand; however, both local common names are sometimes used interchangeably.

Specifics:

Pangasiid catfishes have been placed in the family Schilbidae by some authorities. Currently both species of giant catfishes are considered valid, but it has been suggested they may represent only forms of the same species.

Range:

Thai giant catfish has been described as "particular to Thailand." Mekong giant catfish occurs in the Mekong River basin including Vietnam, Thailand, Burma, and China.

Description:

Pangasiid catfishes in general superficially resemble native ictalurid catfishes in shape, but with much reduced barbels. Teeth are often lost or atrophied, especially in large, old adults; hence, taxonomic confusion with the Asian giant catfishes and the absence of good descriptions of juveniles. Thai and Mekong giant catfishes are among the largest catfishes in the world.

Thai giant catfish has two pairs of small barbels (maxillary and chin); a crescent-shaped patch of vomero-palatine teeth on the roof of the mouth; anterior fin ray extensions on the dorsal, pectoral, pelvic, and caudal fins (and possibly the anal fin); and the eye placed above the angle of the mouth. Coloration is dark

gray to black on the back, sides, and fins, with distinctly divided pale to white areas below; a pale shoulder spot is present above the pectoral fin (but this may appear as only an extension of the general white coloration ventrally. Length reaches 10 feet (3 m).

Mekong giant catfish has only a single pair of barbels (maxillary); lacks teeth; lacks fin ray extensions; and has its eye set below the angle of the mouth. Coloration is generally more pale gray to tan. Although juveniles have been reported as "undescribed," a photograph of a juvenile in Burgess (1990) is attributed to this species (and differs noticeably from Thai giant catfish). Length has been reported to 10 feet (3 m).

Biology:

Both species are large river fish. Most pangasiids in general are fast-moving, pelagic species which are usually predatory. However, both species of giant catfishes are reported to consume vegetation and fallen fruit when large and teeth have been lost. Mekong giant catfish has been described as migratory. Both species have fin spines which can be potentially dangerous in large, powerful specimens. There are claims of fishermen being killed while handling netted specimens.

Commercial Importance:

Both species have been taken by local fishermen as food fishes, but appear to have had little historical importance otherwise. Juvenile Thai giant catfishes have appeared occasionally in pet trade imports in recent years; this could suggest commercial culture techniques used on other pangasiid catfishes in

Southeast Asia are being applied to this species as well.

Reasons For Restriction:

Inclusion on endangered species lists presumably reflects historical and continued rarity, possible over fishing, and years of political unrest in the area.

Similar Species:

Other catfishes in the families Schilbidae and Pangasiidae are most likely to be confused with Asian giant catfishes.

- *Platytrichus* has four pairs of barbels (often long).
- *Eutropiichthys* has four pairs of barbels.
- *Helicophagus* has two pairs of barbels but lacks palatine teeth.
- *Lalides* has three pairs of barbels.
- *Pteropangasius* has two pairs of barbels, but oval or round patches of palatine teeth (not crescent-shaped) and its body is compressed with a lateral keel (not compressed in either giant catfish).
- *Pangasius sutchi* lacks fin ray extensions and the white humeral spot; head width to body length is 1:8 (1:3.7-4.3 in *P. sanitwongsei*); has several broad dark bands running from head to tail; juveniles are imported in large numbers for sale in the pet trade as Siamese or iridescent sharks; an albino form also exists.

- *Pangasius larnaudii* has a black humeral spot and a slight suggestion of fin ray extensions (but far shorter than in Thai giant catfish); head width to body length is 1:6.
- *Pangasius micronemus* has vomerine and palatine teeth in four separate patches which form a crescent-shaped pattern (but not connected into a single patch as in Thai giant catfish); head width to body length is 1:7.
- Other *Pangasius* species do not have crescent-shaped tooth patches or fin ray extensions.

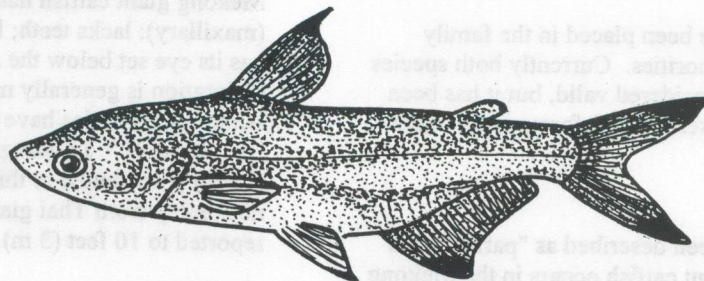
Technical Note:

Three species of *Pangasius* are reared in aquaculture in Southeast Asia: *P. sutchi*, *P. larnaudii*, and *P. micronemus*, with the first also regularly imported for sale in the aquarium trade. The appearance of juvenile Thai giant catfishes in pet trade imports, suggests it to may be the subject of aquacultural efforts as well.

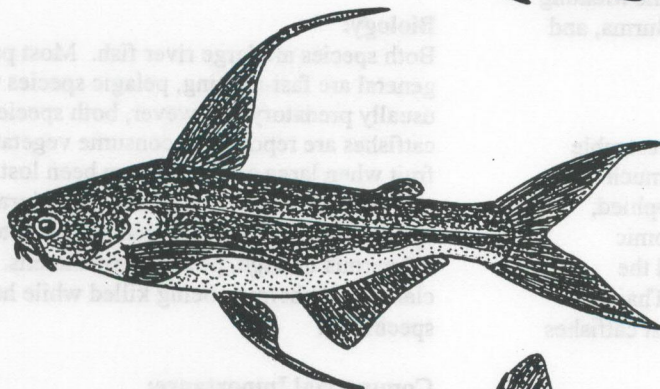
References:

Bardach et al. 1973; Browman and Kramer 1985; Burgess 1989; Frank 1980; Ricciuti 1973.

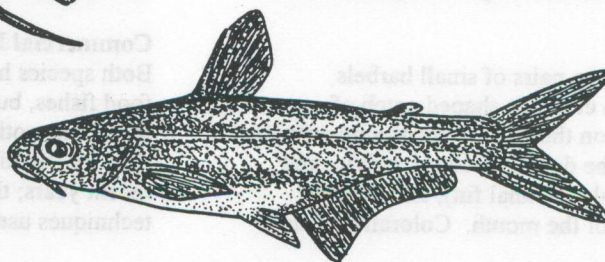
Thai Giant Catfish
Pangasianodon gigas



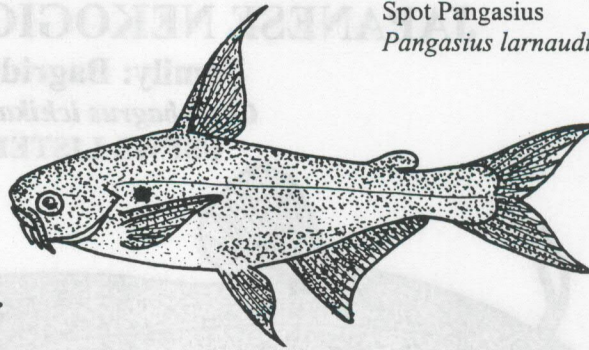
Mekong Giant Catfish
Pangasius sanitwongsei



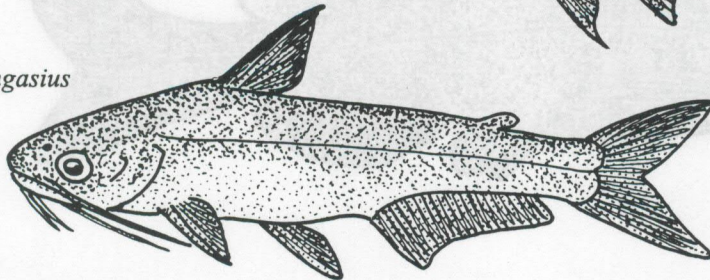
Siamese or Iridescent Shark
Pangasius sutchi



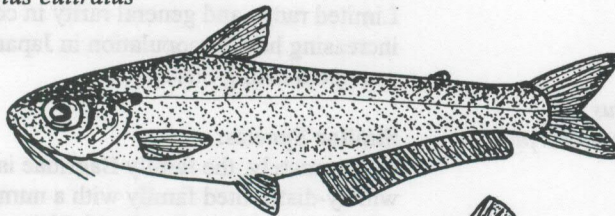
Spot Pangasius
Pangasius larnaudii



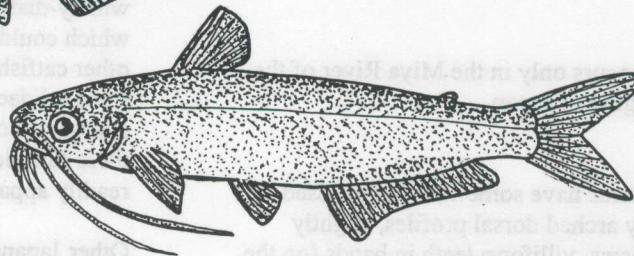
Punagas
Pangasius pangasius



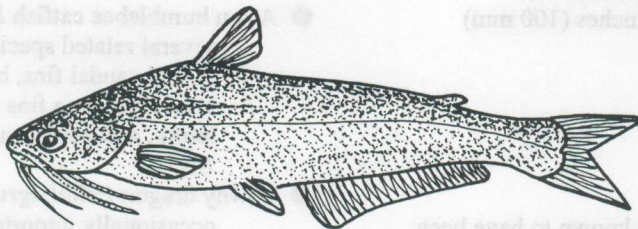
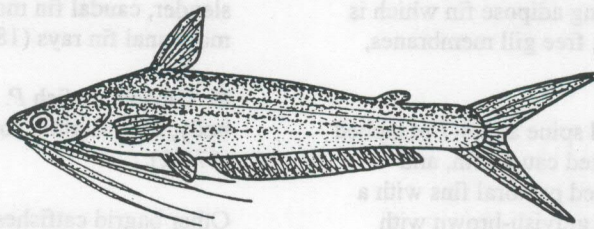
Knife Pangasius
Petropangasius cultratus



Lades hexanema



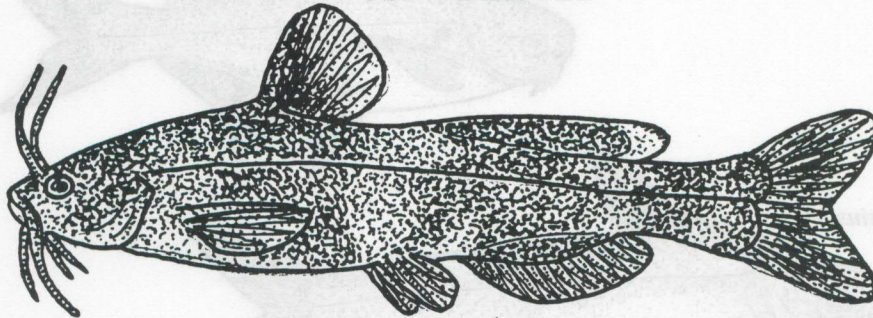
False Siamese Shark
Platyphus siamensis



Helicophagus waandersi

JAPANESE NEKOGIGI CATFISH

Family: Bagridae
Coreobagrus ichikawai
USFWS-LISTED



Japanese Nekogigi Catfish
Coreobagrus ichikawai

Other Names:

None.

Specifics:

This genus contains three species *Coreobagrus ichikawai* and *C. okadai* from Japan and *C. brevicorpus* from Korea.

Range:

Nekogigi catfish occurs only in the Miya River of the central Honshu region of Japan.

Description:

Members of the genus have somewhat compressed bodies and slightly arched dorsal profiles, slightly protruding upper jaws, villiform teeth in bands (on the premaxillary, prevomer, and mandible), four pairs of barbels (one nasal, two chin, and one at each corner of the maxillary), a moderately long adipose fin which is not connected to the caudal fin, free gill membranes, and 8 branchiostegal rays.

Nekogigi catfish has one dorsal spine and 6-7 branched rays, 14-15 anal fin rays, a forked caudal fin, and relatively horizontally-positioned pectoral fins with a spine in each. Coloration is an grayish-brown with indistinct darker banding. Maximum size is unavailable, but specimens of 3.9 inches (100 mm) have been reported.

Biology:

Unavailable.

Commercial Importance:

None reported. This species is not known to have been imported for sale in the pet trade.

Reasons For Restriction:

Limited range and general rarity in conjunction with an increasing human population in Japan probably prompted listing this species.

Similar Species:

Unfortunately, the family Bagridae is large, diverse, widely-distributed family with a number of species which could be confused with Nekogigi catfish. Two other catfish families, Ictaluridae in North America and Pimelodidae in Central and South America, also contain species which are similar. Distinctions between these families often relies on internal features not readily apparent in living specimens.

Other Japanese bagrid catfishes:

- Gigi catfish *Pelteobagrus nudiceps* - body more slender, caudal fin more-deeply forked caudal fin, and more anal fin rays (18-20).
- Gibachi catfish *P. aurantiacus* - has a more-elongate body, only slightly forked tail, and more anal fin rays (17-22).

Other bagrid catfishes:

- Asian bumblebee catfish *Leiocassis siamensis* and several related species have more-deeply forked caudal fins, bolder banding patterns, shorter adipose fins (usually, but sometime long), and occasionally more anal rays (12-16).
- Tawny dragon *Pelteobagrus fulvidraco* is occasionally imported for sale in the pet trade from China; it has brown and tan markings but has more anal fin rays (15-27).

- Black and white bagrid *Bagroides melapterus* is usually deeper bodied, has a prevomer with molar-like teeth, and a bold black and white color pattern.

- South American bumblebee catfishes *Pseudopimelodus raninus* and *P. nigricaudatus* are very broad from side to side and do not have forked caudal fins.

Freshwater bullhead catfishes (family: Ictaluridae):

- None of the species with banding patterns have forked caudal fins.

Pimelodid catfishes (family: Pimelodidae):

- South American bumblebee catfish *Microglanis poecilus* and several related species have fewer anal fin rays (iv-v, 6-8) and caudal fins which are not forked or are only weakly forked.

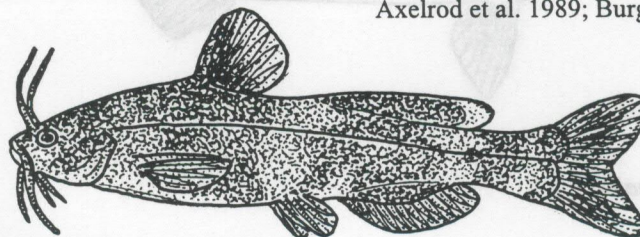
Technical Note:

Japanese Okada catfish *C. okadai* was described from the Suzuka River in 1967 but was not listed by Masuda et al. (1984) in their discussion of Japanese fishes; no description was available at this writing. Similarly, the third species in the genus, *C. brevicarpus*, was described from the Rakuto River in Korea in 1936, but no description was available during preparation of this species account.

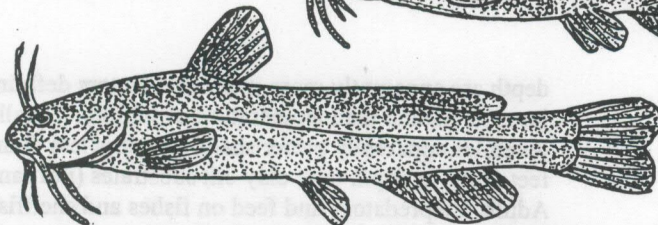
References:

Axelrod et al. 1989; Burgess 1989; Masuda et al. 1984.

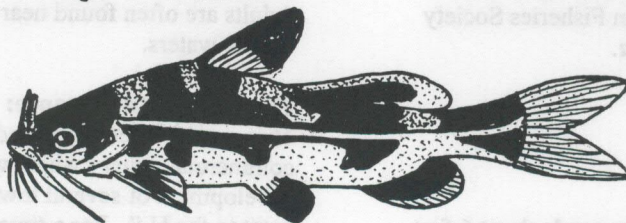
Japanese Nekogigi Catfish
Coreobagrus ichikawai



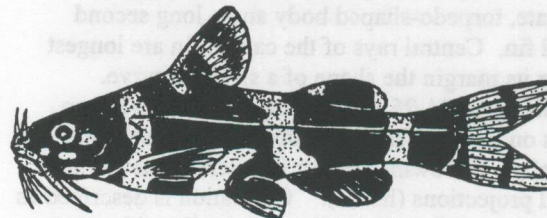
Gibachi Catfish
Pelteobagrus aurantiacus



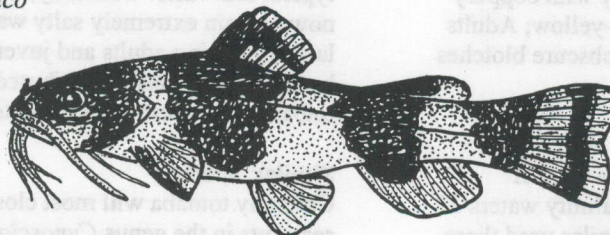
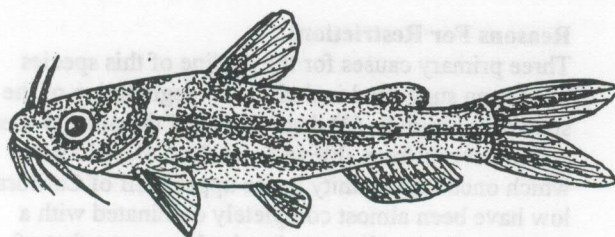
Black and White Bagrid
Bagroides melapterus



Asian Bumblebee Catfish
Leiocassis siamensis



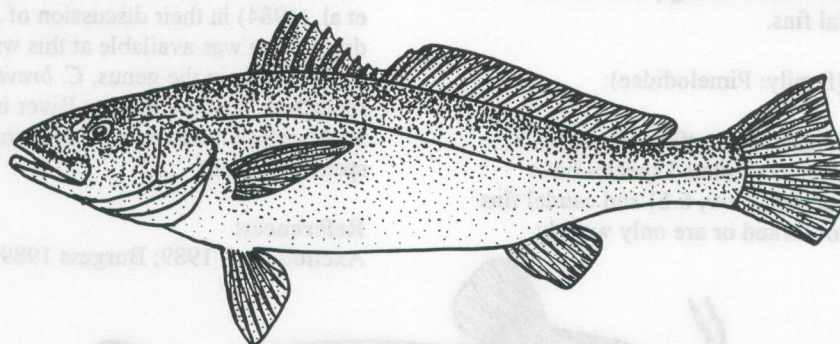
Tawny Dragon
Pelteobagrus fulvidraco



South American Bumblebee Catfish
Microglanis poecilus

TOTOABA (MEXICAN GIANT SEATROUT)

Family: Sciaenidae
Cynoscion (Totoaba) macdonaldi
USFWS, CITES-listed



Totoaba
Cynoscion (Totoaba) macdonaldi

Other Names:
Totoava.

Specifics:
Although long maintained in the genus *Cynoscion*, recent literature from the American Fisheries Society now places it in the genus *Totoaba*.

Range:
Gulf of California, Mexico.

Description:
Totoaba is a large seatrout which can reach about 6 feet (2 m) in length and has been reported to weights over 225 lbs (102 kg). General morphology is typical of other seatrouts of the genus *Cynoscion* with an elongate, torpedo-shaped body and a long second dorsal fin. Central rays of the caudal fin are longest giving its margin the shape of a sigmoid curve. Totoaba have 24-25 soft anal rays and there are no scales on the membranes of this fin. No keel is present ventrally. The swim bladder is described as having lateral projections (horns). Coloration is described as blue above, dull or dirty silvery laterally with coppery colored overtones and the mouth lining yellow; Adults have no patterns of stripes or bars, but obscure blotches are present on the juveniles.

Biology:
Totoaba inhabit the marine waters of the Gulf of California. They moved into the low-salinity waters of the upper Gulf to spawn. Totoaba juveniles used these low-salinity areas as nurseries; however, substrate and

depth are apparently more important factors defining juvenile habitat than temperature or salinity. Small juveniles apparently prefer shallow waters less than 3 feet (1 m) in depth over clay-silt substrates (not sand). Adults are predatory and feed on fishes and shellfishes. Adults are often found near the bottom sometimes in deeper waters.

Commercial Importance:
This species once supported a very important commercial fishery which was responsible for development of several towns in Mexico and exports of meat to the U.S. For a time, even a significant spot fishery existed.

Reasons For Restriction:
Three primary causes for the decline of this species have been suggested including (1) degradation of the spawning grounds, (2) degradation of the nursery areas, and (3) overfishing. Flows from the Colorado River which once kept salinity in the upper Gulf of California low have been almost completely eliminated with a resulting rise in salinity to levels above even that of typical sea water. Similarly, adjacent nursery areas now contain extremely salty water. Overfishing of large spawning adults and juveniles lost in shrimp trawl bycatches have also contributed to the decline in totoabas. Harvest was prohibited in 1975.

Similar Species:
Certainly totoaba will most closely resemble other seatrouts in the genus *Cynoscion*; however, it grows far larger than any other species.

Among the other North American seatrouts:

- Weakfish *C. regalis*, sand seatrout *C. arenarius*, and silver seatrout *C. nothus* have scaled dorsal and anal fins (soft portions).

- Spotted seatrouts *C. nebulosus* and *C. reticulatus* are marked with spots or reticulations.

- Orangemouth corvina *C. xanthulus* has fewer soft dorsal rays (19-21 versus 24-25).

- Shortfin corvina *C. parvipinnis* usually has fewer soft dorsal rays (20-24) and has the posterior margin of the caudal fin (in adults) slightly incurved (central ray are not the longest).

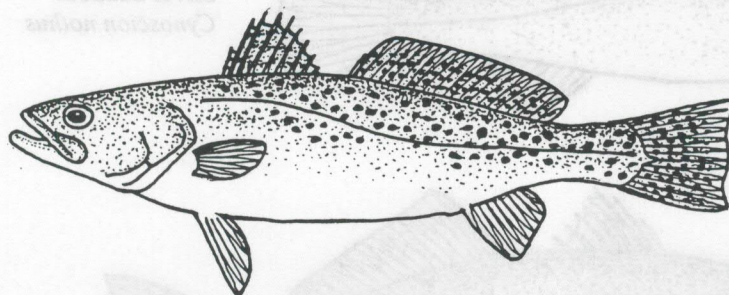
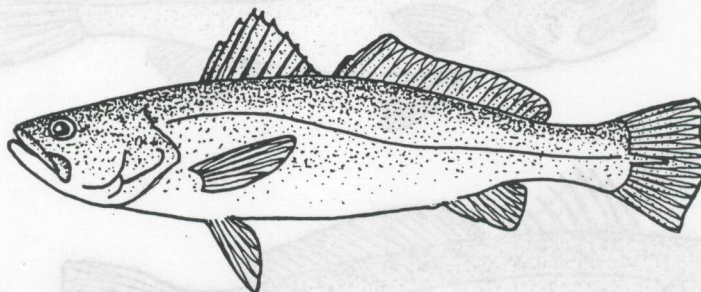
- White seabass *Atractoscion (C.) nobilis* has fewer soft dorsal rays (19-23), lacks canine teeth (present in other seatrouts), has far more lateral line scales than other sciaenids (85-150), and a caudal fin this is very slightly forked or incurved (central rays are not the longest).

- Descriptions of other exotic sea trouts are presented under "Seatrouts and Corvinas" elsewhere in this book.

References:

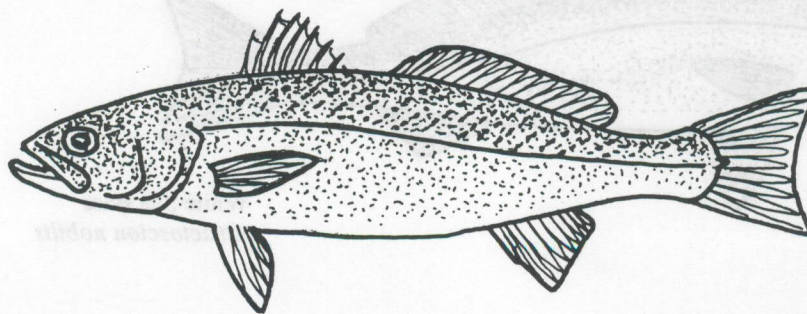
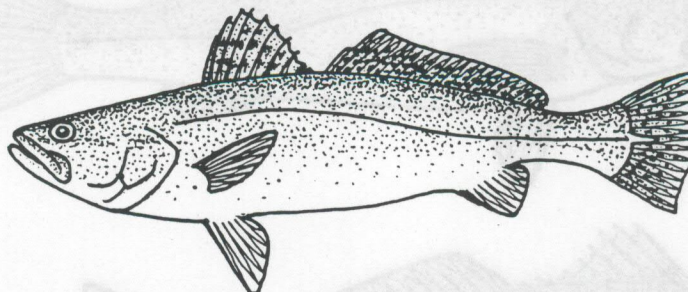
Flanagan and Hendrickson 1976; Gabrielson and Lamonte 1954; Hendrickson 1979; Howells 1991b; Jordan and Eigenmann 1886; Jordan and Evermann 1902; McClane 1972; Robins et al. 1991.

Orangemouth Corvina (OMC)
Cynoscion xanthulus



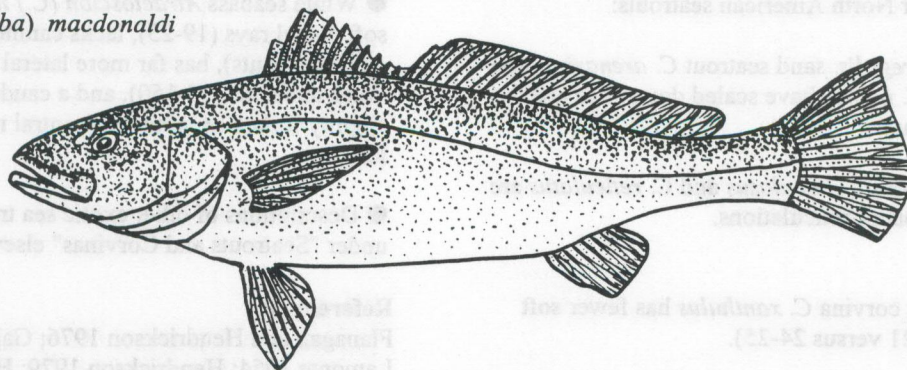
Spotted Seatrout (SST)
Cynoscion nebulosus

Hybrid Corvina
(OMC x SST)

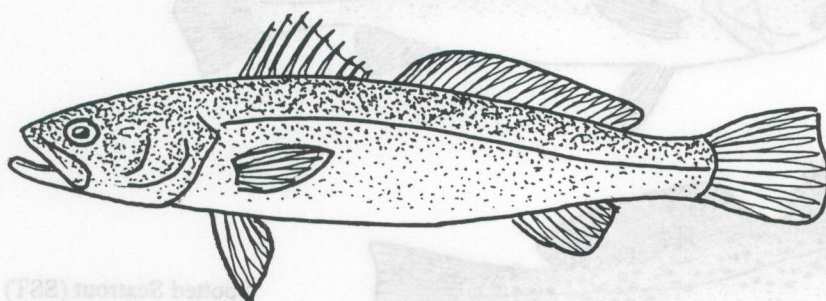
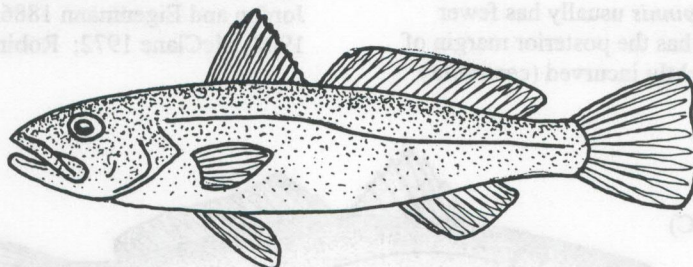


Weakfish
Cynoscion regalis

Totoaba
Cynoscion (Totoaba) macdonaldi

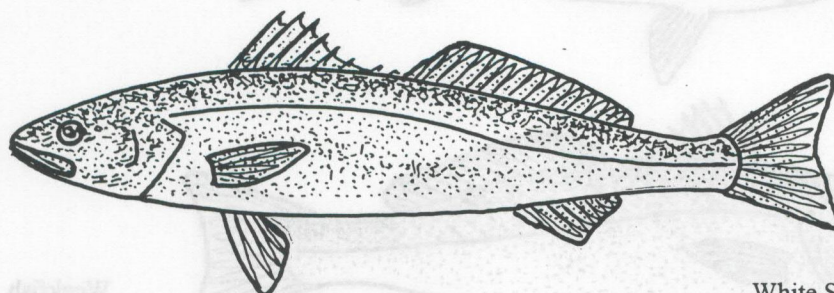
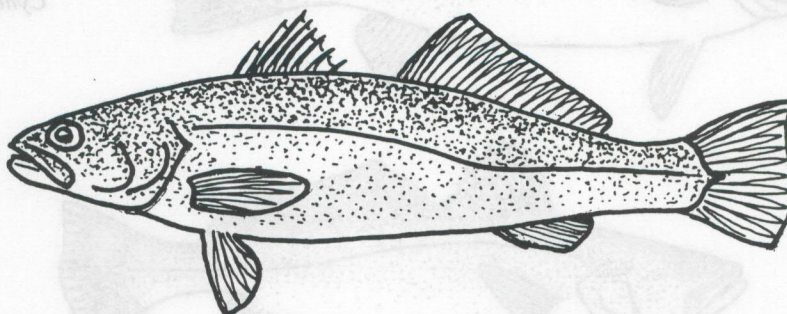


Sand Seatrout
Cynoscion arenarius



Silver Seatrout
Cynoscion nothus

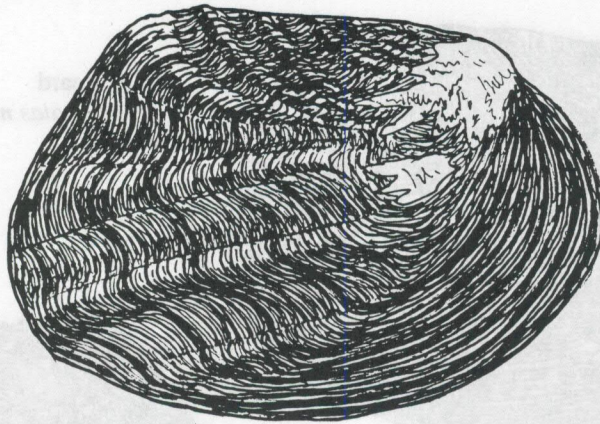
Shortfin Corvina
Cynoscion parvipinnis



White Sea Bass
Atractoscion nobilis

NICKLINS PEARLYMUSSEL

Family: Unionidae
Megaloniaias nicklineana
USFWS, CITES-listed



Nicklins Pearlymussel
Megaloniaias nicklineana

Other Names:
Mexican washboard.

Specifics:
Within this genus, washboard *Megaloniaias nervosa* occurs throughout much of the Mississippi Valley and in Gulf drainages to the east and west (at least to the lower Rio Grande). A second species, round washboard *M. boykiniana*, has a limited distribution in systems feeding the northeastern Gulf of Mexico. Some have questioned if round washboard is actually distinct from washboard, but genetic comparisons of either to Nicklins pearlymussel appear lacking to date.

Range:
Guatemala, southern Mexico.

Description:
The freshwater mussel is relatively large and has been reported to about 6 inches (145 mm) in shell length. It is trapezoidal in shape, somewhat compressed from side to side, with beaks somewhat elevated and slightly inflated. In outline, it is narrowed and rounded anteriorly, broadly curved ventrally, obliquely truncated posteriorly, and has the dorsal margin extending upward into a wing. A hump-like structure is reported along the lower posterior ridge in this species. Internally on the shell, lateral teeth (two left, one right) are relatively short and remote, pseudocardinal teeth (two left, one right) are heavy and rough, and the beak cavity is moderately deep.

External sculpture consists of more or less strongly developed radial folds posteriorly and a finer set of radial wrinkles reaching to the posterior ridge (which is obscure); from the beak broken corrugations blend into irregular, radial wrinkles and pustules below. External coloration is dark greenish-brown to black; internally the shell is white. Shell size reaches at least 5.7 inches (145 mm) long, 4.9 inches (125 mm) high, and 1.8 inches (47 mm) wide; it probably grows substantially larger.

Biology:
Unreported, but presumably similar to that described for the U.S. members of this genus.

Commercial Importance:
None reported, but if the species grew large and thick enough, it could be harvested as a shell used to produce implant nuclei for the cultured pearl industry as are the U.S. species.

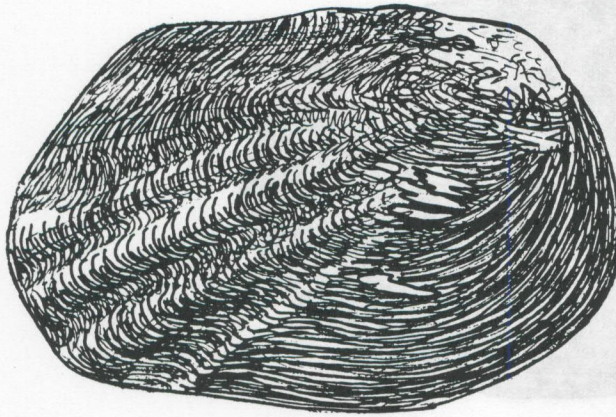
Reasons For Restriction:
Unreported. Presumably, general rarity in conjunction with limited distribution and little first-hand knowledge of the species led to concern.

Similar Species:
Nicklins pearlymussel is most like washboard and round washboard. It is often more compressed from side to side at larger sizes (washboard and round washboard are usually only compressed when small)

and sometimes more heavily ridged than washboard. However, absolute identifications of questionable shells could be difficult without knowledge of the collection location of the specimens. Threeridges *Amblema plicata* and bankclimbers *Plectomerus dombeyanus* are similar, but lack sculpturing in the anterior field.

References:

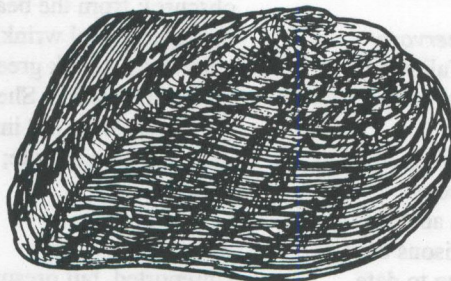
Howells et al. 1996; Simpson 1914.



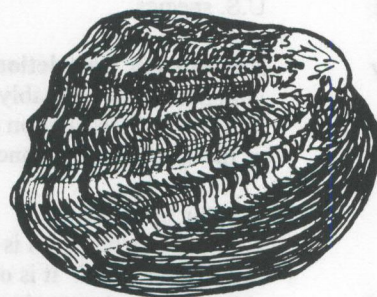
Washboard
Megaloniais nervosa
adult



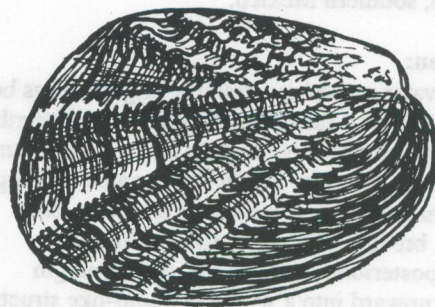
Washboard
Megaloniais nervosa
Juvenile



Bankclimber
Plectomerus dombeyanus



Threeridges
Amblema plicata

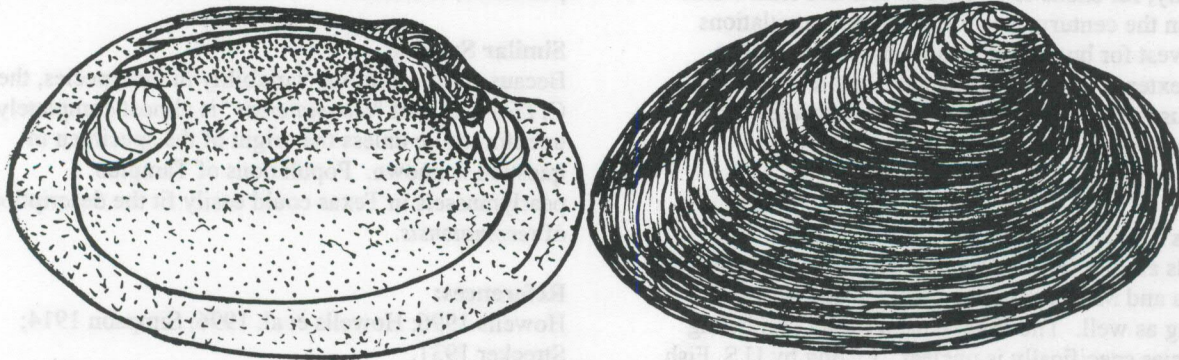


TAMPICO PEARLYMUSSEL

Family: Unionidae

Cyrtonaias tampicoensis tecomatensis

USFWS, CITES-listed



Tampico Pearlymussel *Cyrtonaias tampicoensis tecomatensis*

Other Names:

None (for this subspecies).

Specifics:

There are four or five forms within the *Cyrtonaias tampicoensis* group including: *umbrosa*, *berlandierii*, *tampicoensis*, *tecomatensis*, and possibly *heermannii*. Whether any of these represent separate species, subspecies, or only local ecophenotypes is far from resolved. Among the *berlandierii*, *tampicoensis*, and *heermannii* types and several other apparently unnamed forms in Texas, no significant genetic differences have been identified by Texas Parks and Wildlife Department to date regardless of collection site or morphological appearance. The range of morphological variation within Texas populations easily includes that described for *umbrosa* and *tecomatensis* in Mexico.

Range:

The species ranges from the Brazos River drainage in Central Texas south and west to the Panuco River drainage of northeastern Mexico, with unsuccessful introductions in the upper Trinity River, Texas, and Lake Texoma (Red River), Oklahoma. The "*tecomatensis*" form is reported from Cosamaloapam, Chacotianguis, and the Tecomate River of Mexico.

Description:

The original description and subsequent later comments gives "*tecomatensis*" as elliptical; somewhat inflated; solid; with a moderately angular posterior ridge; full and high beaks; strong, subtriangular pseudocardinal teeth in the left valve and three pseudocardinal teeth in

the right (actually one large right pseudocardinal tooth with a much smaller anterior and posterior denticle); two left and one right lateral teeth; moderately deep beak cavities; externally black shading to olive at the beaks; and dark purple on the shell interior. Size is reported to 3.4 inches (90 mm) shell length.

Biology:

There appears to have been nothing reported about the biology of this subspecies specifically. However, a great deal of work has been done on the Texas forms by Texas Parks and Wildlife Department since January 1992. Tampico pearlymussels in Texas occur in a wide array of habitats and adapt well to many reservoirs. They prefer sand, mud, and gravel bottoms and avoid scoured bedrock and cobble, deep-shifting sands, and deep soft silts. They avoid dense beds of aquatic plants. Texas populations may carry glochidia (parasitic larvae) throughout the year. Hosts have been found to be longnose gar *Lepisosteus osseus*, spotted gar *L. oculatus*, Rio Grande cichlid *Cichlasoma cyanoguttatum*, and golden shiner *Notemigonus crysoleucas*. The species is sufficiently mobile to follow rising and falling water levels if changes are not too abrupt. They have only a limited tolerance to dewatering. Texas populations produce gem-quality pearls more frequently than other unionids in the state and continue to support a sport fishery and jewelry industry. Many of these aspects of species biology probably apply directly to "*tecomatensis*" as well.

Commercial Importance:

The actual commercial importance of the "*tecomatensis*" form of Tampico pearlymussel in its

home range in Mexico is unreported but likely insignificant. Other unionid mussels elsewhere in northeastern

Mexico are often regarded by local residents as food and consumed without regard to species. In Texas, the species is taken for gem-quality pearls and, less frequently, for shells to be used in arts and craft work. Earlier in the century, lower Rio Grande populations saw harvest for button manufacturing, but to only a limited extent. Because shells have colored nacre and are not usually exceptionally thick, this species is not taken commercially for use in the cultured pearl industry.

Reasons For Restriction:

Unionids are the fastest declining faunal group in North America and Mexican populations are apparently declining as well. The exact reason for CITES listing this species specifically is unclear. Listing by U.S. Fish and Wildlife Service apparently occurred when an

entire group of CITES-listed species was added to the federal endangered list collectively without specific justifications as typically done. It should be noted the current federal listing specifies both the "*tecomatensis*" subspecies and "Mexico." Populations in Texas (regardless of subspecies) can still be legally harvested, possessed, and sold.

Similar Species:

Because of the extreme variability in this species, the CITES listing of "*tecomatensis*" is almost completely unenforceable unless the origin of the specimen in question is known. Populations of Tampico pearlymussels in Texas could easily fit the description of *tecomatensis*.

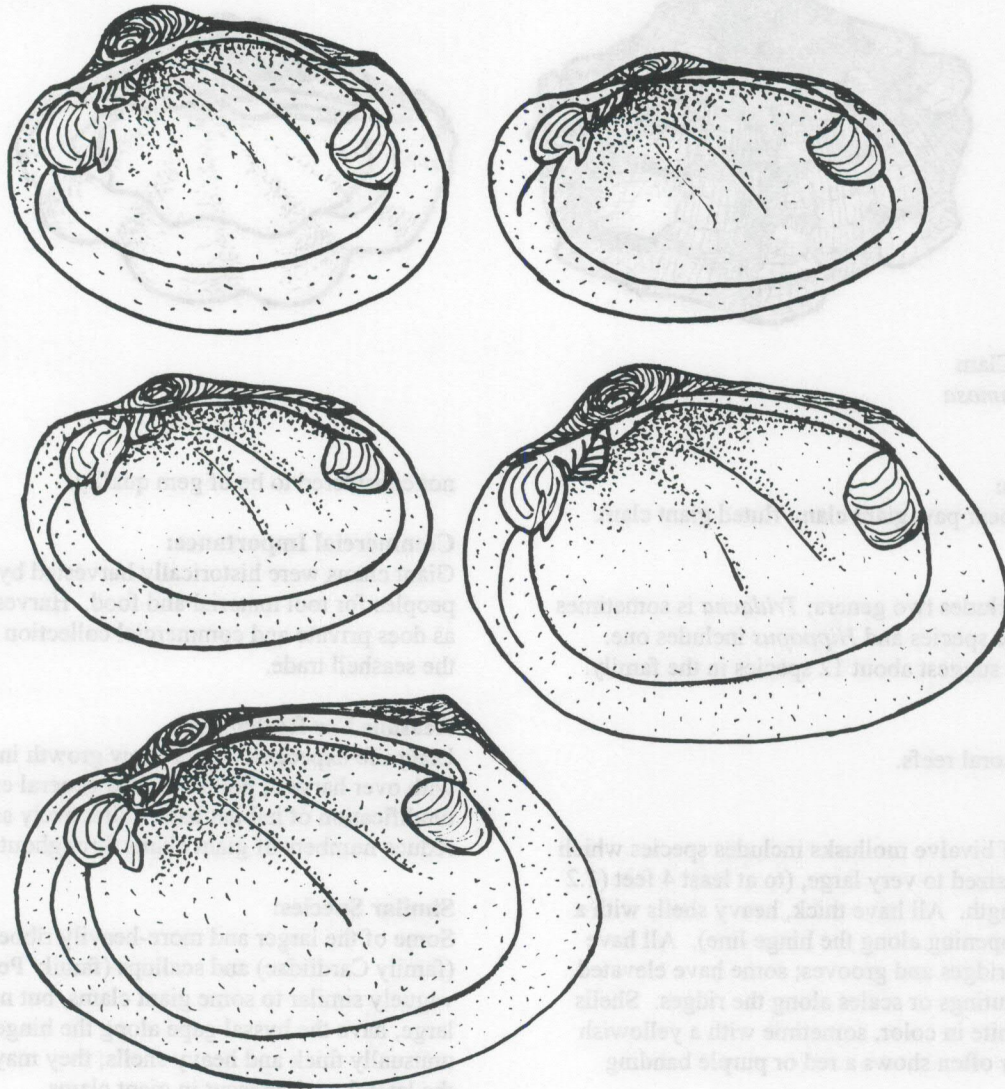
References:

Howells 1996; Howells et al. 1996; Simpson 1914; Strecker 1931.

The following list is based on the original descriptions by I. Lea and interpretation by Simpson (1914) and Strecker (1931) for forms of Tampico pearlymussel, with additional comments by the author under *heermannii*.

Trait	<i>umbrosa</i>	<i>berlandierii</i>	<i>tampicoensis</i>	<i>tecomatensis</i>	<i>heermannii</i>
Described	Lea 1856	Lea 1857	Lea 1838	Lea 1841	Lea 1870
Location	Vera Cruz	NE Mexico SW Texas Matamoras Tamaulipas Colorado R.	NE Mexico SW Texas	Cosamaloapam Chacotianguis Tecomate R.	South Texas
Shape	obovate	rhomboidal	subrhomboidal	elliptical	square
Hardness	subsolid	solid	subsolid	solid	thin
Inflation	subinflated	inflated	scarcely inflated	somewhat inflated	compressed
Beaks	low	full, high	moderately full	full, high	moderately full and high
Beak cavities	shallow	deeper than <i>umbrosa</i>	deep	moderate	moderate
External color	dark brown to black	light to dark brown nearly rayless	chestnut to black	black	light to dark brown, black in large adults
Internal color	white or purple	purple, rose, salmon	purple	dark purple	pastel or white in the Nueces-Frio drainage; dark purple in the Guadalupe-San Antonio drainage

Variation in shell shape and beak elevation
among Tampico pearlymussels
Cyrtonaias tampicoensis from Texas



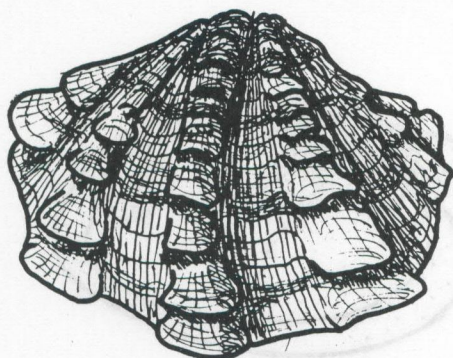
MARINE GIANT CLAMS

Family: Tridacnidae

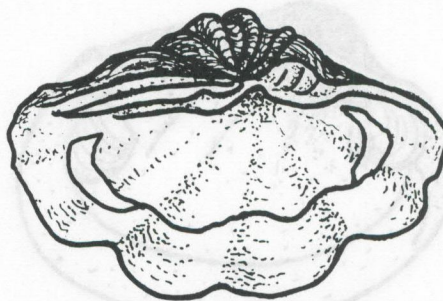
Tridacna deras, *Tridacna gigas*, *Tridacna* - all species

Hippopus - all species

CITES-listed



Fluted Giant Clam
Tridacna squamosa



Other Names:

Giant clams, bear paw giant clam, fluted giant clam.

Specifics:

The family includes two genera; *Tridacna* is sometimes listed with five species and *Hippopus* includes one. Other sources suggest about 12 species in the family.

Range:

Indo-Pacific coral reefs.

Description:

This family of bivalve mollusks includes species which are moderate-sized to very large, (to at least 4 feet (1.2 m) in shell length. All have thick, heavy shells with a byssal gape (opening along the hinge line). All have strong, radial ridges and grooves; some have elevated, shingle-like flutings or scales along the ridges. Shells are usually white in color, sometime with a yellowish tint; *Hippopus* often shows a red or purple banding pattern.

Biology:

Giant clams are typical of marine coral reefs where they may dig into the substrate or grow attached. There are reported local efforts in some areas to relocated giant clams to "clam gardens" in shallower waters where their growth and health can be monitored. Though sometimes presented as man-eaters, living specimens could only be harmful if one were to insert a hand or foot into a gaping specimen and become caught as the valves closed. Giant clams reportedly produce golf ball sized pearls on occasion, but they are usually

not considered to be of gem quality.

Commercial Importance:

Giant clams were historically harvested by local peoples for tool material and food. Harvest continues as does private and commercial collection for sale in the seashell trade.

Reasons For Restriction:

Long life expectancies and slow growth in conjunction with over harvest, pollution, and general environmental modification of habitat have collectively served to reduce numbers of giant clams throughout their range.

Similar Species:

Some of the larger and more-heavily ribbed cockles (family Cardiidae) and scallops (family Pectinidae) are vaguely similar to some giant clams, but none grow as large, have the byssal gape along the hinge, or have unusually thick and heavy shells; they may also lack the lateral teeth present in giant clams.

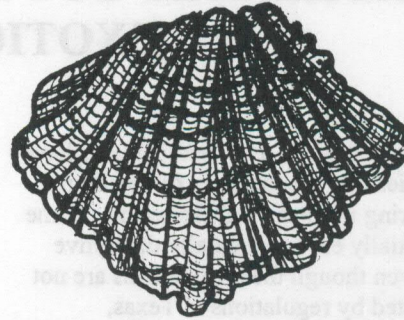
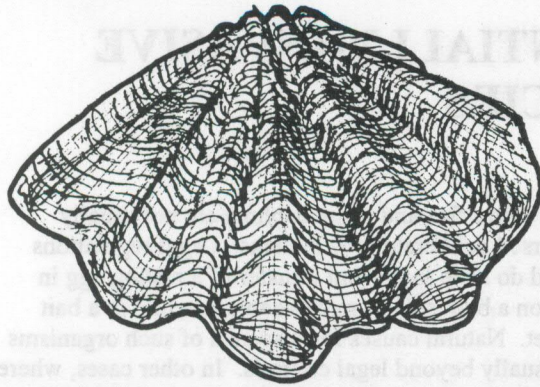
Technical Note:

Several species of giant clams are still regularly sold in the seashell and curio trade. Some were harvested and imported before regulations were put in place. However, imported shells lacking the appropriate paperwork or those arriving through inappropriate ports of entry may be seized by federal authorities.

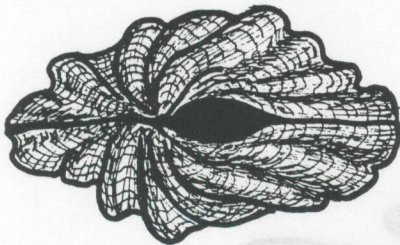
References:

Abbott 1962; Dance 1976, 1992.

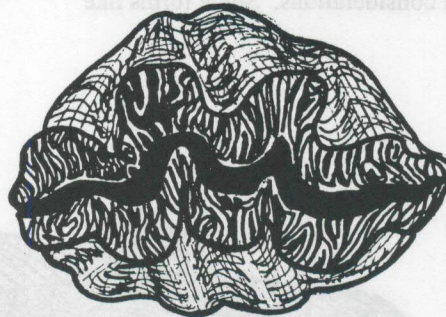
Bear Paw Giant Clam
Tridacna gigas



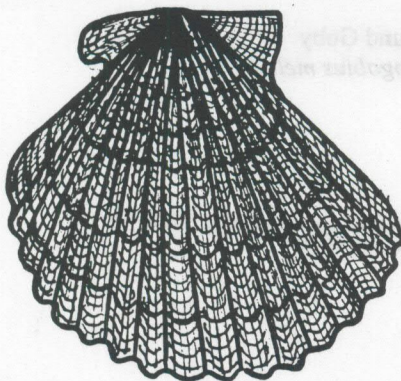
Bear Paw Giant Clam
Hippopus hippopus



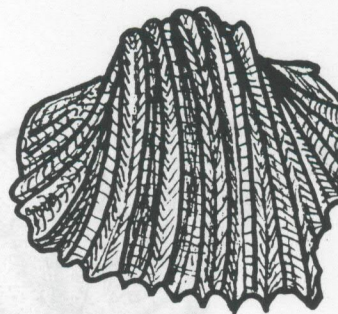
Giant Clam with byssal
gape at hinge line



Giant Clam - living
specimen with mantle



Giant Scallop
Pecten sp.



Ridged Cockle
Cardium costatum

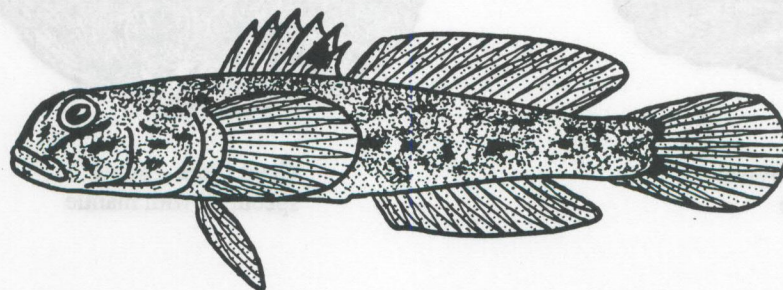
APPENDIX VI

UNPROHIBITED BUT POTENTIALLY-INVASIVE EXOTIC SPECIES

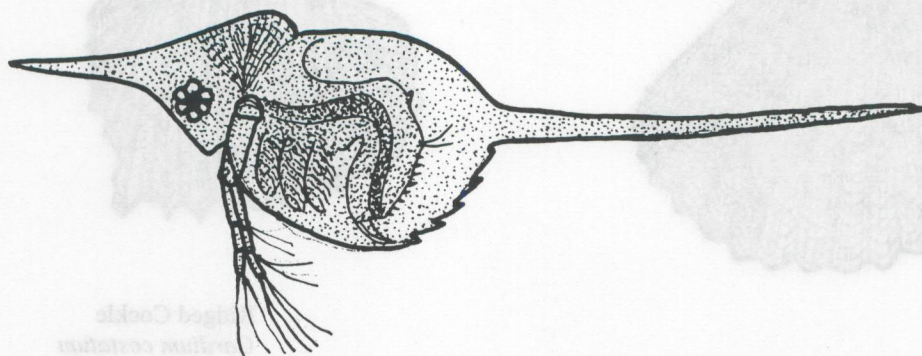
A variety of fishes, shellfishes, and aquatic plants have increased possibilities and probabilities of becoming invasive and appearing in Texas and elsewhere. Some such taxa are potentially environmentally disruptive and destructive. Even though these organisms are not specifically prohibited by regulations in Texas, descriptions are provided herein to assist with recognition when and if they appear in the state.

Current lack of regulations covering these species reflects a number of considerations. Some forms like

spiny water flea and spiny daphnia are not usually dispersed deliberately by humans. Legal regulations would do little to prevent transfer of a resting egg in mud on a boot sole or microscopic juvenile in a bait bucket. Natural causes for dispersal of such organisms are usually beyond legal controls. In other cases, where a species is already present in the state or is the subject of commercial trade, drafting prohibitive regulations after the fact becomes much more problematic and such restrictions are often of limited value.



Round Goby
Neogobius melanostoma

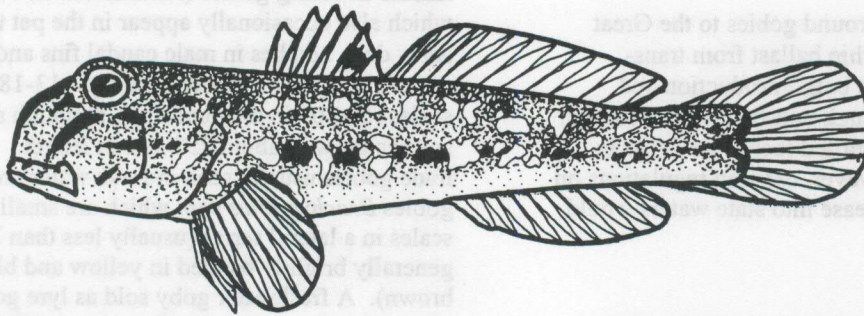


Spiny Daphnia
Daphnia lumholtzi

ROUND GOBY

Family: **Gobiidae**

Neogobius melanostoma



Round Goby
Neogobius melanostoma

Other Names:

Black goby, Black Sea round goby, Caspian round goby. Locally, strongil, Bytschok-krugleak, and Kumkaya baligi.

Specifics:

Also known as *Gobius (Apollonia) melanostomus*. Gobiidae is the largest family of marine fishes; it also includes estuarine and freshwater representatives and collectively covers about 170 genera. Most species are small and secretive.

Range:

Round goby is native to the Black and Caspian seas and the Sea of Azov where it ascends rivers and occupies shorezone areas. In North America, this species was first found in the St. Clair River in 1990. It has since increased in abundance and distribution throughout the Great Lakes. It will probably spread well beyond the Great Lakes drainage basin in time.

Description:

Round gobies have very typical goby morphology (like several hundred other species). Bodies are "torpedo-shaped" with large pectoral fins and pelvic fins fused to form a suction-cup-like disk. Like most gobies, spiny and soft dorsal fins are separate or only slightly connected with relatively soft spines (note: some sources report incorrectly that gobies lack spines). The spiny dorsal has VI spines and the soft dorsal has I spine and 14-16 rays (rarely 11-17 rays). The anal fin count is I, (10) 12-13. The caudal fin is relatively rounded on the posterior margin and pelvic fins reach back nearly to the vent. There are usually 47-54 (45-58) scales in a lateral series, with scales present on the

nape, back, throat, abdomen, pectoral peduncles, and the upper quarter of the gill covers. The head is as wide or wider than deep. Adults reach ca 10 inches (250 mm) in length (much larger than most other gobies). Young are solid, slate gray in color. Adults are gray-brown and blotched in black and brown. Spawning males may become nearly black. The spiny dorsal has a black spot (usually about the fifth spine) and fins may be tinged in green.

Biology:

They are aggressive and pugnacious. They defend spawning sites in rocky areas, logs, cans; guard incubating eggs; and spawn over an extended period of time in summer. Round gobies are reported to burrow in gravel as well. They have been known to consume other fishes and their eggs; a well-developed sensory system allows round gobies to feed in complete darkness. They also consume mollusks, including zebra mussels (*Dreissena* spp.). The species tolerates degraded water quality and brackish waters; they may migrate to deeper waters to overwinter (to at least 197 feet; 60 m). They are capable of rapid dispersal and have been reported to reach densities of over 20 per square meter.

Commercial Importance: Although taken commercially for human consumption in its native waters, commercial importance in North America is indirect through impacts on more desirable species and aquatic ecosystems. Though round gobies are known to be eaten by a variety of predatory sport fishes in U.S. waters, gobies may negatively impact other fishes by consuming their eggs and young, competing for food and spawning areas, and consuming forage species

required by other fishes. Round gobies aggressively take baited hooks and can actually interfere with sport angling for other species. On the positive side, round gobies do consume zebra mussels and may prove helpful in control of these extremely undesirable mussels.

Legal Restrictions:

The initial introduction of round gobies to the Great Lakes likely occurred via ship ballast from trans-Atlantic shipping. Because both introduction and dispersal has occurred through non-deliberate vehicles, no regulations have been drafted locally in Texas to restrict round gobies. However, existing regulations on deliberate or accidental release into state waters would include this species.

Similar Species:

Within the Great Lakes, there were no native gobies. Aside from round goby, another exotic goby, tubenose goby (*Proterorhinus marmoratus*), has also become established. Tubenose goby, which is rare in its native waters, has remained uncommon thus far in North America. It differs from round goby in having tubular nostrils and larger scales (36-48 in a lateral row). Also within the Great Lakes, sculpins (*Cottus* and *Myoxocephalus*) might be confused with round goby; however, pectoral fins are never fused in sculpins to form a suction disk as in gobies.

Elsewhere in the U.S., most gobies are marine or estuarine, but a number of species occasionally enter fresh water. Additionally, a number of goby genera appear regularly in the pet trade in both fresh- and saltwater tanks, two other exotic gobies have been introduced on the West Coast, and some occasionally are sold as live bait in California. River goby *Awaous tajasica*, a rare native species, has fewer dorsal rays (10) and more scales (61-69 in a lateral row), but can grow even larger than round goby (to 12 inches; 280 mm). A number of native genera and their various species have pointed caudal fins (not rounded as in round goby); these include: green goby *Microgobius thalassinus* and clown goby *M. gulosus*; darter goby *Gobionellus boleosoma*, sharptail goby *G. hastatus*, and freshwater goby *G. shufeldti*; ragged goby *Bollmannia communis*; lyre goby *Evorthodus lyricus*; and blue goby *Loglossus calliurus* and other members of these genera. Frillfin goby *Bathygobius soporator* has fewer dorsal rays (10), fewer anal rays (9), and fewer scales (42 in a lateral series). Members of the genus *Gobiosoma* such as naked goby *G. bosci* and neon goby *G. oceanops* generally lack scales completely or have scales only at the upper and lower base of the caudal fin. Sponge goby *Evermannichthys spongicola* (and related forms) have extremely elongate bodies.

Citron goby *Gobiodon citrinus* and its relatives appear in the pet trade; imported species usually have distinctive coloration (yellow, red, black) and are much deeper bodied. Two California gobies which occasionally appear in the pet trade, blueband goby *Lythrypnus dalli* and zebra goby *L. zebra* are small and boldly patterned in bright red-orange and blue. Some marine hovering gobies (*Nemateleotris*, *Ptereleotris*) which also occasionally appear in the pet trade may show deep notches in male caudal fins and far more dorsal rays (13-18), more anal rays (13-18) and more scales (68-105 in a lateral row), although several species grow to about 250 mm in length. Among pet trade gobies usually seen in fresh water are bumble gobies *Brachygobius* spp. which are small, with fewer scales in a lateral series (usually less than 30), and generally brightly banded in yellow and black (or brown). A freshwater goby sold as lyre goby *Gobius lyricus* has few scales in a lateral row (27-29) and 2-3 elongated spines. A number of marine and estuarine mudskippers occasionally appear in the pet trade; among these members of the genus *Periophthalmus* usually have far more dorsal spines (typically IX to XVII) and members of the genera *Boleophthalmus* and *Scartelaos* have much more elongate bodies. Mudskippers also generally have dorsally-placed bulging eyes which are distinctive as well.

A goby from California, including the Salton Sea, called longjaw mudsucker *Gillichthys mirabilis* may reach 8 inches in length and is sold as a live bait species locally. Dorsal and anal counts are IV-VII+I-III, 9-14 and I-III, 8-14, respectively. Longjaw mudsucker has a very elongate jaw (lip) which extends posteriorly well beyond the eye. Yellowfin goby *Acanthogobius flavimanus* introduced into California from Japan has a distinctly pointed caudal fin. Another small, exotic from the Orient established in Los Angeles Harbor and San Francisco Bay, California, chameleon goby *Tridentiger trigonocephalus* has similar dorsal (VI+I, 11-12), anal (I, 10-11), and scale (50-58) counts to round goby, but has a dark bar and adjacent yellow area at the base of the pectoral fins not present in round goby; it also lacks the black blotch present in the spiny dorsal of round goby.

A group of goby-relatives called sleepers (Family Eleotridae; included in Gobiidae by some authorities) are similar to gobies but differ in having pelvic fins which are either connected by only a basal membrane or are not connected at all. Members of this family occur on both the Atlantic and Pacific coasts and appear in the pet trade in marine and estuarine situations, with some freshwater or freshwater-tolerant species. Another family of goby-like fishes called dragonets (Family Callionymidae) includes marine species from the western Atlantic and several Indo-

Pacific species which are regularly imported for sale in the pet trade. All generally have distinctive coloration and fin development which readily distinguish them from true gobies.

Technical Notes:

(1) Tubenose goby *Proterorhinus marmoratus* is native to the Black and Caspian seas. It first appeared in the St. Clair River in 1990, but has remained uncommon in North American waters. Dorsal counts include VI (VII)+I(14)15-17 and anal counts are I(II), (11)12-15(16). Its head is deeper than wide, scale rows between the origin of the second dorsal fin and origin of the anal fin are 15-17, and length reaches 115 mm TL. Coloration is brownish-gray or yellowish-gray, with several dark bars along the sides of the body, a dark spot with a white streak under each eye, and a triangular dark spot at the base of the caudal fin with a white spot on either side. Its most distinguishing trait

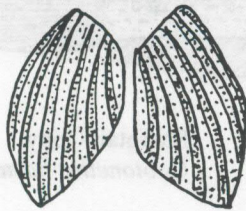
are the barbel-shaped tubular nostrils which overhang the upper lip.

(2) A wide array of goby genera and species occur in eastern Europe and Eurasia. Some of these taxa might also represent introduction risks in North America just as round and tubenose gobies. References including Berg (1949b) and Blanc et al. (1971) contain descriptions and illustrations of other Old World gobies which may be helpful if other species are encountered in U.S. waters.

References:

Berg 1949b; Blanc et al. 1971; Marsden and Jude 1995. Additionally, other related information can be found in Aquatic Nuisance Species Information and Education Materials Relevant to the Great Lakes Basin prepared in 1997 by the Great Lakes Panel on Aquatic Nuisance Species of the Great Lakes Commission, Ann Arbor, Michigan.

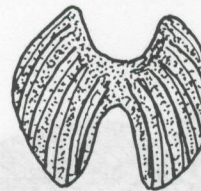
TYPES OF PELVIC FINS IN GOBIES AND SLEEPERS



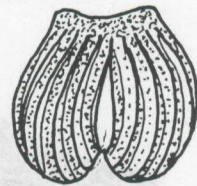
Pelvic Fins
Not Fused



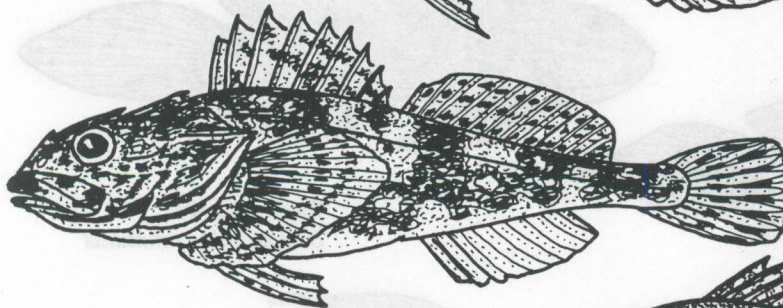
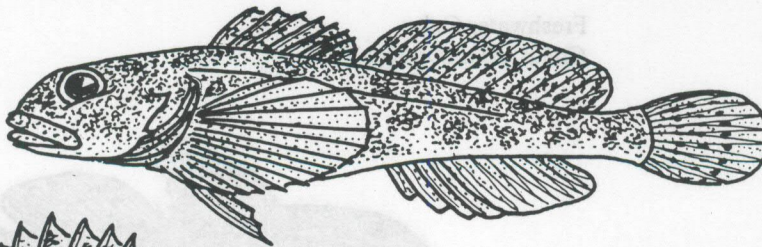
Pelvic Fins
Fused



Pelvic Fins
Partially Fused

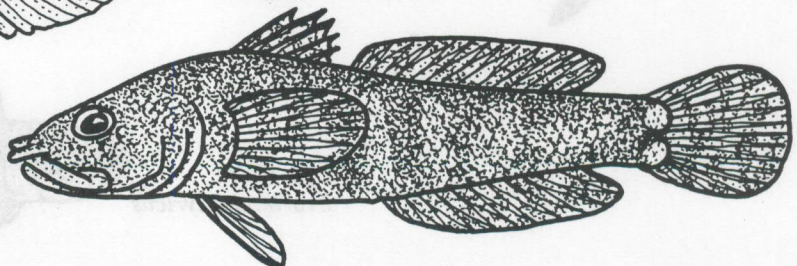


Mottled Sculpin
Cottus bairdi

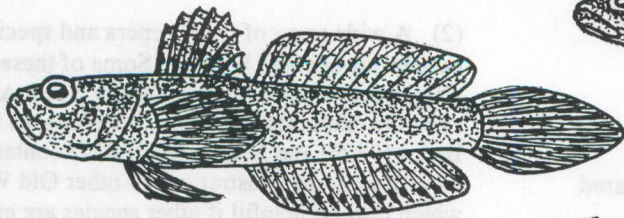


Tubenose Goby
Proterorhinus marmoratus

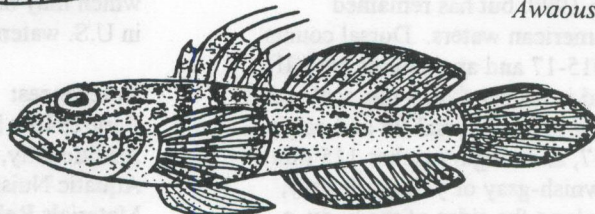
Grubby Sculpin
Myoxocephalus aeneus



Green Goby
Microgobius thalassinus



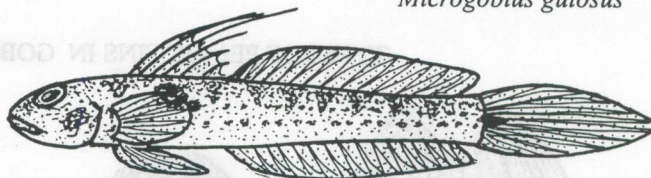
River Goby
Awaous tajasica



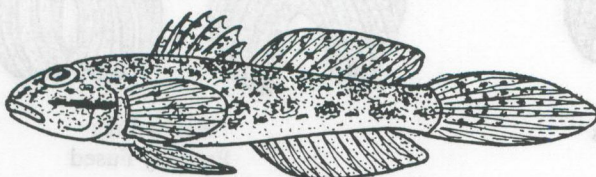
Clown Goby
Microgobius gulosus



Darter Goby
Gobionellus boleosoma

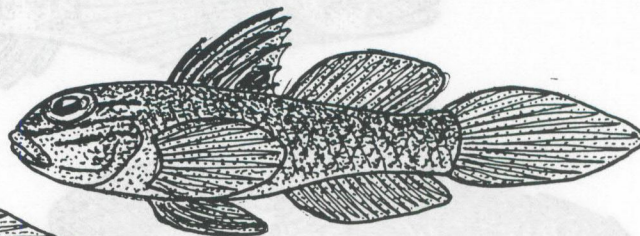
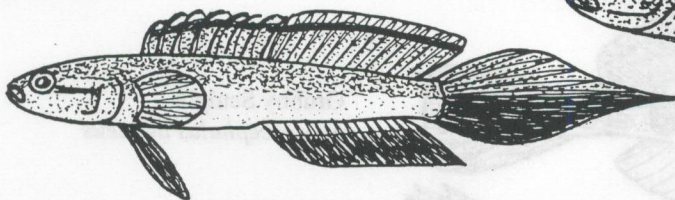


Sharptail Goby
Gobionellus hastatus



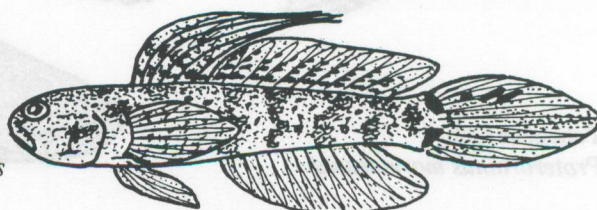
Freshwater Goby
Gobionellus shufeldti

Blue Goby
Loglossus calliurus

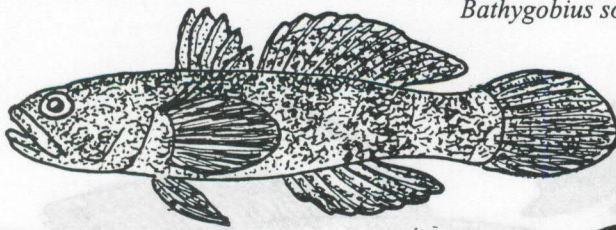


Ragged Goby
Bollmannia communis

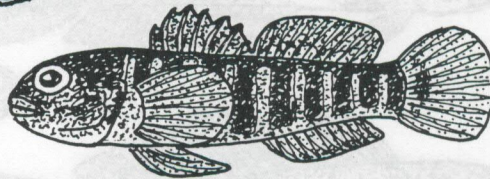
Lyre Goby
Evorthodus lyricus



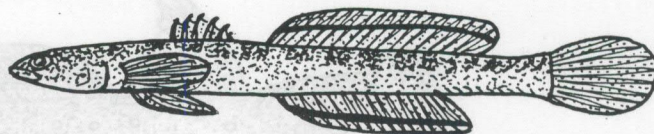
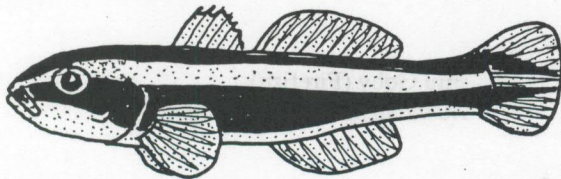
Frillfin Goby
Bathygobius soporator



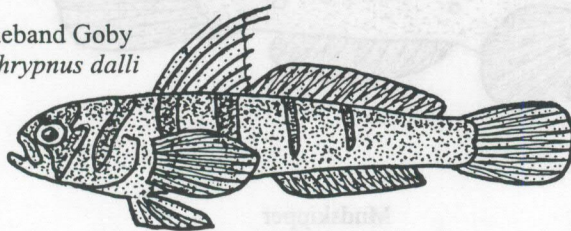
Naked Goby
Gobiosoma bosci



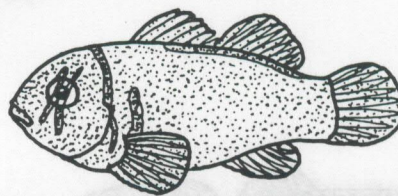
Neon Goby
Gobiosoma oceanops



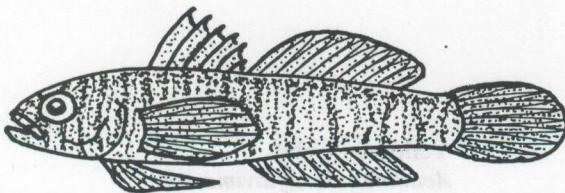
Blueband Goby
Lythrypnus dalli



Sponge Goby
Evermannichthys spongicola

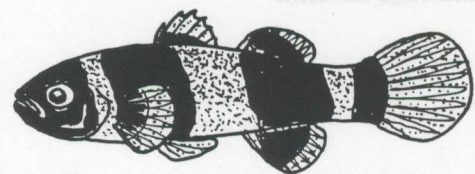
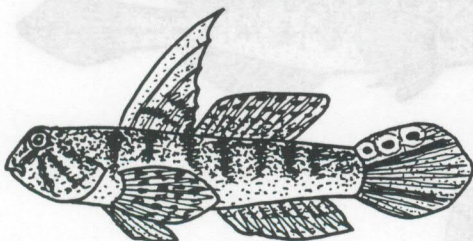


Citron Goby
Gobiodon citrinus



Zebra Goby
Lythrypnus zebra

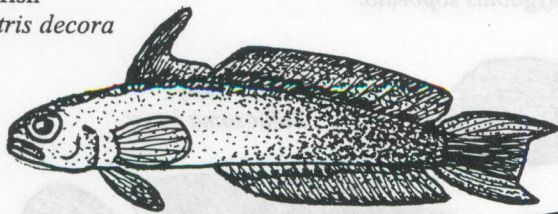
Lyre Goby
Gobius lyricus



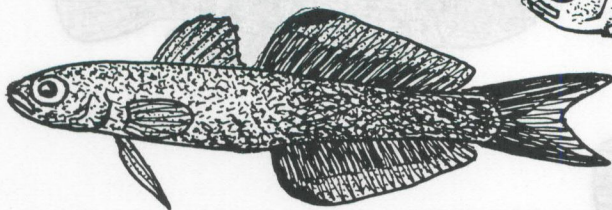
Bumblebee Gobies
Brachygobius spp.



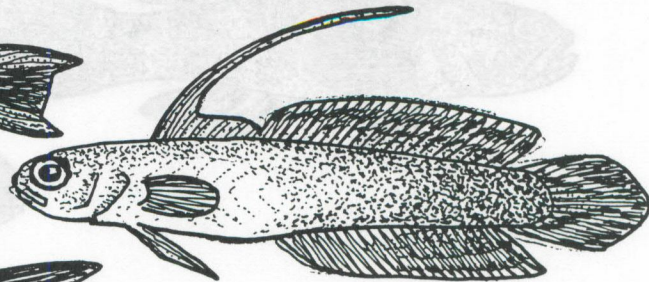
Violet Firefish
Nemateleotris decora



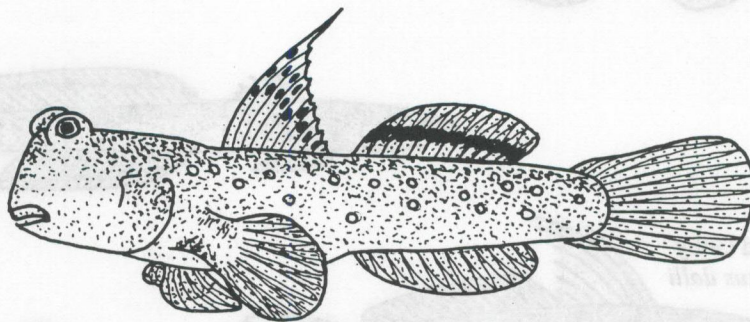
Hovering Gobies



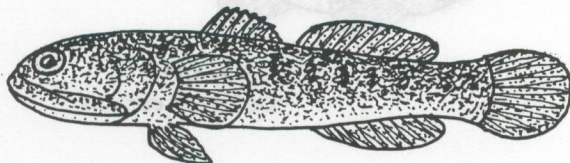
Tricolor Firefish
Ptereleotris tricolor



Fire Goby (Firefish)
Nemateleotris splendidatum

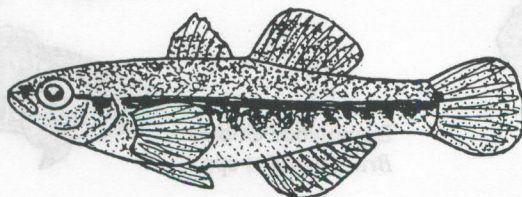
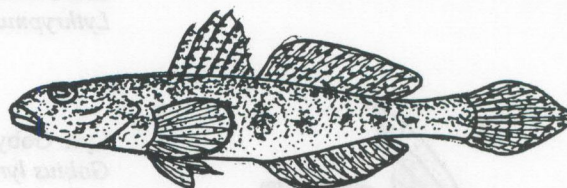


Mudskipper
Periophthalmus sp.



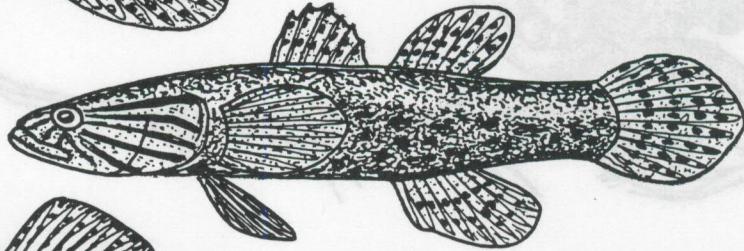
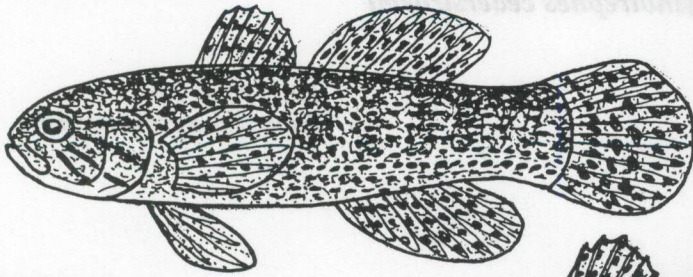
Longjaw Mudsucker
Gillichthys mirabilis

Yellowfin Goby
Acanthogobius flavimanus

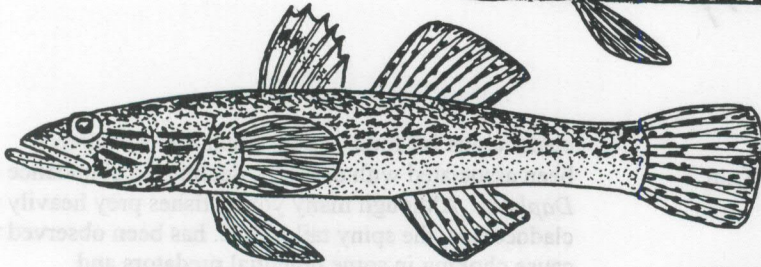


Chameleon Sleeper
Hypseleotris cyprinoides

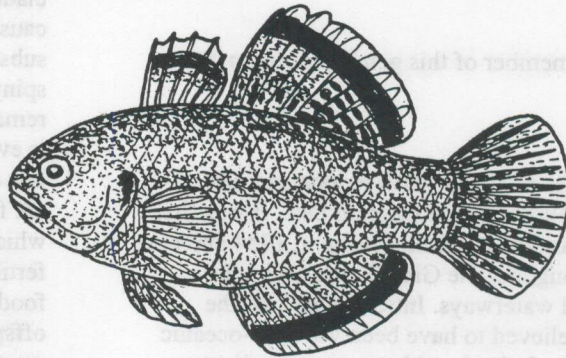
Pacific Fat Sleeper
Dormitator latifrons



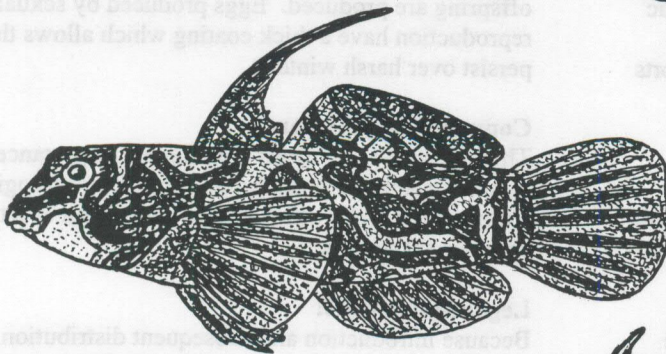
Spinycheek Sleeper
Eleotris pisonis



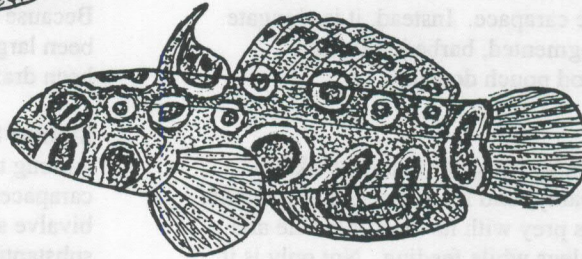
Bigmouth Sleeper
Gobiomorus dormitor



Empire Sleeper
Hypseleotris compressa



Mandarin Dragonet
Synchiropus splendidus

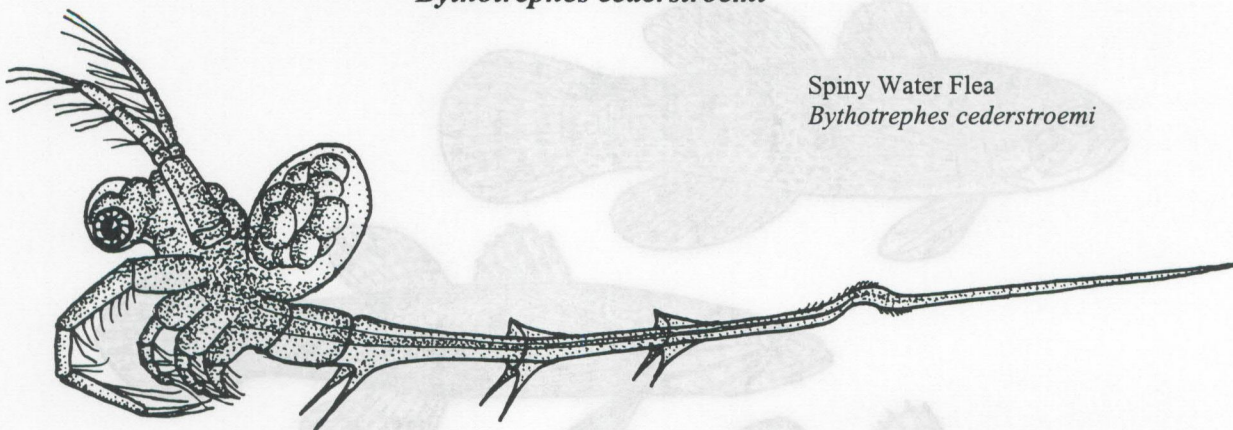


Green Dragonet
Synchiropus picturatus

SPINY WATER FLEA

Order: Cladocera

Bythotrephes cederstroemi



Spiny Water Flea
Bythotrephes cederstroemi

Other Names:

Also called simply "Bythotrephes" or "B.C." Do not confuse with spiny daphnia *Daphnia lumholtzi*.

Specifics:

This is the only member of this genus present in North America.

Range:

Spiny water flea is native to Great Britain and east across northern Europe to the Caspian Sea. It was first found in North America in Lake Huron in 1984 and has since spread throughout the Great Lakes and other associated inland waterways. Introduction into the Great Lakes is believed to have been via trans-oceanic ship ballast water. Indeed, evidence suggests it was introduced from eastern Baltic ports on grain transports which carry grain to St. Petersburg, but return west empty (thus requiring ballast water).

Description:

Spiny water flea adults are nearly half an inch in length (0.375 inches; 9.5 mm); thus, far larger than most other water fleas or cladocera. Unlike all but a few other cladocera, spiny water flea does not have a body encased in a bivalve carapace. Instead, it is elongate with a very long, segmented, barbed tail spine. Females have a brood pouch dorsally.

Biology:

Like other cladocera, spiny water flea is planktonic (floats or swims weakly) and feeds on other planktonic organisms. It seizes prey with its long antennae and holds them with its legs while feeding. Not only is it able to catch and kill other water fleas like *Daphnia*, but it competes with many other ecologically-important

cladocerans for food. Spiny water flea has already been associated with dramatic declines in abundance in *Daphnia*. Although many young fishes prey heavily on cladocerans, the spiny tail in B.C. has been observed to cause choking in some potential predators and subsequent avoidance behavior. The ultimate impact of spiny water flea on North American aquatic ecosystems remains to be seen, but its potential to alter food webs is evident. Spiny water flea is active from late spring to late autumn. Throughout warmer months, most adults are females, with life spans of a few days or weeks, which produce only female offspring (no egg fertilization is required). If water temperatures and food availability decrease, both male and female offspring are produced. Eggs produced by sexual reproduction have a thick coating which allows them to persist over harsh winters.

Commercial Importance:

This species has no direct commercial importance, but may ultimately have profound impacts by ecologically altering food webs which support important sport and commercial species.

Legal Restrictions:

Because introduction and subsequent distribution has been largely unintentional, no local restrictions have been drafted which directly list spiny water flea.

Similar Species:

Among native North American cladocerans, all have carapaces which encase their bodies almost like a bivalve shell, except two species, and all but one are substantially smaller than spiny water flea. Among these *Leptodora kindtii* is most similar to spiny water flea. It reaches a similar size and some females may

grow to nearly twice as large (to ca. 0.71 inch/18 mm in length). *Leptodora* has longer antennae, has a long but soft and spineless abdomen, and males have two, long filamentous appendages on the head. *Leptodora* has a very long intestine with the stomach actually situated in the last abdominal segment (sometimes apparent when filled with food). A second species, *Polyphemus pediculus*, from U.S. waters is smaller (to 0.06 inch/1.5 mm long) and much less elongate.

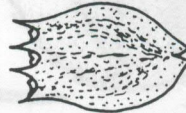
Technical Note:

Rotifers (Rotifera) include many species which are important prey items for larval fishes and other planktonic predators. Among these, one native species *Kellicottia longispina* has also been observed to cause choking problems in small fishes similar to those caused by spiny water flea; other rotifers like *Polyarthra* and *Brachionus* are usually not problematic.

References:

A number of sources covering spiny water flea are available on the Worldwide Web including: Fishing News, Ohio State University Fact Sheet, Ohio Sea Grant College Program, University of Minnesota Sea Grant Program, The Great Lakes Information Network, and many others. References covering native cladocerans include Balcer et al. 1984; Pennak 1953; Ward and Whipple 1959; and others.

Brachionus sp.

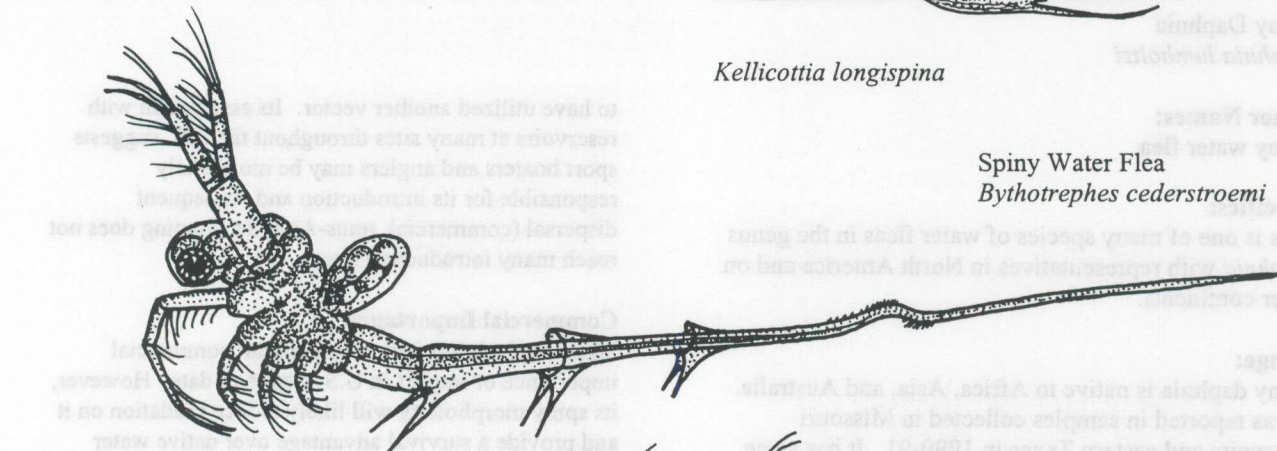


Polyarthra sp.

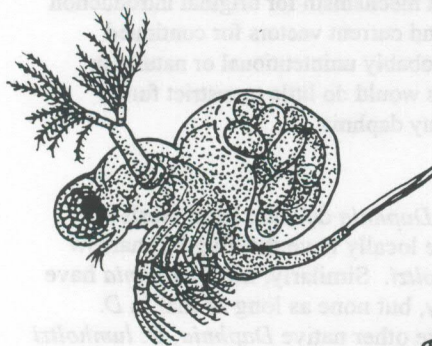
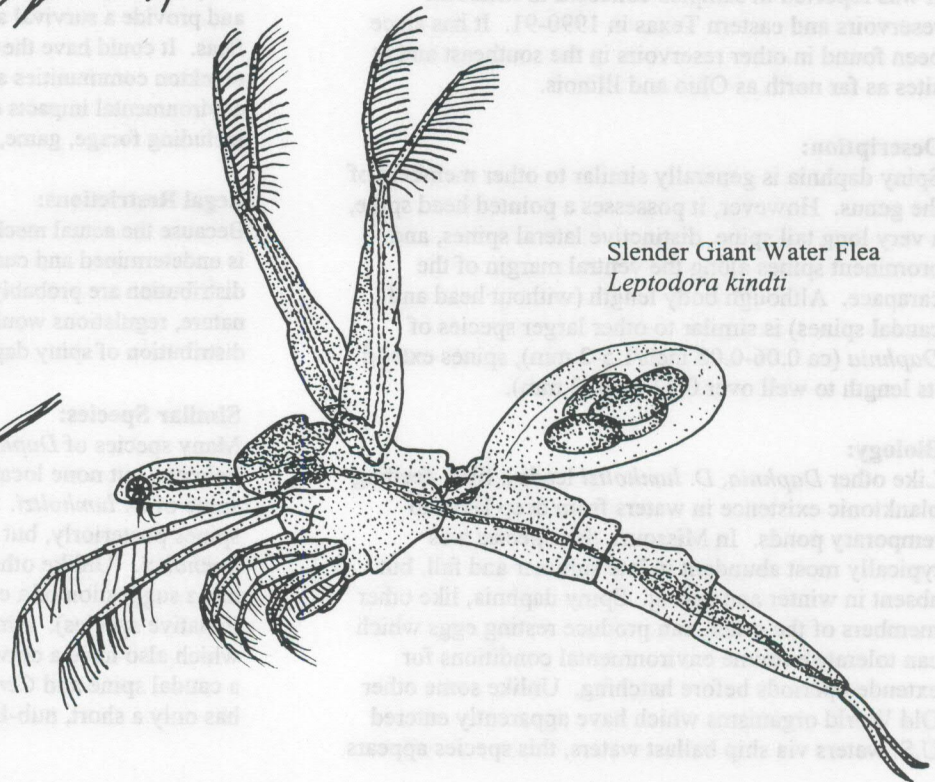


Kellicottia longispina

Spiny Water Flea
Bythotrephes cederstroemi



Slender Giant Water Flea
Leptodora kindtii

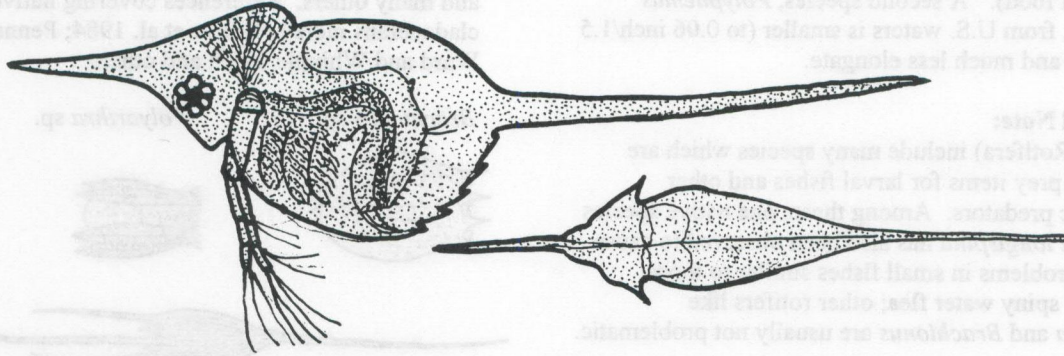


Polyphemus Water Flea
Polyphemus pediculus

SPINY DAPHNIA

Order: Cladocera

Daphnia lumholtzi



Spiny Daphnia
Daphnia lumholtzi

Other Names:

Spiny water flea.

Specifics:

This is one of many species of water fleas in the genus *Daphnia* with representatives in North America and on other continents.

Range:

Spiny daphnia is native to Africa, Asia, and Australia. It was reported in samples collected in Missouri reservoirs and eastern Texas in 1990-91. It has since been found in other reservoirs in the southeast and at sites as far north as Ohio and Illinois.

Description:

Spiny daphnia is generally similar to other members of the genus. However, it possesses a pointed head spine, a very long tail spine, distinctive lateral spines, and prominent spines along the ventral margin of the carapace. Although body length (without head and caudal spines) is similar to other larger species of *Daphnia* (ca 0.06-0.08 inch/1.5-2 mm), spines extend its length to well over 0.12 inch (3 mm).

Biology:

Like other *Daphnia*, *D. lumholtzi* leads a filter-feeding planktonic existence in waters from deep lakes to temporary ponds. In Missouri, this species was typically most abundant in late summer and fall, but absent in winter and spring. Spiny daphnia, like other members of the order, can produce resting eggs which can tolerate extreme environmental conditions for extended periods before hatching. Unlike some other Old World organisms which have apparently entered U.S. waters via ship ballast waters, this species appears

to have utilized another vector. Its association with reservoirs at many sites throughout the U.S. suggests sport boaters and anglers may be more likely responsible for its introduction and subsequent dispersal (commercial, trans-Atlantic shipping does not reach many introduction sites).

Commercial Importance:

Spiny daphnia has had no significant commercial importance or impact in U.S. waters to date. However, its spiny morphology will likely reduce predation on it and provide a survival advantage over native water fleas. It could have the potential to dramatically change plankton communities and subsequently have major environmental impacts on upper trophic levels including forage, game, and commercial fishes.

Legal Restrictions:

Because the actual mechanism for original introduction is undetermined and current vectors for continued distribution are probably unintentional or natural in nature, regulations would do little to restrict future distribution of spiny daphnia.

Similar Species:

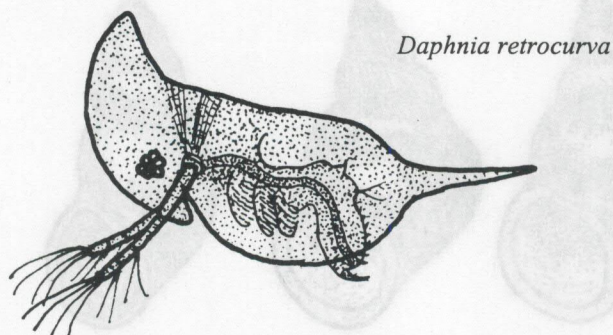
Many species of *Daphnia* develop head crests or helmets, but none locally have the long but narrow spine of *D. lumholtzi*. Similarly, most *Daphnia* have spines posteriorly, but none as long as that in *D. lumholtzi*. Unlike other native *Daphnia*, *D. lumholtzi* has a suggestion of a cervical groove (typically absent in native species). Among other native cladocerans which also have a cervical groove, *Simocephalus* lacks a caudal spine and *Ceriodaphnia* lacks a rostrum and has only a short, nub-like caudal spine.

Technical Note:

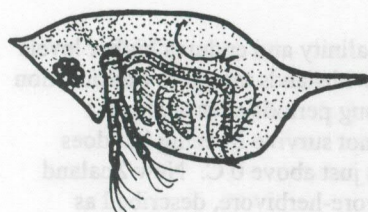
Recent (March 1998) plankton samples in Lake Alice, a small impoundment near Corpus Christi, Texas, found this daphnia to be the only species of cladoceran represented in the plankton community.

References:

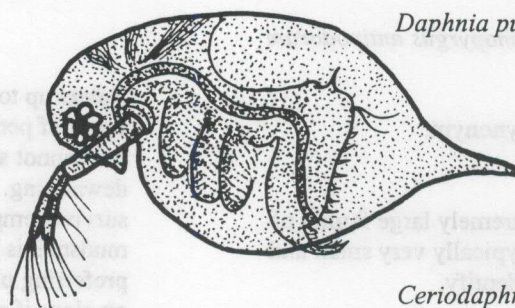
Havel et al. 1995; Kolar et al. 1997; Sorensen and Sterner 1992; Stoeckel et al. 1996.



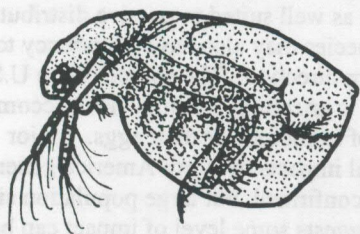
Daphnia retrocurva



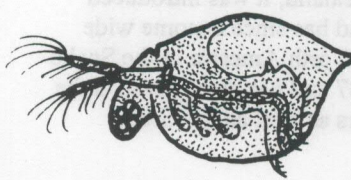
Daphnia dubia



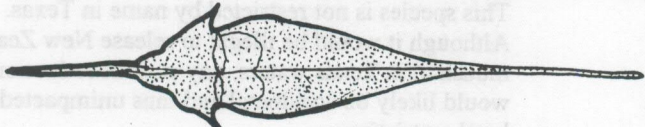
Daphnia pulex



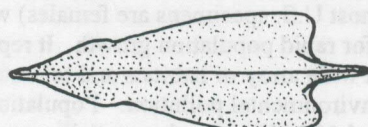
Ceriodaphnia sp.



Simocephalus sp.



Dorsal View
Daphnia lumholtzi

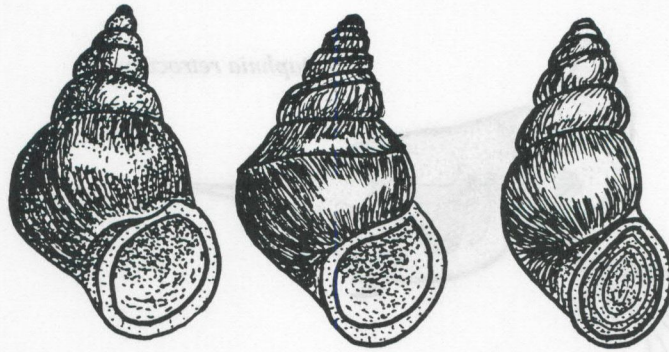


Dorsal View
Native *Daphnia*

NEW ZEALAND MUDSNAIL

Family Hydrobiidae

Potamopyrgus antipodarum



New Zealand Mudsnail *Potamopyrgus antipodarum*

Other Names:

Potamopyrgus jenkinsi is a synonym.

Specifics:

This is one member of an extremely large family of freshwater snails which are typically very small and often extremely difficult to identify.

Range:

Originally native to New Zealand, it was introduced into Europe in the 1800s and has since become wide spread. It first appeared in North America in the Snake River system, Idaho, in 1987 and has since invaded the Madison and Missouri rivers as well as the Great Lakes.

Description:

This is a small snail which may reach 0.47 inch (12 mm) in shell length but rarely exceeds 0.20 inch (5 mm). It is dextral, has 7-8 whorls, solid (but not thick), with a broadly elliptical aperture with an operculum, concave columella, and outer and basal lips thickened internally; it usually has 7-8 whorls with the first whorl minute and raised, and the other whorls well rounded.

Biology:

New Zealand mudsnail is a live-bearing parthenogenic species (most U.S. specimens are females) with potential for rapid population growth. It reportedly tolerates a wide array of habitats and tolerates some level of environmental pollution. Population levels may exceed 100,000/m² and essentially completely cover the substrate. Appears to prefer moderate currents and solid substrates, including marginal grasses, and avoids main channel areas and substrates of silt or soft mud. It reportedly tolerates brackish

waters up to 26 ppt salinity and endures higher levels for brief periods. It withstands temporary desiccation but cannot survive long periods of drought and dewatering. It does not survive freezing but does survive temperatures just above 0 C. New Zealand mudsnail is a detritivore-herbivore, described as preferring plant and animal detritus, but able to graze on algae if necessary. This snail may be able to survive passage through fish digestive tracts and it has been characterized as well suited to passive distribution by birds. The species may also have a tendency to crawl in an upstream direction. The source of the U.S. introductions is uncertain, but may have accompanied importation of salmonids or their eggs. Major environmental impacts in North America generally remain to be confirmed, but large population size at some sites suggests some level of impact can be expected.

Commercial Importance:

There is no direct commercial importance attached to this species; however, if high-density populations do produce negative environmental effects which ultimately impact other species like salmonids, indirect economic importance could be significant.

Legal Restriction:

This species is not restricted by name in Texas. Although it would be illegal to release New Zealand mudsnail in Texas waters, any such introductions would likely be accidental and thus unimpacted by legal restrictions.

Similar Species:

New Zealand mudsnail has been reported to differ from native hydrobiids by (1) having an attenuate, concave

spire and (2) small protruding apical whirl, traits unique to this species in North America.

Among some of the morphologically similar gastropods locally which may be confused with New Zealand mudsnail are members of the families Hydrobiidae, Pleuroceridae, and Lymnaeidae.

Hydrobiidae: This group of spring snails contains species in Texas and elsewhere which could be easily confused with New Zealand mudsnails. In general, they have gills and opercula, head and foot not divided by a groove, eyes at the bases of tentacles but not on swellings, and are usually small in size (less than 0.2 inches; 5 mm). Some local species include:

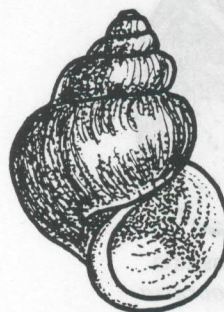
- Spiny crownsnail *Pyrgophorus spinosus* from the Guadalupe and Comal rivers in Central Texas has 5 whorls, is greater than 0.12 inch (3 mm), and has the shell sculptured with striae and often has ridges with developed spines. Other members of the genus elsewhere have shallower sutures and a first whorl which is rounded.
- Devil tryonia *Tryonia diaboli* from the Devils River and San Felipe Creek, Val Verde County, Texas, 4-5 whorls, less than 0.06 inch (1.5 mm), a small but distinct umbilicus, top of shell not truncated, and males with single-ducted verges (copulatory organ) with accessory lobes.
- Phantom tryonia *T. chaetumi* from Phantom Lake, Reeves County, Texas, 5 whorls, greater than 0.12 inch (3 mm).



Phantom Tryonia
Tryonia chaetumi



Devil Tryonia
Tryonia diaboli



Texas Slitsnail
Cincinnatia cincinnatiensis



Comal Slitsnail
Cincinnatia comalensis

- Comal slitsnails *Cincinnatia cincinnatiensis* and *C. comalensis* and other member of the genus occur in Texas and elsewhere; usually less than 0.20 inch (5 mm); shells usually subglobose, ovate, or conical; penises small, slender, and conical; verge with elaborate patterns.

- Other Texas hydrobiids include (1) spiral pebble snail *Cochliopina riograndensis* with a very low spire, (2) fluted mudsnail *Phreatodrobia/Hortia/Hauffenia micra* coiled in a ramshorn shape; and (3) a straight-shelled spring snail *Orygoceras* spp. which is essentially uncoiled.

Pleuroceridae: Generally only two of the elimias might be considered similar.

- Comal slitsnail *Elimia comalensis fontinalis* and Balcones elimia *E. comalensis comalensis* have gills and an operculum but are larger, greater than 0.59 inch (15 mm); one is more slender and the other more inflated. Their distributions are restricted to the Comal and Guadalupe rivers.

Lymnaeidae:

- Golden fossaria *Fossaria obrussa* and Cockerell's fossaria *F. cockerelli* are among the members of this family most similar to New Zealand mudsnail but both lack gills and opercula which are present in the exotic species.

References:

Bowler 1991, 1992; Frest and Bowler 1993; Bowler and Olmstead 1991; Burch 1989; Zaranko et al. 1997.



Balcones Elimia
Elimia comalensis



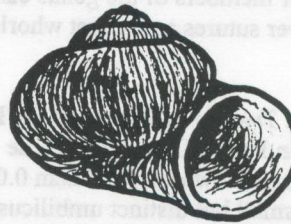
Spiny Crownssnail
Pyrgophorus spinosus



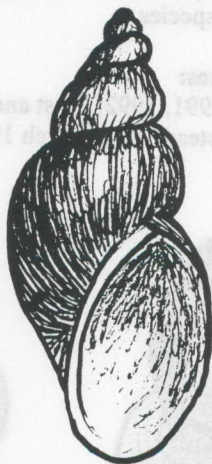
Straight-shelled Spring Snail
Orygoceras sp.



Flattened Mudsnail
Phreatodrobia micra



Spiral Pebblesnail
Cochliopina riograndensis



Golden Fossaria
Fossaria obrussa

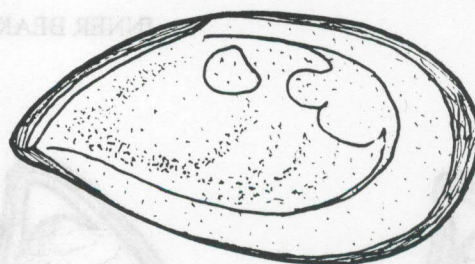
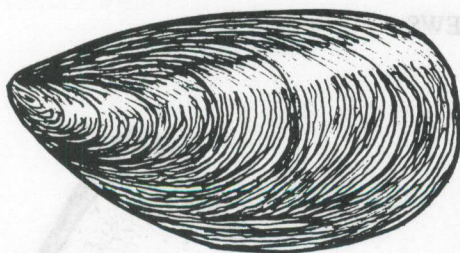


Cockerels Fossaria
Fossaria cockerelli

EDIBLE BROWN MUSSEL

Family: Mytilidae

Perna perna



Edible Brown Mussel
Perna perna

Other Names:

Brown mussel, exotic brown mussel.

Specifics:

Perna is one of a number of genera to true mussels in the family Mytilidae with several species in this genus. It is most similar to the genus *Mytilus* which include native blue mussel *M. edulis*.

Range:

Worldwide records for this species include: the Red Sea, Madagascar, eastern Africa from central Mozambique to South Africa, western Africa north to Gibraltar and into the Mediterranean to the Gulf of Tunis, Brazil, Uruguay, Venezuela, the Straits of Magellan, and the West Indies. It was first detected in Texas on jetties at Port Aransas in February 1990. Within four years it had expanded its range in the northern Gulf of Mexico from Matagorda, Texas, south to Playa Escondida, Veracruz, Mexico.

Description:

Edible brown mussel reaches 6.7 inches (170 mm) in shell length (usually about half that) and has an elongate mytilid mussel shape with a smooth shell and concentric growth lines. Coloration externally is usually brown or dark brown and typically glossy; some may show yellowish-green bands near the ventral margin. It can be distinguished from other members of the genus by the enlarged sensory papillae along the mantle margin. It is reportedly somewhat sexually dimorphic; however, mature males have white gonads and females have orange or red. As with other mytilids, edible brown mussel produces adhesive byssal threads for attachment. Like other members of the genus *Perna*, it is characterized by the anterior position of the pedal retractor muscle and scar, widely separated posterior retractor muscles and scars, and absence of an anterior adductor muscle and scar.

Biology:

Edible brown mussel is a filter feeder which attaches to solid objects like most other members of the family. It has been characterized as a marine counterpart of zebra mussel (*Dreissena* spp.; Family Dreissenidae) with byssally attached adults, veliger stage, high fecundity, and rapid growth rate. Densities in Texas have been reported to 27,000/m². They appear to prefer higher salinity waters but also have some degree of tolerance of hyposalinity conditions. Populations in Texas suffered several year-class failures which, in conjunction with harvest, have dramatically reduced abundance in many areas.

Commercial Importance:

This species is harvested for human consumption in its native waters and harvest by Asian fishermen has been reported in Texas. Major importance of this species relates to ecological consequences of its invasion and potential problems as a marine biofouling organism.

Legal Restrictions:

Because invasion and dispersal locally appears not to have been the result of deliberate human activity, no regulations to restrict its harvest, possession, or use have been drafted to date.

Similar Species:

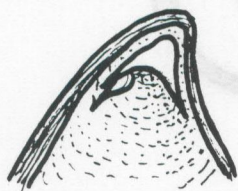
The genus *Perna* is most similar to *Mytilus* but is usually more elongate and without anterior adductor muscle scar impressions on the shell interior (except in smaller juveniles). There are no other members of the genus in Texas or other U.S. waters. Other mytilid mussels in Texas waters are typically more wedge-shaped, much more elongate, or with deep grooves on the shell exterior. New Zealand greenlip mussel *P. (M.) canaliculus* or green mussel *P. viridis* are sometime imported for use in restaurants or otherwise for human consumption, but are clearly bright green in color. Blue mussel *M. edulis* is also often available in

restaurants and food stores but is usually dark blue in color (with traits typical of the genus), but can occasionally be brown or rayed.

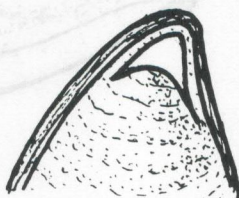
References:

Andrews 1981; Berry 1978; Dance 1976; Hicks and Tunnell 1994.

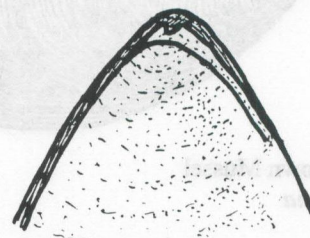
INNER BEAK VIEWS



Dark Falseness
Mytilopsis leucophaeata
with shelf-like structures

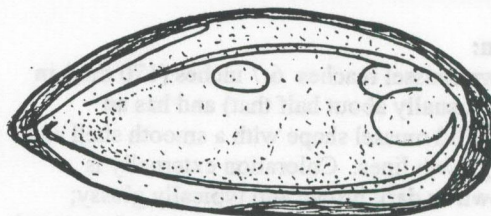
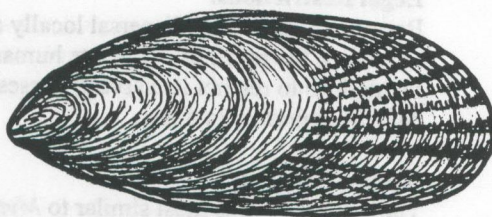
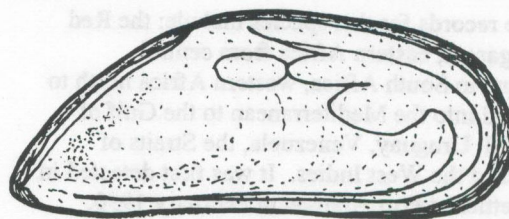
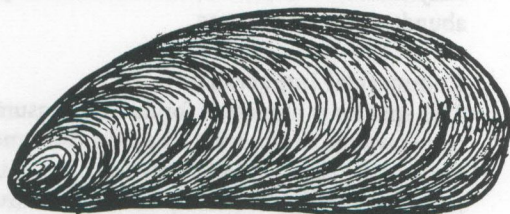


Zebra Mussels
Dreissena spp.
with shelf-like structure



Mytilid Mussels
Perna spp. and *Mytilus* spp.
without shelf-like structures

Blue Mussel *Mytilus edulis*

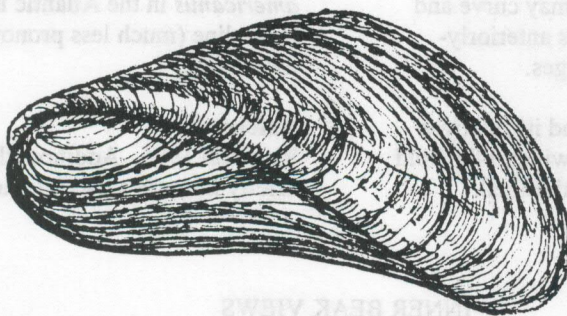


New Zealand Greenlip Mussel
Mytilus/Perna canaliculus

FORTUNE'S MODIOLUS (ASIAN LAKE MUSSEL)

Family: Mytilidae

Limnoperna fortunei



Fortune's Modiolus
Limnoperna fortunei

Other Names:

Previously placed in the genera *Volsella* and *Modiola*.

Specifics:

This is one of several species in the genus including *L. fortunei*, *L. siamensis*, *L. depressa*, and *L. supoli*. However, these reportedly have only minor differences and may prove to be forms of the same species. Note: classification of members of this family has changed dramatically in recent years.

Range:

Southeastern Asia; introduced into Argentina.

Description:

This species is rather small, usually < 1.4 inches (35 mm) shell length; also reported as 2.2 inches (55 mm) shell length, 1.1 inches (27.5 mm) in shell height, and 0.8 inches (20 mm) in shell width. Shell shape is an oblong oval and somewhat triangular, with ridge or keel running diagonally across the shell. Historical literature refers to its surface as concentrically, rugosely striated. The beak is small, slightly elevated, and set back from the most anterior point. The ligament is long and thin. The epidermis is greenish and apparently violet near the beaks and fading to white near the shell margin. Internally coloration has been described as purple above and pearly below.

Biology:

Fortune's modiolus is currently described as primarily a freshwater species which inhabits rivers and lakes throughout southeastern Asia. However, the species tolerates high salinity water and may maintain substantial estuarine populations as well. Original descriptions mention it from the China Sea but do not

report it from freshwater. It is also described as tolerant of somewhat lower calcium levels (less than 10 mg/liter) than those required by zebra mussel *Dreissena polymorpha*. Fortune's modiolus attaches to solid objects with adhesive byssal threads as do zebra mussels. It is a dioecious species which uses external fertilization, and has a free-floating veliger stage. It may reach sexual maturity in its first year and live 2-3 years. Spawning occurs at 16-28 C. The species reportedly tolerates temperatures between 8 and 32 C and may reach densities as great as 80,000/m².

Commercial Importance:

The primary economic importance of this species is indirect by clogging reservoirs, fouling water pipes, or displacing more-desirable native species.

Legal Restrictions:

Neither state or federal regulations specifically prohibit this genus or species by name; however, it would be illegal in Texas to release it into public waters without a permit (a moot point since most introductions are likely to be accidental and unrecognized).

Similar Species:

Fortune's modiolus is most likely to be confused with true mussels (Family Mytilidae) in coastal waters and zebra mussel and its relatives (Family Dreissenidae) in freshwater areas of North America including zebra mussel *Dreissena polymorpha*, quagga mussel *D. bugensis*, and dark falsemussel *Mytilopsis leucophaeata*.

- All members of the zebra mussel family have a small shelf-like structure internally below the beak (hence the name shelf mussels); this structure is not

present in mytilids.

- Blue mussel *Mytilus edulis* and brown mussel *Perna perna* have beaks positioned at the most anterior point on the shell. Beaks in Fortune's modiolus are set back from the anterior-most edge of the shell.

- Hooked mussel *Ishadium recurvum* may curve and appear somewhat triangular, but also has anteriorly-positioned beaks as well as radiating ridges.

- Ribbed mussel *Geukensia dimissa* and its relatives often have rather strong radial ribs, but without the bold ridge or keel running diagonally across the shell.

- Horsemussels *Modiolus* most closely resemble Fortune's modiolus (once in this genus). Most U.S. species in this genus occur in the Pacific Ocean. Even the most curved and elongate forms like fan horsemussel *M. flabellatus* have beaks positioned even farther from the anterior margin than those in Fortune's modiolus. American horsemussel or tulip mussel *M. americanus* in the Atlantic is slightly winged along the hinge line (much less pronounced in Fortune's modiolus).

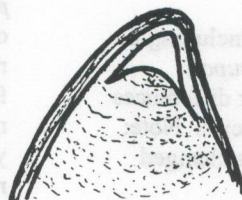
References:

Ricciardi 1996. Additionally, this species is mentioned briefly through some Internet sources.

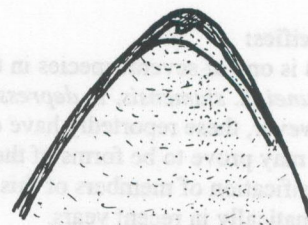
INNER BEAK VIEWS



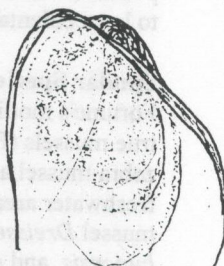
Dark Falseness
Mytilopsis leucophaea
with shelf-like structures
beaks terminal



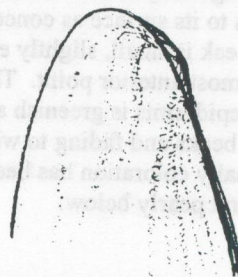
Zebra Mussels
Dreissena spp.
with shelf-like structure
beaks terminal



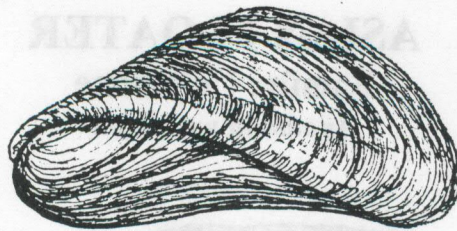
Mytilid Mussels
Perna spp. and *Mytilus* spp.
without shelf-like
structures, beaks terminal



Tulip Mussel
Modiolus americana
no shelf, beaks set back



Ribbed Mussel
Geukensia dimissa
no shelf, beaks set back



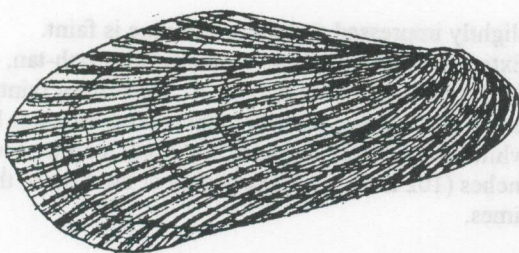
Fortune's Modiolus
Limnoperna fortunei



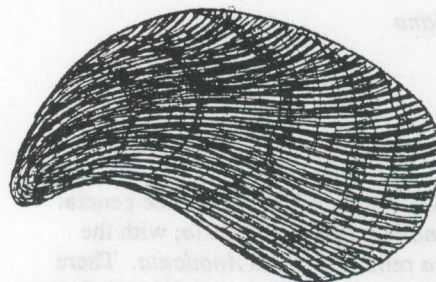
Fan Horsemussel
Modiolus flabellatus



Tulip Mussel
Modiolus americana



Ribbed Mussel
Geukensia dimissa



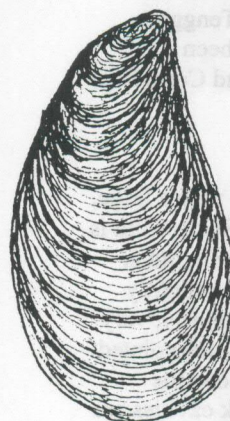
Hooked Mussel
Ishadium recurvum



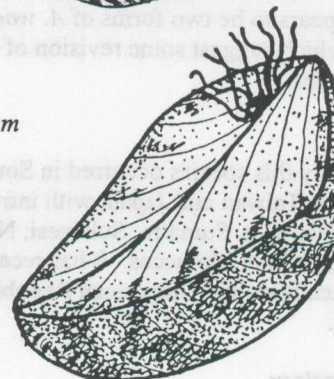
Blue Mussel
Mytilus edulis



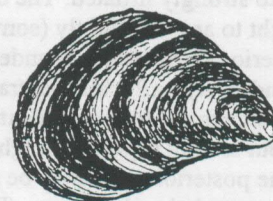
Brown Mussel
Perna perna



Dark Falsemussel
Mytilopsis leucophaea



Zebra Mussel
Dreissena polymorpha



Quagga Mussel
Dreissena bugensis

ASIAN FLOATER

Family: Unionidae

Anodonta woodiana



Asian Floater
Anodonta woodiana

Other names:

None.

Specifics:

The genus *Anodonta* was divided into three genera: *Anodonta*, *Pyganodon*, and *Utterbackia*; with the species *woodiana* remaining with *Anodonta*. There also appears to be two forms of *A. woodiana* in Japan alone which suggest some revision of the species may be in order.

Range:

Originally this species occurred in Southeast Asia including Taiwan and Japan, with introductions into Indonesia, Java, Sumatra, Sulawesi, Nusa Tenggara Islands, and the Moluccas. It has recently been introduced into the Dominican Republic and Costa Rica as well.

Description:

Asian floater is typical of other anodontids with a large, but thin shell (often cracks upon drying). Shell width is moderately to strongly inflated. The dorsal margin is nearly straight to arched slightly (sometimes slightly winged posterior to the beak), rounded anteriorly, very broadly rounded ventrally, and centrally round-pointed posteriorly. Beaks are full and elevated above the hinge line, but are not especially high; beak cavities are shallow. The posterior ridge may be slightly angular or very broadly rounded and obscure. There is no external sculpturing. There are no hinge teeth (pseudocardinal and lateral teeth). Adductor muscle scars are only

slightly impressed and the pallial line is faint.

Externally coloration ranges from yellowish-tan, to brown, and dark brown to black; sometimes faintly rayed posteriorly. Interior coloration is white or bluish-white and iridescent posteriorly. Shell length exceeds 4 inches (102 mm), and is probably at least twice that at times.

Biology:

Like other floaters, Asian floater probably prefers softer bottoms of soft mud and sand, but tolerates a wide variety of conditions. Adults do not produce adhesive threads for attachment to solid objects but crawl on and in the substrate. They are filter feeders. As with other unionids, Asian floaters produce a larval stage which is parasitic on fishes. Identified fish hosts include: barbs like *Puntius semifasciolatus*, the bitterling *Rhodeus tabira*, and others like *Metzia takakii*, *Rhinogobius brunneus*, and several species of *Zacco* in addition to the introduced western mosquitofish *Gambusia*. Other Asian carps and African tilapia (*Tilapia*, *Sarotherodon*, *Oreochromis*) may be hosts as well; introductions throughout Asia and in the New World have been linked to parasitic larvae being transported on aquacultural fishes.

Commercial Importance:

None. This species is not handled by the pet trade or aquaculturists and has no particular economic value.

Legal Restriction:

Introductions into Costa Rica and the Dominican

Republic are fairly recent, poorly known, and their ecological impacts have not been evaluated (though unionid introductions outside their native ranges are usually not ecologically problematic). Because introductions have occurred on aquacultural fishes carrying the microscopic larval stage, it would be difficult to enforce restrictions on potentially-infected host fishes. Additionally, typical maintenance procedures on aquacultural ponds at U.S. facilities often precludes long-term stable conditions required for a successful unionid introduction to establish.

Similar Species:

Asian floater will most likely be confused with other anodontid unionids. Most other members of the family can be excluded by the presence of hinge teeth, heavier shells, or sometime external sculpturing. The three most common native floaters in much of the U.S. include giant floater *Pyganodon grandis*, flat floater *Anodonta suborbiculata*, and paper pondshell *Utterbackia imbecillis*. Both flat floater and paper pondshell have beaks which are not elevated above the hinge line; flat floater is much more compressed from side to side; and paper pondshell is less deep bodied. Giant floater is more problematic because it is extremely variable in shape; however, it usually has

beaks which are far more elevated than those in Asian floater.

Technical Note:

A problematic form from Texas and Mississippi (*Anodonta* or *Pyganodon*) is similar to flat floater or intermediate between it and giant floater being more inflated, less deep bodied, with higher beaks, and darker coloration than flat floater. The actual identity of this form remains to be fully defined, but, despite similarity to Asian floater, it is not that species.

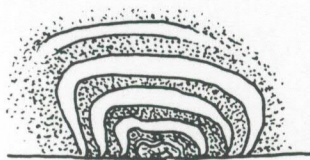
Technical Note:

Beak sculpture can be diagnostic in unionids. However, because the beak is the oldest part of the shell, it is often eroded and sculpturing lost. American floaters (*Anodonta*, *Pyganodon*, *Utterbackia*) often have a double-looped pattern of ridges, but Asian floater may only show concentric lines without indication of loops.

References:

Dharma 1992; Djajasasmita 1982; Habe 1975; Howells et al. 1996; Keferel 1995; Watters 1994; Watters and Kohl 1995.

BEAK SCULPTURE PATTERNS



Asian Floater
Anodonta woodiana



Unidentified Floater
Anodonta/Pyganodon?

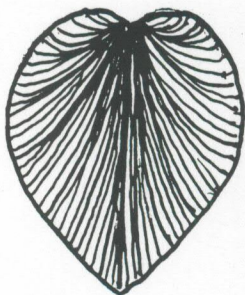


Giant Floater
Pyganodon grandis

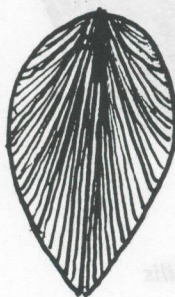


Paper Pondshell
Utterbackia imbecillis

CROSS-SECTION VIEWS



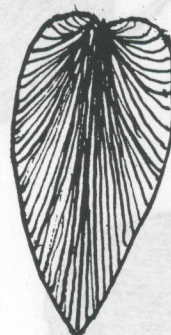
Asian Floater
A. woodiana
Japan



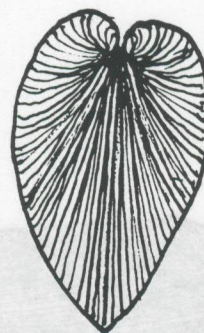
Asian Floater
A. woodiana
China



Flat Floater
A. suborbiculata



Unidentified Floater
Anodonta/Pyganodon

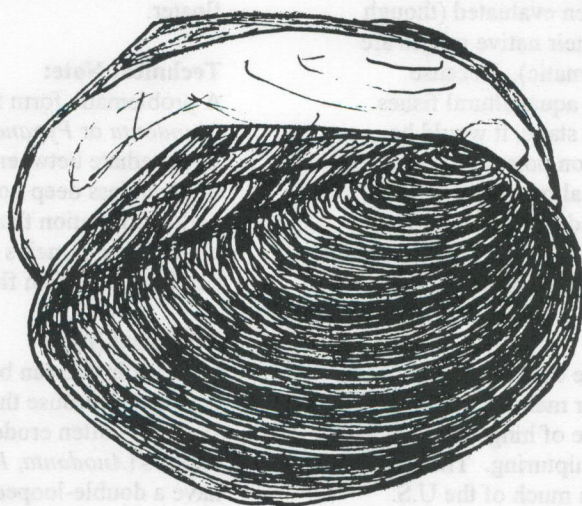


Giant Floater
P. grandis

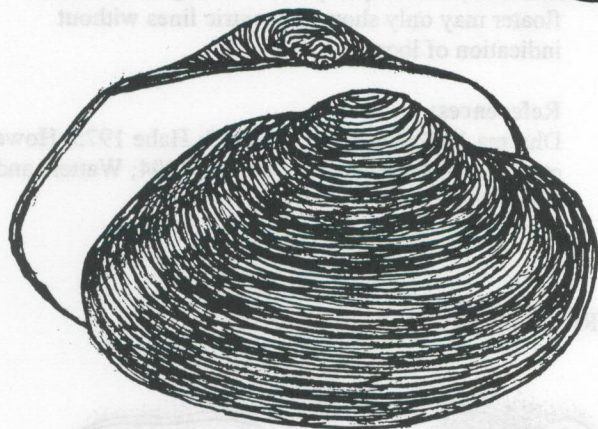


Paper Pondshell
U. imbecillis

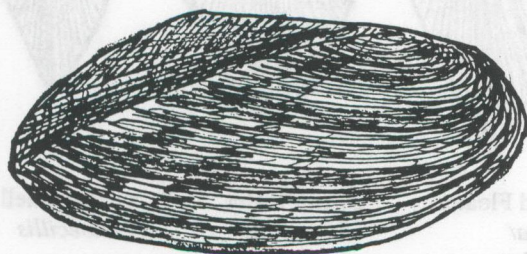
Asian Floater
Anodonta woodiana



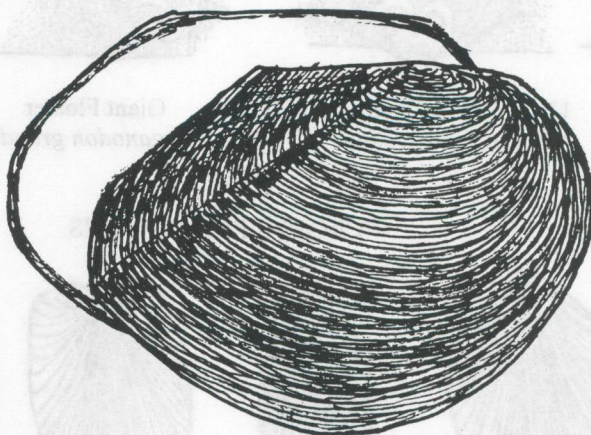
Giant Floater
Pyganodon grandis



Flat Floater
Anodonta suborbiculata



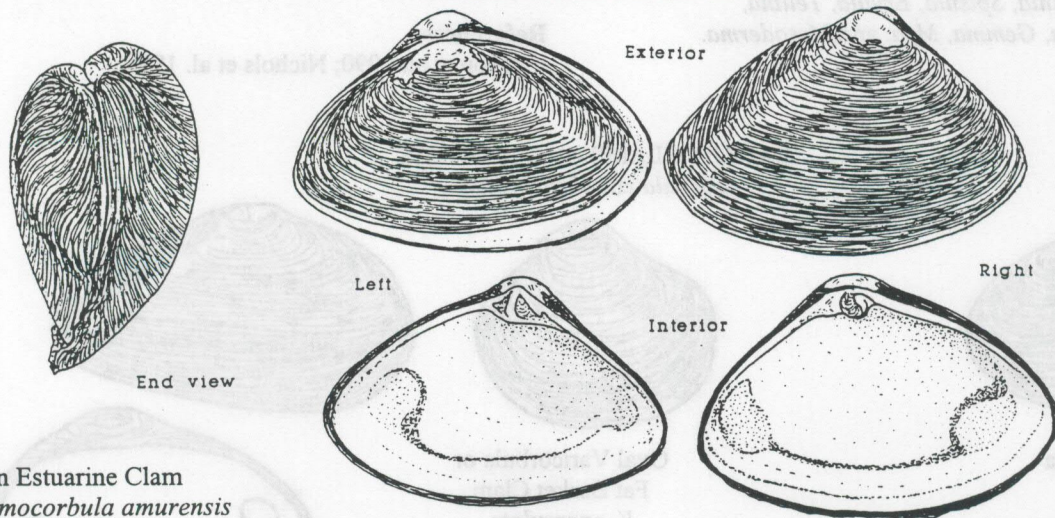
Paper Pondshell
Utterbackia imbecillis



ASIAN ESTUARINE CLAM

Family Corbulidae

Potamocorbula amurensis



Asian Estuarine Clam
Potamocorbula amurensis

Other Names:

Asian basket clam.

Specifics:

This species is a member of the basket clam family (Corbulidae) which includes the genera *Corbula* and *Varicorbula* in U.S. waters. Despite similarities in both common and scientific names, it is not closely related to Asian or Asiatic clams of the genus *Corbicula* in the family Corbiculidae. Three additional species in the genus are known (*P. laevis*, *P. urstulata*, *P. rubromuscula*), but none have been reported from U.S. waters to date.

Range:

This bivalve is native to eastern Asia from the lower delta of the Pearl River to the mouth of the Amur River and Korea. It was first collected in San Francisco Bay, California, in 1986. It has never been reported in Texas, but its natural range includes latitudes which overlap those of Texas.

Description:

Asian estuarine clam is relatively small, to about 1 inch (25.5 mm) shell length, but is usually less. The left valve is markedly smaller than the right valve. Externally, fine radial striations may be present on larger specimens. A pallial sinus is present on the inner shell surface, but may not be obvious (especially in wet specimens) and the pallial line may superficially appear simple and without a sinus. Externally shells are white, tan, yellow, to brown or nearly black; internally the nacre is white. The siphons are brown in color; the incurrent siphon has small pinnate tentacles and the excurrent siphon has two non-pinnate medial filaments.

The mantle is fringed with small papillae. Byssal thread-like structure may be present on the antero-ventral margin of some specimens.

Biology:

This species tolerates salinities from 1 to 33 ppt, but may be excluded below 2-3 ppt. It has been found at water temperatures from 8 to at least 28 C. Since invading San Francisco Bay, it has attained numerical abundance and displaced both native and other introduced bivalve mollusks. It has been reported to reach densities of at least 10,000 per square meter.

Commercial Importance:

Thus far Asian estuarine clam has no major commercial importance beyond competition with other bivalves. Possible ecological impacts from displacement of other species and extreme abundance remain to be fully documented.

Legal Restriction:

Because the introduction into San Francisco Bay was likely accidental, legal restrictions are largely lacking. This species is not prohibited in Texas; however, it should never be imported or released into local waters.

Similar Species:

In U.S. waters, Asian estuarine clam is most similar to other basket clams of the genera *Corbula* (8 Atlantic and 5 Pacific species) and *Varicorbula* (1 species). All are smaller, 0.24-0.51 inch (6-13 mm) shell length, many are more globular, and several have posterior beaks, straight ventral edges, more triangular shapes, or pink coloration. However, all also have unequal-sized valves.

Species of several other bivalve genera (especially juveniles) could be confused with Asian estuarine clam. Although the following genera have a similar shell shape, they have equal-sized valves and a well-defined pallial sinus: *Mulinia*, *Spisula*, *Ervilia*, *Tellina*, *Macoma*, *Strigilla*, *Gemma*, *Mya*, and *Mesoderma*.

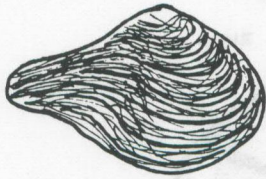
Other genera which lack a pallial sinus, but have equal-sized valves include: *Lucina*, *Diplodonta*, *Aligena*, *Lepton*, *Mactra*, and *Crassinella* (slightly unequal valves, but with a trigonal shape).

References:

Carlton et al. 1990; Nichols et al. 1990.

BASKET CLAMS OR CORBULAS

Corbula and *Varicorbula*



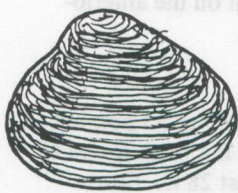
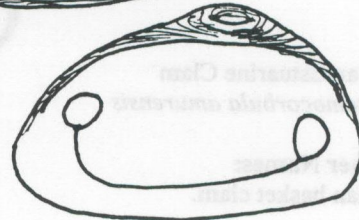
Caribbean Corbula
C. caribaea
(= *barrattiana*?)



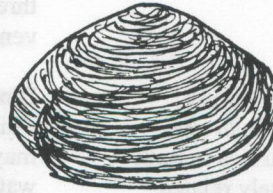
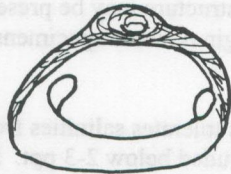
Oval Varicorbula or
Fat Basket Clam
V. operculata



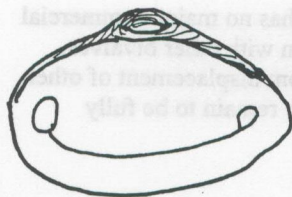
Contracted Corbula
C. contracta



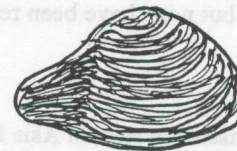
Equal-valved Basket Clam
C. aequivalvis



Swifts Corbula
C. swiftiana

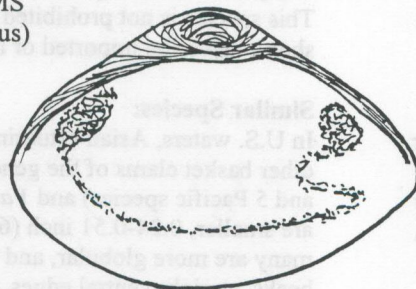


Western Corbula
C. luteola

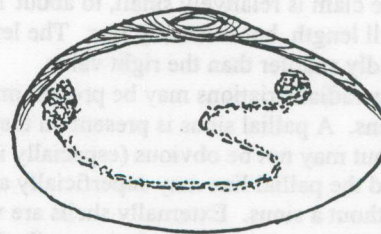


Snubby Corbula
C. nasuta

OTHER MARINE CLAMS (Note Pallial Line and Sinus)



Surf Clam *Spisula* sp.



Soft Clam *Mya* sp.

PURPLE LOOSESTRIFE

Family: Lythraceae

Lythrum salicaria

Other Names:

Spiked loosestrife, spiked willow-herb, purple lythrum, long-purples.

Specifics:

Loosestrife includes members of the family Lythraceae and genus *Lythrum*; however, the term has also been applied to swamp loosestrifes (*Decodon*) in this same family and yellow loosestrifes (*Lysimachia*) in the primrose family (Primulaceae). Two European species, both called purple loosestrife, have become established in North America, but one has a restricted range in New England. Classification of native loosestrifes is much more problematic (see comments under Similar Species).

Range:

Purple loosestrife *L. salicaria* is native to Europe and Asia. This species was introduced along the East Coast of the U.S. in the 1800s (probably accidentally in ship ballast waters) and later actually distributed as an ornamental garden plant. It already occurs in at least 40 U.S. states as well as in Canada.

Description:

Purple loosestrife usually grows 2-4 feet (0.6-1.2 m) tall and reported by some to 10 feet (3 m) with as many as 30-50 branched, square (4-angled), herbaceous stems. Produces tapering terminal spikes of small, purple flowers 1 inch across with 4-6 petals (usually 6) appear in leaf axils (where leaves join the stem). Leaves are sessile (without leaf stems) and attach directly to the stem and almost wrap around it with their wide bases; leaves are 1-4 inches (25-102 mm) long, somewhat downy, and are usually placed in opposite pairs (occasionally in 3s). A variety of horticultural forms also occur which often have different flower colors (deep purple, pink, rose, red); these are generally considered sterile or nonaggressive and not as potentially problematic as wild-type purple loosestrife.

Biology:

This species tolerates drier garden settings but often grows in marshes and along lake and river shorelines. It can form dense stands which preclude or replace native vegetation including cattails and similar marsh plants. Unlike displaced native plants, North American wildlife may not utilize purple loosestrife. It produces as many as 2.5 million seeds per plant annually and can



Purple Loosestrife
Lythrum salicaria

propagate by stem and root fragmentation or cuttings. In one example in New York, this species reportedly became 90% of total biomass at one impoundment within 13 years.

Commercial Importance:

A variety of horticulturally-produced cultivars of purple loosestrife are sold commercially in Texas and elsewhere. Otherwise, the primary commercial importance of this species in economic and ecological damage associated with invasions and displacing native plants and animals.

Legal Restrictions:

Purple loosestrife is not legally prohibited by Texas Parks and Wildlife Department (TPWD) as a harmful or potentially harmful aquatic plant. In part, legal restrictions have not been enacted because of problems with sale of horticultural specimens, presence of the species locally already, and the fact that most introductions are not done deliberately. State law in Texas still prohibits the introduction of any native or non-native aquatic plant into the waters of Texas without a permit from TPWD. It should also be noted, some other states have regulations to control the sale and distribution of this plant.

Similar Species:

A second species of purple loosestrife from Europe *L. virgatum* has also been introduced into North America, but it has a limited distribution in New England. Although *L. salicaria* has downy leaves with wide bases, *L. virgatum* has non-downy leaves with narrow bases.

Although the exact number and taxonomic status of native North American loosestrifes (*Lythrum*) is still under debate, all are readily distinguishable from introduced purple loosestrife. Within Texas, some authorities list California loosestrife *L. californicum*, low or oval-leaf loosestrife *L. ovalifolium*, with introduced purple loosestrife *L. salicaria* and possibly wing-angled loosestrife (*L. alatum* = lance-leaf loosestrife *L. lanceolatum*; some place *L. californicum* under this species as well). Another species *L. dacotanum* is also occasionally mentioned in older literature sources as present in Texas. Other species elsewhere include: narrow-leaf loosestrife *L. lineare* and hyssop-leaved loosestrife *L. hyssopifolia*.

- Wing-angled loosestrife *L. alatum* - stems 4-angled and slightly winged (also *L. californicum*, *L. lanceolatum*)
- Narrow-leaved loosestrife *L. lineare* - leaves opposite but very narrow
- Hyssop-leaved loosestrife *L. hyssopifolia* - small, alternate leaves (not opposite)
- Low loosestrife *L. ovalifolium* - plant small, leaves small and oval

Yellow loosestrifes (*Lysimachia*) are somewhat similar, but typically have flowers with 5 petals which are yellow (not purple or pink) and are positioned on stems (not sessile).

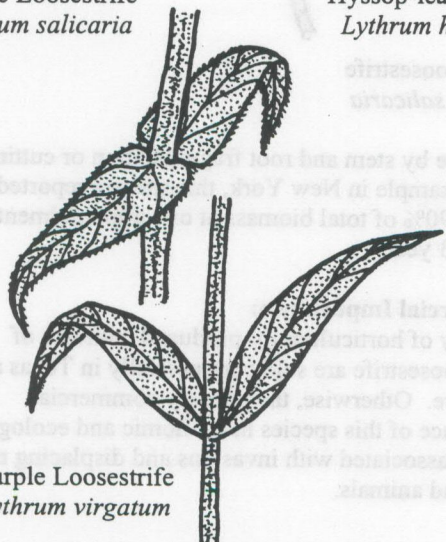
Technical Note:

Although purple loosestrife has many biological control agents in Europe and Asia, none in North America have had major impacts on it. A root weevil *Hylobius transversovittatus* and two leaf-eating beetles *Galerucella pusilla* and *G. salicaria* are now being used as control agents in North America with some success. These reportedly feed only on purple loosestrife and so not pose threats to other plants.

References:

Correll and Correll 1972; Fassett 1957; Hatch et al. 1990; Muenscher 1967; Peterson and McKinney 1968; Reed 1988a b; Toman and Felix 1974; Zim and Martin 1950. Note: a wide array of information on purple loosestrife is available on the Internet. Additionally, the Great Lakes Panel on Aquatic Nuisance Species of the Great Lakes Commission has produced Aquatic Nuisance Species Information and Education Material Relevant to the Great Lakes Basin: Recommendations and Descriptive Inventory which provides reference to other materials on this species.

Purple Loosestrife
Lythrum salicaria



Hyssop-leaved Loosestrife
Lythrum hyssopifolia



Low Loosestrife
Lythrum ovalifolium



Purple Loosestrife
Lythrum virgatum

Narrow-leaf Loosestrife
Lythrum lineare

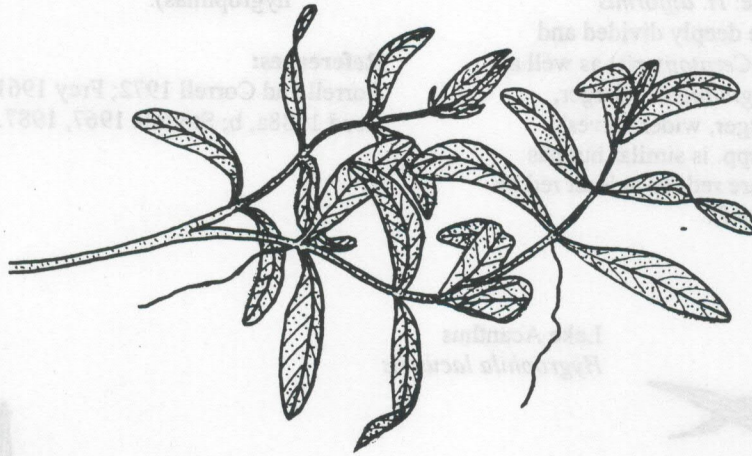
Wing-angled Loosestrife
Lythrum alatum



INDIAN HYGROPHILA (INDIAN WATER STAR)

Family: Acanthaceae

Hygrophila polysperma



Indian Hygrophila
Hygrophila polysperma

Other Names:

Hygrophila, East Indian hygrophila, *Justicia polysperma*.

Specifics:

Some 60-80 species in this genus are considered valid. This and several other exotic members of the genus are regularly imported for sale in the pet trade and another species is native to the southern U.S.

Range:

Indian hygrophila ranges across southern Asia from India to the Malayan Peninsula. It has been introduced in Florida, Texas, and elsewhere.

Description:

Plant height reaches about 1.5 feet (0.5 m) but is often much less. Leaves are positioned opposite each other on the stem and are bright green, elongate egg-shaped, 1.6 inches (40 mm) in length and 0.6 inches (15 mm) wide, but becoming narrower and darker when growing above the water line. Flowers are stalkless (sessile) in the leaf axils (where leaves join the stem), 0.2-0.6 inches (5-15 mm) long, with 5 pointed sepals, white petals with 2 lips, 2 stamens, fruit capsules 0.2-0.5 inches (6-12 mm) long, and with 20-30 seeds.

Biology:

Indian hygrophila may grow along the shoreline as an emergent plant or completely submerged at depths over 10 feet (3 m). In the pet trade, it is considered hardy and adaptive. It requires high light levels. Virtually every part of the plant can generate a new plant when broken off the parent plant making vegetative

reproduction typical for the species. Flowering occurs only at the leaf axils of emergent plants (never under water) and is often rather infrequent. Vigorous growth often crowds out more desirable native vegetation. Aquarium literature sources caution of a tendency to turn neutral water acidic over time thus making it difficult for plants which prefer alkaline conditions to survive. It reportedly grows well in soft waters, but tolerates hard-water as well.

Commercial Importance:

Although apparently not available in the pet trade until 1948, Indian hygrophila is a popular plant in the industry and is widely sold. In some places in the U.S., introductions have grown rapidly and become noxious, especially in situations where other native or exotic macrophytes have been reduced in number.

Legal Restrictions:

Neither Indian hygrophila nor its relatives are prohibited in Texas. In part this reflects the fact that the species is already reportedly established here, is similar to native plants, and is commercially important to the aquarium trade.

Similar Species:

Indian hygrophila is most likely to be confused with native hygrophila, other exotic members of the genus, or several similar aquatic plants like water primrose *Ludwigia* and water willow *Justicia*.

- *Hygrophila lacustris* (lake hicottea, lake acanthus) is native from Florida to Texas. It has longer, lance-shaped leaves with pointed tips; flowers

with yellow petals and 2 lips with 3 lobes on the lower lip; and seed capsules with only 16-18 seeds. This plant has often been placed in the genus *Justicia*.

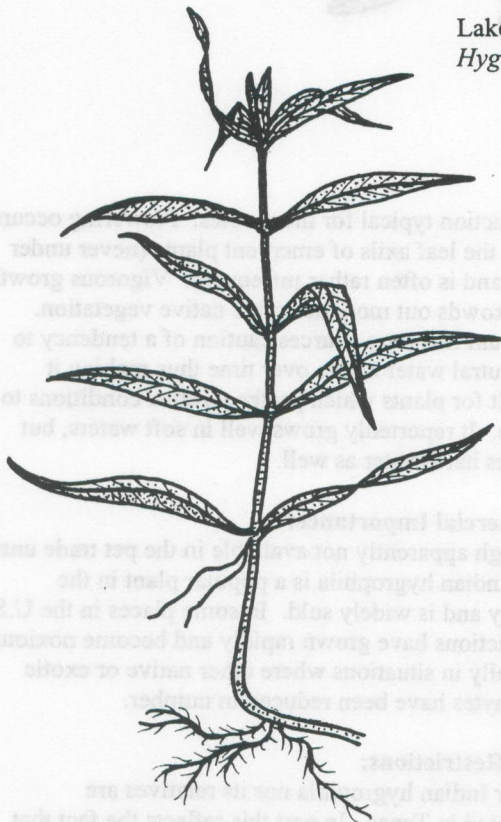
- Other exotic *Hygrophila* species imported by the aquarium trade include: *H. difformis* (submerged leaves are deeply divided and resemble water sprite *Ceratopteris*) as well as *H. corymbosa* and *H. guianensis* (larger, heavier plants with larger, wider leaves).
- Water primrose *Ludwigia* spp. is similar but has shorter leaves which are red (or at least red on the lower side of the leaf).

- Water willow *Justicia americana* and several other native species in the genus are often far more emergent in nature, with darker green leaves and have flowers with white and purple petals mounted on stems (peduncles, absent in *hygrophilas*).

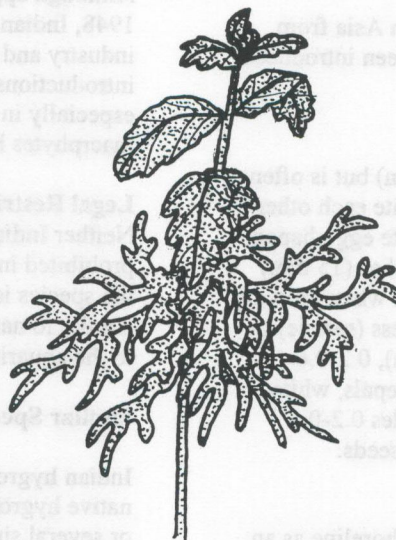
References:

Correll and Correll 1972; Frey 1961; Hatch et al. 1990; Reed 1988a, b; Stodola 1967, 1987.

Lake Acanthus
Hygrophila lacustris



Hygrophila
guianensis



Hygrophila difformis

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