Special Publication

# Guide to Identification of Harmful and Potentially Harmful Fishes, Shellfishes, and Aquatic Plants Prohibited in Texas

Revised Edition

by
Robert G. Howells

Texas Parks & Wildlife Department
Inland Fisheries Division
4200 Smith School Road
Austin, Texas 78744

1999

PWD BK T3200-376 (11/99)

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# Contents

# INTRODUCTION

Trade in exotic aquacultural fishes, shellfishes and plants, including ornamental pool and aquarium species, is a multi-million dollar industry with extensive financial impacts on other support businesses (pharmaceuticals, fertilizers, aquarium supplies, etc.). Certainly, there is little argument that aquacultural species can be used to supplement failing catches of wild fishes and shellfishes, or that the aesthetic value of a home aquarium can be highly desirable; however, after many decades of international transfer of aquatic organisms, many species have escaped captivity and others have been deliberately released. In general, most such displaced animals and plants have failed to have major environmental impacts or to even survive. Unfortunately, in some cases, released organisms have caused environmental damage and even extinction of native species. Typically, once an exotic is released and becomes widely and firmly established, it cannot be removed.

Common carp *Cyprinus carpio* were imported from Europe in the mid-1800's by both the federal government and private individuals. Federal authorities distributed the species to state agencies and it was widely stocked across the United States. However, before the turn of the century, it had become apparent to nearly all that the species was not only a failure as a game or food fish, but it sometimes had negative impacts on both native fish populations and the aquatic environment. Sadly, the dye was cast and common carp became part of the American fish fauna.

More recently, several species of tilapia *Tilapia* spp. have become established in U.S. waters. In Texas where they have taken advantage of heated power plant reservoirs, some populations have become large enough to occasionally reach densities of 2,000 pounds/acre (1,786 kg/hectare).

Although young tilapia are eaten by large, predatory fishes, they reproduce rapidly and can destroy aquatic vegetation, compete with some native fishes, and even inhibit spawning of game species like largemouth bass *Micropterus salmoides* and channel catfish *Ictalurus punctatus*.

Even seemingly insignificant species like the guppy *Poecilia reticulata* or mosquitofish *Gambusia affinis*, when introduced into non-native habitats, have threatened native fishes and have even been implicated in the extinction of others.

Certainly most aquaculturists or aquarists who release exotic species, or from whom escapes have occurred, rarely if ever intend specific harm to the environment or to other species. Presumably most deliberate releases are done with the best of intentions, but with limited understanding of the potentially negative impacts that might result. Recently, use of certain exotic fishes for vegetation control or as bait has resulted in deliberate use and release of exotic fishes for specific purposes, but again, with little thought of possible negative impacts. Aquatic ecosystems are very complex in nature, and results of non-native species introductions are difficult or impossible to accurately predict, even for the most learned experts.

During the mid-1960's, perhaps as a function of developing environmental awareness, Texas began to develop a concern for the impact of non-native introductions in state waters. In 1967 the 60th Texas Legislature instructed the Texas Parks and Wildlife Department (TPWD) to determine which fishes were harmful or potentially harmful, and to list and regulate these species. Such a list was ultimately established and has evolved through the years to the present.

# HISTORICAL OVERVIEW

| Date | Action |
|---|---|
| 1967 | The Texas Legislature instructed TPWD to determine which fishes were harmful or potentially harmful, and to list and regulate them. Regional experts were consulted, and a list of restricted fishes prepared that year. [There is little documentation as to why certain fishes were restricted and others not]. |
| July 1974 | Modifications were made to the original restricted list and some of the associated regulations. Arowana *Osteoglossum bicirrhosum* was deleted from the list. Two catfish genera, *Tridens* and *Pygidium*, were deleted from the original listing under parasitic catfishes since, although both genera were part of that family, neither was in fact parasitic. A then subgenus of tilapia, *Oreochromis*, was added to the new list, but without comment (it was subsequently deleted from later lists, likewise without comment). |

| Date | Action |
|---|---|
| Dec 1974 | The Texas Parks and Wildlife Commission (TPWC) requested a literature review concerning grass carp *Ctenopharyngodon idella*. Use of the species in other states for vegetation control sparked both interest and concern about possible importation into Texas. |
| April 1975 | An extensive literature review on grass carp (Provine 1975) was presented to the TPWC. TPWD ultimately did not favor use of grass carp in Texas waters. |
| 1981 | The Lake Conroe Association, which wanted grass carp for vegetation control in Lake Conroe, met many times with the TPWC. Ultimately, a compromise was reached and legislation passed to allow grass carp research by Texas A&M University at Lake Conroe (with other work at Lewis Creek Reservoir and a commercial facility near Houston). |
| May 1982 | The restricted fish list and associated regulations were again revised. Restricted fishes were differentiated as to "totally restricted" and "partially restricted" permitting research on partially restricted species. Tilapia were listed as partially restricted except for Mozambique tilapia *Tilapia mossambica* and blue tilapia *T. aurea*. Problems with tilapia classification became a point of discussion. The Executive Director of TPWD was given the authority to up-date taxonomy (fish classification) as needed. |
| 1984 | Possession of eviscerated grass carp was proposed and later adopted by the TPWC. Grass carp and tilapia were ultimately classified as rough fishes. |
| 1988 | TPWD developed and proposed new, more restrictive regulations on tilapia in response to the expanding distribution and possible impact of tilapia throughout the state. Proposed regulations were supported by some parties but opposed by others. Ultimately a compromise was reached and new regulations passed in September, but with a delayed effective date to allow aquaculturists to complete the 1988 harvest. New regulations did not allow use of non-eviscerated tilapia as bait, required transport and culture permits for tilapia, required genetic identification and certification of all cultured tilapia stocks and only permitted culture of Mozambique and blue tilapia, and hybrids between the two. All other tilapia species or hybrids were restricted. Only Mozambique tilapia could be stocked as a forage fish, and then only in private waters. Only minor technical changes were added to other species listed. Tilapia classification was clarified. Comments were added to include "fish, their hybrids, subspecies, or eggs". The totally and partially restricted categories were retained. The grass carp permit (and law) for research at Lake Conroe expired in September. |
| Jan 1989 | The new tilapia restrictions went into effect. |
| Mid-1989 | The Texas Legislature passed the Fish Farming Act of 1989 (SB 1507) requiring TPWD to maintain a list of harmful and potentially harmful fishes, shellfishes, and aquatic plants, but regulation of fish farming activity was moved to the Texas Department of Agriculture (TDA). |
| Nov 1989 | TPWD developed a new restricted fish, shellfish and aquatic plant list, and associated regulations in response to the requirements of SB 1507. New restricted fishes, shellfishes and plants were added to the list, and other previous listings were modified. |
| Jan 1, 1990 | New TPWD restricted fish regulations went into effect. In addition, previously required tilapia transport permits became unnecessary. |
| Jan 25, 1990 | New amendments and additions to the November 1989 regulations were presented to the TPWC, and passed. |
| Mar 22, 1990 | The new amendments and additions went into effect. |
| Nov 1990 | Additional amendments to further refine the January 1990 regulations and addition and deletion of several species were presented to the TPWC, and passed. |
| Jan 1991 | The new amendments, additions and deletions went into effect. |
| May 20 1993 | Nile tilapia *T. nilotica* was added to the list of tilapia which could be possessed by fish farmers with permits. |
| Aug 12 1993 | Nile tilapia proposal goes into effect |

| Date | Action |
|---|---|
| Dec 1994 | First Exotic Species Task Force meeting held at TPWD headquarters. |
| Mar 1995 | Egeria *Egeria densa* removed from prohibited plant list and wording which permitted hybrid grass carp possession deleted. Wording on public aquaria, shellfish health certification, permit dates, and effluent screening requirements included. |
| May 1995 | March 1995 regulations go into effect. |
| Nov 1996 | Regulations on Pacific white shrimp *P. vannamei* modified, triploid grass carp legalized with permit, and pike cichlids, banded knifefish, and Asian clams are deleted from the prohibited list. |
| Jan 1997 | First-time exotic species permit applicants must obtain authorization from the Texas Natural Resource Conservation Commission for facility waste-water discharges. |
| Feb 1997 | November 1996 and January 1997 regulations go into effect. |
| Nov 1997 | Swamp eels (Synbranchidae) and freshwater eels (Anguillidae) except *Anguilla rostrata* are prohibited. |
| Dec 1997 | November 1997 regulations go into effect. |
| Apr 1998 | Japanese eel *A. japonica* is permitted only for a single fish farmer. |
| Jun 21 1998 | April 1998 regulation goes into effect. |

# THE LACEY ACT

The Lacey Act, a federal regulation, has a number of aspects that relate to imported fishes, state restricted fish regulations, and certain fish diseases. Other than walking catfishes (Family Clariidae) and uncertified salmonids (Family Salmonidae), it does not otherwise restrict exotic fishes, amphibians, or reptiles. Major points include:

- Importation, transportation and acquisition of live walking catfishes or their viable eggs is prohibited.
- Live or dead imported salmonids (salmon and trout) or their eggs must be certified free from whirling disease and viral hemorrhagic septicemia.
- No live fish, mollusk, crustacean, or any progeny thereof may be released into the wild except by state fish and wildlife agencies or persons with written permission from those agencies.
- Any violation of any state law regarding possession or transportation of fish or wildlife is considered a federal offense (1981 Amendment: Public Law 97-79).

# THE TEXAS FISH FARMING ACT OF 1989 (SB 1507)

The Texas Fish Farming Act transferred much of the fish farmer regulation and authority from TPWD to the Texas Department of Agriculture (with input from Texas A&M University). TPWD was still required to maintain a list of restricted species, and retained the authority to inspect fish farms. The act was designed to address concerns of fish farmers; it did not directly address the pet trade, and subsequently some ambiguities exist in its wording. Although there are many aspects of this bill, some important points are given below:

- Private pond was defined to include any structure capable of holding a cultured fish. In effect then, an aquarium can be considered a pond (previous TPWD regulations had similar

wording).

- Exotic species was defined as any "non-indigenous fish or shellfish species [i.e., to Texas] that is not normally found in the water of the state." Note that the wording indicates "species" not "individual". This means that although a guppy, for example, may have been born in Texas, the species, none the less, is not indigenous to the state.

- The term "tropical" was deleted from the law. The previous 1967 legislation specified "harmful or potentially harmful tropical fishes". This term had previously created a problem with certain temperate-climate exotics which were considered harmful.

- Fish farming was defined as the business of producing, propagating, transporting **"and"** selling cultured fish ...excluding bait fishes.

- The Act prohibited the placing of any fish, shellfish or aquatic plant into state waters without a permit from TPWD...except for native nongame fishes. For example, rudd *Scardinius erythrophthalmus*, which had been imported from out-of-state for use as bait in Texas, was now restricted. It also specified that any escape from stocked private water would be considered a violation (unless under TPWD permit).

- The concept of harmful or potentially harmful was retained. Therefore, a species can be restricted if for no other reason than it might be harmful... documented proof is not needed for restriction. In the broadest sense, this could be interpreted to mean literally any non-native species.

- The Act specified only "species" but does not discuss hybrids or subspecies. Subsequent TPWD regulations were written to cover subspecies, hybrids, etc.

- The Act did not differentiate between live or dead.

- The Act did not specify status of fish eggs (presumably considered to be fish).

# TPWD Regulations: November 2, 1989
## (Effective January 1, 1990)

Passage of the Texas Fish Farmer Act required TPWD to revise its own regulations on restricted fishes, shellfishes and aquatic plants. Many TPWD restricted fish regulations which went into effect in January 1989 needed to be deleted or revised with the transfer of responsibility of over-seeing aquaculture to TDA. Some points of interest include:

- These regulations revised the list of restricted fishes with deletions and additions, as well as technical name changes; several crustaceans (crayfishes and crabs) were added; restricted plants were also listed.

- The term "group" (e.g., piranha group) used in previous restricted fish lists was deleted and replaced with specific scientific classification.

- Under fishes and crustaceans an effort was made to list taxonomic units (families, genera, etc.) of restricted fishes rather than attempting to specifically list each restricted species. This simplified identification for biologists, Law Enforcement officers and the public alike. For example, previous restrictions listed banded knifefish *Gymnotus carapo*; however, because the family includes three or four very similar species, the new restriction covered the entire family (all species). This simplified identification only to recognizing a knifefish is in the banded knifefish family (Family Gymnotidae); exactly which of the banded knifefishes one had at hand was no longer relevant.

- The new regulations listed species, subspecies, hybrids, eggs, seeds and reproductive parts of harmful or potentially harmful animals and plants as restricted. Hybrids were listed as "hybrid among [harmful or potentially harmful] species"; this could be read to mean that only hybrids where both parental species are restricted would also be restricted. However, the probable intent was to include any hybrid involving any restricted species (e.g., the hybrid between grass carp and common carp would be restricted even though

common carp is not restricted). Subsequent amendments in January 1990 redefined this as "any hybrid of a [restricted] species."

- TPWD may still inspect fish farms.
- Tilapia certification and tilapia fish farmer regulations have largely remained in place from the earlier 1988 regulations (See Appendix I).
- Live or dead were not specified except that anyone may possess harmful or potentially harmful fish if the intestines have been removed (previous regulations specified dead grass carp and tilapia may be possessed if eviscerated). An unwritten intent was that restrictions should even apply to formaldehyde-preserved or mounted specimens if intestines were not removed, as well as to live individuals.
- Fish eggs have been listed, but unlike federal regulations where only viable eggs are restricted, TPWD does not specify egg status (no distinction between viable and unviable eggs). Therefore in an extreme example, if eggs are considered to be fish (with unspecified live-dead status), use of preserved salmon *Oncorhynchus* spp. eggs as bait could be interpreted to represent an illegal introduction of an exotic species into state waters.
- Hybrid grass carp (grass carp x bighead carp *Aristichthys nobilis*) remained unrestricted.

# TPWD Regulations: January 25, 1990
## Amendments and Modifications
## (Effective March 25, 1990)

- Exotic species was defined as a nonindigenous species of fish, shellfish or aquatic plant which is not normally found in public water. This is similar to the definition given in SB 1507, but (1) includes aquatic plants and (2) specifies public water whereas SB 1507 did not include aquatic plants and did not specify public water. Note also that while the term exotic is defined, neither nonindigenous, native or commonly found are defined either in SB 1507 or in TPWD regulations.
- The listing of the banded knifefish family was changed back to previous wording where only the banded knifefish *Gymnotus carapo* was restricted and two or three other nearly identical banded knifefishes in the same family and genus were unrestricted (could be imported, cultured and sold legally). Reasons for the reversal were based on statements by the pet trade and university biologists that other gynmotid species were not as potentially harmful as *G. carapo*; however, published references are apparently lacking.
- Hybrid grass carp (grass carp x bighead carp) which has historically been unrestricted in Texas was included as restricted. However, documented specimens in possession prior to January 25, 1990 may be legally retained (but not replaced or supplemented) until January 1, 1995.
- New regulations listed any species, hybrid of a species, subspecies, eggs, seeds or any part of a species defined as harmful or potentially harmful. These modifications more clearly indicated any hybrid (not just hybrids between two restricted species), spores (in plants that do not produce seeds) and more strongly suggest that genetic variants of restricted species are themselves restricted. It did not however deal with the viable or nonviable status of restricted organisms, their eggs or their seeds (e.g., use of nonviable salmon eggs as bait could still be viewed as a violation).
- European pike perches *Stizostedion* spp., three species of seatrouts *Cynoscion* spp., Nile perches *Lates* and *Luciolates,* giant ramshorn snail *Marisa cornuarietis*, Asiatic clams *Corbicula* spp., and zebra mussels *Dreissena* spp. were added to the restricted list.
- The Tilapia Permit was changed to the Exotic Species Permit and included bighead carp, silver carp *Hypophthalmichthys molitrix* and black carps *Mylopharyngodon* spp. as well as blue tilapia, Mozambique tilapia and blue x Mozambique tilapia hybrids. Possession,

propagation, transport and sale of bighead carp under an Exotic Species Permit was allowed until February 1, 1991.

- Fish farming was defined, in agreement with SB 1507, as the business of producing, propagating, transporting, possessing, **"and"** selling cultured fish raised in a private pond, but does not include the business of producing, propagating, transporting, possessing, and selling fishes cultured for bait purposes.
- A fish farm was defined as the property including private ponds from which fish or shellfish are produced, propagated, transported **"or"** sold." This differs from SB 1507 in using the word "or".
- A statement was added to clarify that any scientific reclassification or renaming should not necessarily be considered a redefinition of the species' harmful or potentially harmful status.
- Retail sale regulations that previously applied to certain tilapia were broadened to include bighead, silver and black carps as well.
- Possession of Mozambique tilapia in a private pond was still retained as legal.

# TPWD Regulations: October 9, 1990
## Amendments and Modifications
## (Effective October 29, 1990)

- Several wording changes were added to better clarify regulation intentions.
- Whale catfishes (Family Cetopsidae), airsac catfishes (Family Heteropneustidae), ruffe and its relatives *Gymnocephalus* spp., non-native penaeid shrimps and water spinach *Ipomoea aquatica* were added to the restricted list.
- Wording on seatrouts and corvinas *Cynoscion* spp. was changed to prohibit all species except three native seatrouts; restrictions on giant ramshorn snails, Asiatic clams and zebra mussels were changed to include all species in their respective genera and restriction of salvinia *Salvinia rotundifolia* was changed to include all species of the genus.
- Wording was added to clearly state that common carp, goldfish, and Crucian carp *Carassius carassius* can be legally used as bait.
- Water fern *Azolla caroliniana* was deleted from the prohibited plant list.
- Water hyacinth *Eichhornia crassipes* remained prohibited, but can be used for water purification in certain situations.
- Wording was changed to include waste-water processing operations as well as fish farms relative to possession of water hyacinth, bighead carp and silver carp (in use for water purification).
- Possession of restricted fish and shellfish which previously included only specimens with intestines removed was broadened to included specimens with heads removed. Similarly, licensed retailers and wholesalers could deliver restricted fishes or shellfishes to the final consumer if the intestines or head had been removed, or the specimen was dead and on ice.

# TPWD Regulations: January 23, 1992
## (Effective March 1, 1992)

- Triploid grass carp were legalized for sale and possession under special permits and conditions.
- Pacific oyster was added to the restricted list.
- Additional terms were defined (e.g., nauplii, postlarvae).
- Regulations for health certification of exotic shellfish were added.

# TPWD Regulations: May 20, 1993
## (Effective August 12, 1993 )

- Nile tilapia *Tilapia* (*Oreochromis*) *nilotica* was added to the list of tilapia species which could be possessed by fish farmers with appropriate permits. Nile tilapia had originally not been present in aquaculture or as feral populations in Texas previously. Because they are very similar to blue tilapia *T.* (*O*). *aurea*, hybridize readily with blue tilapia, and existing feral blue tilapia stocks had arisen from a very small gene pool (limiting genetic variability), the absence of Nile tilapia may have helped reduce potentially undesirable genetic combinations among feral populations.

# TPWD Regulations: Exotic Species Coordinator and Task Force

TPWD created the position of an exotic species/ aquaculture coordinator in September 1989 as per requirements of the Fish Farming Act of 1989. On 8 December 1994, TPWD's Inland and Coastal Fisheries Divisions held a public meeting attended by individuals from the academic community, bait dealers and producers, aquarium fish trade, aquaculture, ornamental fish pond trade, and others including other TPWD divisions. A wide array of issues was discussed and opinions from different groups expressed. Ultimately an Exotic Species Task Force (advisory board) was selected with one or two individuals from most of the major interest groups represented. This met on several occasions over the subsequent months. However, during a political climate nationwide at the time to reduce restrictive regulations of all kinds in all areas of government, the TPWC indicated a lack of inclination to address any dramatic changes to existing TPWD regulations. This task force is currently on a "meet by need" status.

# TPWD Regulations: March 23, 1995
## (Effective May 8, 1995)

- Egeria *Egeria densa* was removed from the list of prohibited plants. Because this species was (1) already established in Texas, (2) abundant only at sites in San Marcos and New Braunfels, and (3) sold extensively through biological supply catalogues for use in classroom studies, continued restriction appeared to provide little environmental protection and confounded science education.
- TPWD was allowed use of exotic species in department approved research activities and by public aquaria.

- A regulation which allowed possession of grass carp x bighead carp hybrids was deleted. This regulation had originally been written years earlier and ultimately maintained for a time until most existing stocks were lost. A wide array of genetic types found in TPWD research among this hybrid led to concerns about its safety. This in conjunction with permitting of triploid grass carp prompted the elimination of legal possession of hybrid grass carp.

- A health certification was required for all exotic shell fishes in possession by individuals conducting research or at public aquaria.

- Authority was provided for transportation of harmful or potentially harmful fishes, shellfishes, and aquatic plants by permit holders doing research or displaying such species at public aquaria.

- Permit applicants were required to provide the department an emergency plan covering harmful or potentially harmful exotics held within an exotic species exclusion zone (coastally to a line drawn from Laredo to San Antonio to Bryan to Nacogdoches and eastward to the Louisiana-Texas state line).

- Date of expiration and renewal of exotic species permits was defined as 31 December 1995.

- New effluent screening requirements for facilities which house permitted exotic species were defined.

- Criteria, fees, expiration, and permit requirements for Exotic Species Interstate Transport Permits were also defined.

# TPWD Regulations: November 7, 1996
## (Effective February 25, 1997)

As part of a periodic sunset process which requires review and readoption of regulations, the TPWD repealed existing regulations on harmful and potentially harmful fishes, shellfishes, and aquatic plants and then readopted these regulations with the following modifications.

- Licensed retailers or wholesalers could purchase Mexican white shrimp *Penaeus vannamei* without an exotic species permit if their facilities were not located within the Exotic Species Exclusion Zone and the shrimp were dead and packed on ice or frozen.

- TPWD was authorized to stock triploid grass carp.

- Pike cichlids *Crenicichla* and *Batrachops*, banded knifefish *Gymnotus carapo*, and Asian clam *Corbicula* spp. were deleted from the prohibited list. Pike cichlids were removed largely under pressure from the exotic fish trade. Banded knifefish was included in the first TPWD list in the 1960s, but without explanation. Because it is one of several nearly identical species (regulation was nearly unenforceable), much less potentially problematic than some other knifefishes, and currently of little interest to the pet trade (other species are preferred) but was of interest in certain medical research. Therefore, continued restriction was unnecessary. Asian clams were deleted because they are already distributed statewide, dispersal was largely due to natural methods unimpacted by legal restrictions, and academic research was being confounded by the lengthy times required to obtained exotic species permits necessary to work with Asian clams.

- Comments from the Texas Natural Resources Conservation Commission (TNRCC) relating to permits for planned discharges by new facilities were sent to the Texas Register for publication.

# TPWD Regulations: January 23, 1997
## (Effective February 25, 1997)

- First-time exotic species permit applicants must obtain appropriate authorization or exemption from TNRCC for facility waste-water discharges.

# TPWD Regulations: November 6, 1997
## (Effective December 29, 1997)

- All species of swamp eels (Family Synbranchidae) and freshwater eels (Anguillidae, except *Anguilla rostrata*) are added to the prohibited list.
- Definitions for disease, disease-free, waste, and water are added to the regulations.
- Quarantine of pathogen-infected exotic shellfishes discussed along with notification of the Department in the case of mortalities and clarified requirements for certification of disease-free shellfish stocks.
- Applicants for renewal of exotic species permits must also obtain authorization or exemption from TNRCC for facility waste-water discharges.
- A Memorandum of Understanding between TPWD and TNRCC is developed concerning exotic species issues concerning permits and emergencies at waste-water discharge sites.

# TPWD Regulations: April 16, 1998
## (Effective June 21, 1998)

- Status of Japanese eel *Anguilla japonica* had been changed on the list of Harmful and Potentially Harmful Exotic Fish Species so that it could be possessed, propagated, transported, and sold with an appropriate permit. New wording allows only a single company currently in possession of stocks of this fish to continue to culture it, but prohibits any future individuals to do so.

# OTHER REGULATIONS AND LAWS

Both state and federal regulations also restrict possession and sale of threatened and endangered species. In Texas, threatened and endangered species listed are all native to the state; however, federal lists also contain certain exotic as well as native species. In general, these federally restricted exotics are not discussed here. Similarly, various state and federal health and agriculture department regulations may also restrict certain species which also are not described here.

## National Invasive Species Act and 100th Meridian Initiative

The Nonindigenous Aquatic Nuisance Act of 1990 was reauthorized in 1997 as the National Invasive Species Act (NISA). Though initially motivated by invasive zebra mussels in the Great Lakes, the importance of this problem has become more widely recognized. The reauthorization expanded the concerns of this Act to include funding for certain projects and establishment of educational efforts. Also included was the "100 Meridian Initiative." This concept was aggressively pushed by far-western states where zebra mussels have

not been introduced or established as yet. Its major thrust focuses on states like Texas positioned along the 100th meridian (roughly the east side of the Texas Panhandle) as a line across which no zebra mussel incursions should be permitted. It encourages the U.S. Fish and Wildlife Service to prompt states like Texas which has no zebra mussel programs (*i.e.*, no monitoring, no educational efforts, etc.) to become more functionally active in preventing zebra mussels from expanding further west.

# GENETIC CONSIDERATIONS

Many of our views about what a species actually is have undergone certain changes in recent years. A species is generally defined as a group of interbreeding or potentially interbreeding populations of organisms that are reproductively isolated from other groups. Some definitions include certain characteristics in common or the ability to produce fertile offspring. Historically, an organism's physical appearance, geographic range and even coloration were used to define it as a unique species. However, the development of biochemical genetic analysis, in conjunction with domestic breeding and the introduction of species outside their native ranges, has resulted both in new insights and new problems in defining species. For example, Mexican tetra *Astyanax mexicanus*, a silvery fish native to some South Texas streams, has been shown to be the same species as Mexican blind cave tetra (previously *Anoptichthys jordani*) which is a pigmentless pink and without eyes (two fishes that appear very different are actually the same species). Conversely, some cultured tilapia species cannot definitely be identified solely on appearance; detailed biochemical techniques in the laboratory are needed to determine the identity (i.e., two species that appear nearly identical are actually distinct). Because of problems like these, some understanding of genetics and of genetic terms is necessary, especially when considering cultured fishes.

**Basic Genetic Concepts**

Genetics is the branch of biology concerned with heredity and variation in inherited characters. Genes are the basic units of inheritance, and are arranged within each cell in long chains called chromosomes. Most cells in most organisms contain two pairs of chromosomes and are referred to as 2N. Sperm and unfertilized egg cells contain half of each chromosome pair or 1N. At fertilization, the chromosomes (hence the genes) from the sperm are combined with the chromosomes from the egg to produce a cell that is 2N again (1N + 1N = 2N). Typically then, half the genes the newly fertilized egg receives come from the father and half from the mother. The two genes in each pair may be alike (called homozygous) or may be different (called heterozygous). For example, wild-type guppies typically have a gene for basic coloration (actually a pair of the same genes); however, another gene for gold exists but only produces gold- or yellow-colored fish when two gold genes are present. Guppies with a pair of wild-type genes (homozygous) or with one wild-type gene and one gold gene (heterozygous) appear normal and cannot be visually differentiated.

**Ploidy**

Typical 2N organisms are called diploid, or are said to have a diploid number of chromosomes. The 1N number of chromosomes in their sperm or unfertilized eggs is called haploid, or the haploid number. Some organisms, common carp and goldfish *Carassius auratus* for example, normally contain four sets of chromosomes and are said to be tetraploid (4N). When three sets of chromosomes are present, the individual is called triploid (3N).

Advances in genetic manipulation of cells in the laboratory have enabled fisheries scientists to deliberately produce abnormal triploid specimens. In general, triploids tend to be and sometimes grow larger and faster than normal diploid individuals. The triploid grass carp is an example of a laboratory-produced animal that is believed to be incapable of reproduction.

The TPWD position is that specimens of all ploidys are considered the same species. For example, because grass carp are restricted, both normal diploid and triploid grass carp are still the same species and are also restricted. One minor problem to be aware of relates to a Biological Opinion on triploid grass carp issued several years ago by R. E. Stevens and J. G. Stanley of the U.S. Fish and Wildlife Service which stated "such a sterile animal [a triploid] technically is not a species because it is incapable of reproduction, hence regulations against exotic species may not be legally binding to triploid animals." This statement is far more philosophical than scientific and few professional scientists are likely to take it seriously; none the less, it may open the door for legal challenges of some restricted fish regulations that specify "species" without clearly addressing the status of genetic variants.

**Hybrids**

The definition of "hybrid" used here in terms of classification is the result of a cross between two different species. Such individuals are heterozygous for many characteristics. Also, in basic genetic terms, hybrid may simply mean the heterozygous condition for any characteristic. For example, a gold-colored goldfish crossed with an olive-colored goldfish could produce some offspring which would be considered hybrid for color. However, use of the term here refers to the hybrid between species.

**Domestic Strains**

Most American fisheries scientists have been trained to deal with native fishes. Most have limited experience with a broad number of exotic species, and fewer still have had extensive exposure to the large number of domestic strains seen in some cultured species. These domestic variants may differ dramatically in color or form from the original wild-types. Goldfish is a prime example where strains may vary in color, number of tails, presence or absence of dorsal fins, length of fins, normal or bulging eyes, presence or absence of scales, scale patterns and many other characters. Channel catfish has both albino (white) and melanistic (black) strains. Several species of tilapia being cultured may be red, gold, white, pink and spotted as well as in their normal wild-type colors. Some normally elongated tilapia have been bred to be extremely deep bodied.

Unfortunately these domestic variants can confuse accurate identification. However, most of the restricted species described here do not differ substantially from normal wild-types. Where domestic variants or wild mutations are known, comments are provided under each species account.

# AQUACULTURE AND THE PET TRADE

The majority of species of exotic fishes introduced in the U.S. has probably come from pet trade sources including deliberate and accidental releases from tropical fish farmers in the southern states and from aquarists around the country. In general, most aquarists are unaware of legal and environmental implications of releasing aquarium fishes. While many could probably understand potential problems with releasing piranhas, fewer understand that even seemingly insignificant species like guppies or swordtails *Xiphophorus* spp. can threaten certain native fishes under some conditions. Because public acceptance of restricted fish regulations is to a large part voluntary compliance, educating aquarists about both regulations and potential release-related problems is essential.

It should also be noted that over an estimated 2,000 species of freshwater and marine fishes may be imported annually for sale in the pet trade (but not to be interpreted as 2,000 new species). E.A. Lachner, C.R. Robins and W.R. Courtenay indicated in a 1970 paper that in excess of 6,000 species of tropical freshwater fishes have been recognized (not to mention marine species and those more recently described). Often imported species are not well known to either aquarists or scientists. For example, one African rift-lake cichlid was imported and spawned commercially for several years as *Pseudotropheus* "kennyi" before it was formally described as a species (*P. lombardoi*). Similarly, some species are entirely new forms and unknown to ichthyologists. Violations of restricted fish regulations may occur unintentionally.

Frequently when fish are shipped either from their native ranges or from large domestic wholesalers, shipments may include unordered fish species, often under invented common names. One Ohio tropical fish store once received a shipment of Central American poison arrow frogs *Dendrobates* sp. invoiced as "clown frogs." The shipper had failed to mention to the retailer, who had ordered fish, that while the frogs were attractive, they were also quite toxic. In another instance, a shipment to a Delaware retailer contained unordered fishes labeled "butterfly cod." These fish were actually poisonous Australian scorpionfishes *Notesthes robusta*. Even conscientious wholesalers, retailers and aquarists may be confused as to the identity and subsequently the legality of some species.

Aquaculturists (fish farmers, as opposed to aquarists) may rear non-native fishes for stocking as game fish or forage, use as bait, aquatic vegetation control, human consumption and even ornamental purposes, in a few cases. Although most of the species listed as restricted in Texas are more likely to be encountered in the aquarium trade, restricted aquacultural fishes such as tilapia and Chinese carps may account for fewer species but may involve far more individual specimens and overall biomass than do pet trade fishes. Aquacultural species like Chinese carps and rudd often originate in temperate regions and may have a better chance of long-term survival in Texas waters than do most tropical aquarium fishes. Further, the possibility of accidental releases or escapes is often far greater for

fishes held in ponds and outdoor tanks than for aquarium specimens.

Over time, representatives of the pet industry have approached the Department with suggested reasons to modify existing restrictive regulations on exotic species. Among some of the more-recent suggests was a request to allow dealers to import for display purposes virtually any prohibited species under the claim that such display specimens would enhance sales of other species. Another such concept was that prohibited species which were generally considered "freshwater fishes" would not be prohibited if maintained in salt water. Thus far the Department has rejected both concepts.

# USING THIS GUIDE

This revised guide updates the species restricted in Texas, and includes additional information not in the previous guide (Howells, R.G. 1985. A Preliminary Guide to Fishes Restricted in Texas, TPWD). A substantial amount of technical information has not been included in an effort to make this material more readable and more useable to the non-fisheries scientist. In some cases, technical details which may be of use have been included (often in Technical Notes at the end of the species account).

The guide provides an illustration and description of the species and discussion of its biology, as well as similar species which may cause confusion. It provides an indication of whether restricted species are of interest to either aquaculturists or to the pet trade. Discussion is also provided as to reasons for restricted status.

While fishes are largely listed in taxonomic order, several similar groups have been combined for simplicity of identification. Several complex groups are described in more detail where brief descriptions could lead to misidentification. Note that while most accounts discuss the prohibited species or group, several discuss a small number of exemptions rather than the larger number of prohibited species (e.g., "all except..."). Major topics in species accounts include:

- Other Names
- Specifics (relative to classification)
- Range (including introductions, if any)
- Description (including appearance and size)
- Biology
- Commercial Importance (to U.S. aquaculture or pet trade)
- Reasons For Restriction
- Similar Species
- Technical Notes

Note that illustrations herein are diagrammatic. Do Not attempt to obtain spine, ray or scale counts from these drawings. Consult text descriptions for details.

A list of references has been added at the end; however, most in-text cites typical of scientific publications have been excluded. Use of point by point citations would have made the text cumbersome for quick reference use.

# SPECIES ACCOUNTS: PROHIBITED FISHES

## Definitions

**Note: Types of measurements and counting methods were indicated where possible and where necessary; however, because information was compiled from both recent and dated as well as American and foreign references, a wide variety of data types and notation was encountered. Some sources failed to define the basis for their counts and measurements. Figures which correspond to the following definitions are presented on pages 18 through 20.**

**Body depth** - measured as the greatest vertical distance from the top (dorsal) to the bottom (ventral) surfaces (excluding fins and their associated supporting structures), wherever it occurs.

**Fork length (FL)** - measured from the most forward (anterior) point on the head (tip of the snout or lower jaw) to the rear-most (posterior) tip of the central tail fin (caudal fin) rays; note that this applies to fishes with rounded or diamond-shaped tails as well as to fork-tailed species.

**Gill rakers** - typically counted on the first gill arch and

may be given as the count for the total arch, the count for the lower arch only or as the lower number plus the upper number; if only the count for the lower arch is given, it should be so designated, but some authors have failed to do so; gill rakers that fall at the angle of the gill arch are included in the count for the lower arch; generally only the outer-most major gill rakers (anterior) are counted (an inner or posterior row is sometime present), unless otherwise stated.

**Lateral line scale count** - typically includes all scales along the lateral line with pores, but may represent the lateral series of scales whether pored or not; pored versus unpored counts may be very similar or may differ dramatically in some species; American counts terminate at the base of the caudal fin, but Europeans often count additional scales that extend onto the caudal fin itself.

**Pharyngeal teeth** - rows of projections on the modified fifth gill arch that are counted as they occur in vertical rows from left to right (e.g., 1,2,3-3,2,1 or three rows on each side with 1, 2, and 3 teeth in each row, respectively). Pharyngeal teeth are sometimes illustrated in reverse order (i.e., the left gill arch and teeth appear on the right side of the illustration with the right arch and teeth on the left side of the figure, the opposite of the numerical designation).

**Rays (in fins)** - soft (occasionally hardened or ossified), segmented and branched or unbranched; note that American scientists typically count only the last unbranched ray plus all the branched rays to produce a total ray count, but Europeans often count all unbranched rays; also note that some count hardened, spine-like rays as spines; the last ray of the dorsal and anal fins is often branched both at the tip and at the base but is still usually counted as a single ray; although there are many different types of notation to designate rays, lower case letters are used here to indicated unbranched rays and Arabic numerals to indicate branched rays (e.g., iii, 7-9 indicates three unbranched and seven to nine branched rays); the term "rays" can also be used more broadly to mean all spines and rays collectively.

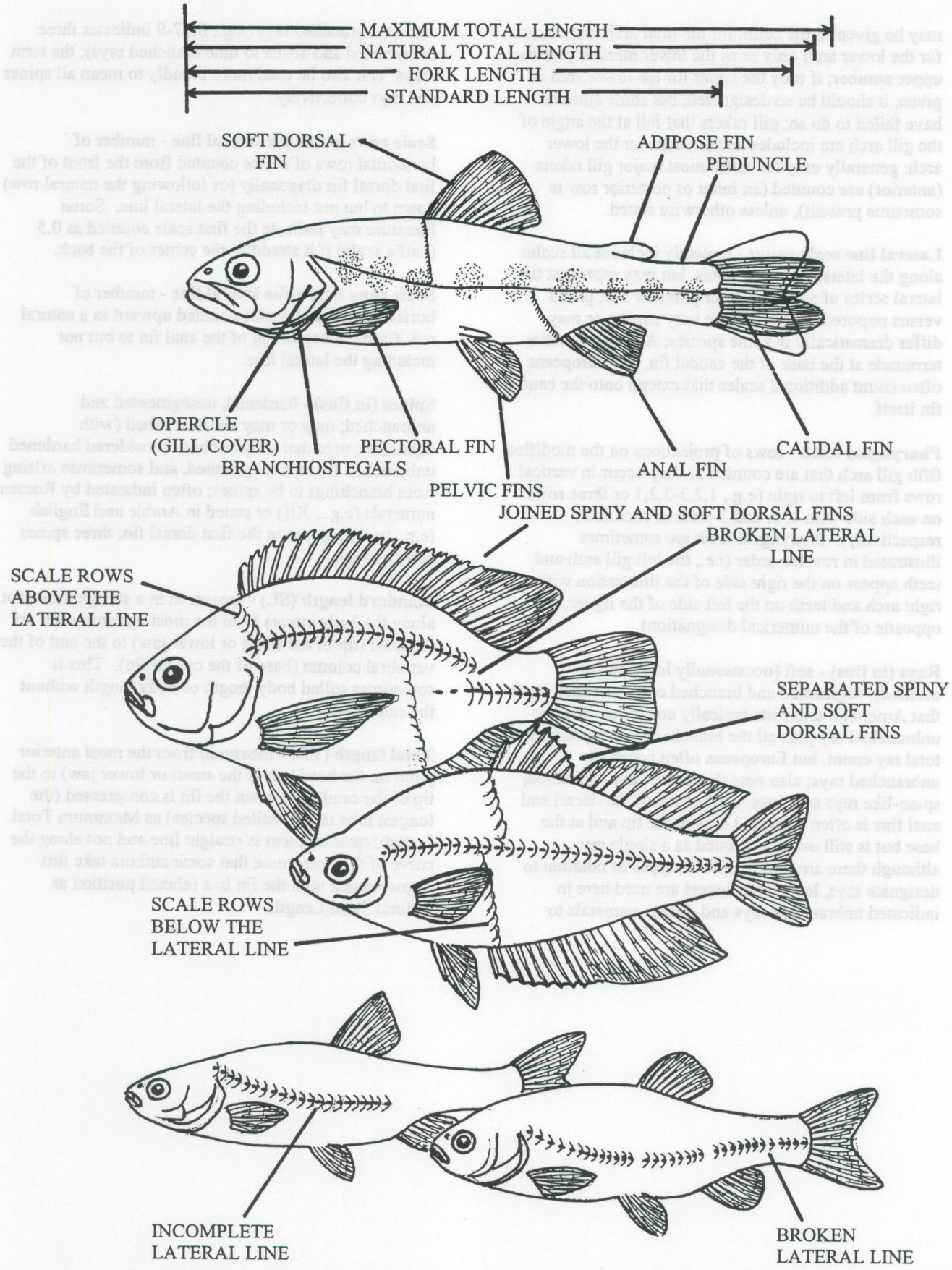
**Scale rows above the lateral line** - number of horizontal rows of scales counted from the front of the first dorsal fin diagonally (or following the natural row) down to but not including the lateral line. Some literature may indicate the first scale counted as 0.5 (half a scale) if it straddles the center of the back.

**Scale rows below the lateral line** - number of horizontal rows of scales counted upward in a natural row from the beginning of the anal fin to but not including the lateral line.

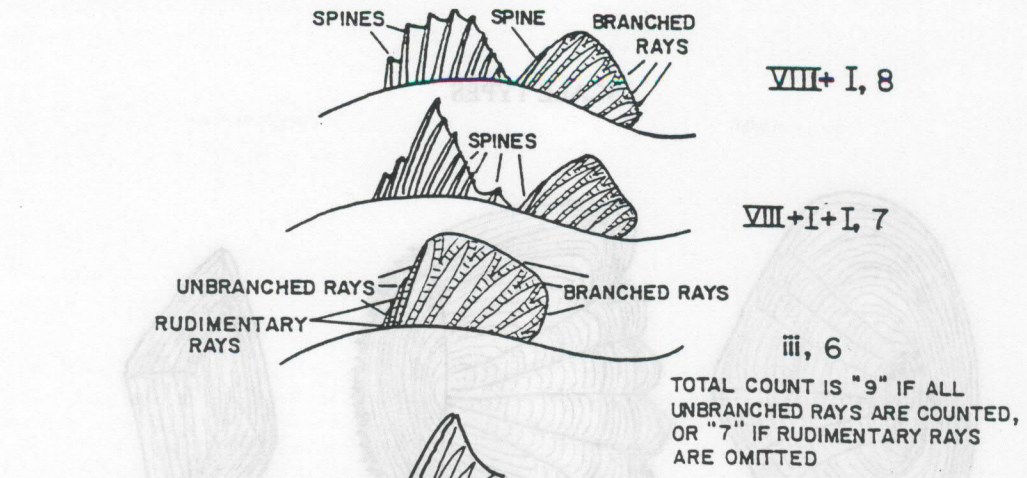
**Spines (in fins)** - hardened, unsegmented and unbranched; may or may not be toothed (with denticles); note that some authors considered hardened unbranched fin rays (segmented, and sometimes arising from branching) to be spines; often indicated by Roman numerals (e.g.., XII) or stated in Arabic and English (e.g., twelve spines in the first dorsal fin; three spines and 12 rays).

**Standard length (SL)** - measured in a straight line (not along the body curve) from the most anterior point on the head (tip of the snout or lower jaw) to the end of the vertebral column (base of the caudal fin). This is sometimes called body length or body length without the caudal fin.

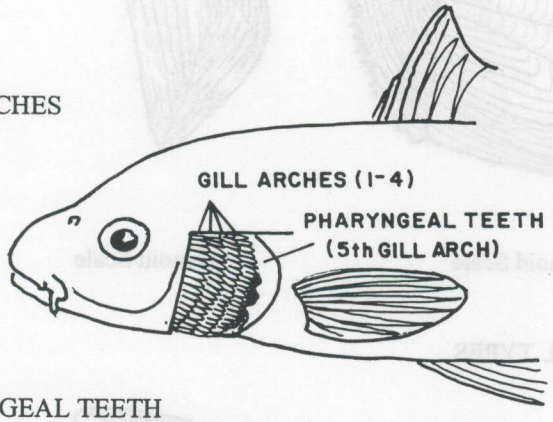
**Total length (TL)** - measured from the most anterior point on the head (tip of the snout or lower jaw) to the tip of the caudal fin when the fin is compressed (the longest lobe in fork-tailed species) as Maximum Total Length; measurement is straight line and not along the curve of the body; note that some authors take this measurement with the fin in a relaxed position as Natural Total Length.


MAXIMUM TOTAL LENGTH
NATURAL TOTAL LENGTH
FORK LENGTH
STANDARD LENGTH
SOFT DORSAL FIN
ADIPOSE FIN
PEDUNCLE
OPERCLE (GILL COVER)
BRANCHIOSTEGALS
PECTORAL FIN
PELVIC FINS
ANAL FIN
CAUDAL FIN
JOINED SPINY AND SOFT DORSAL FINS
BROKEN LATERAL LINE
SCALE ROWS ABOVE THE LATERAL LINE
SEPARATED SPINY AND SOFT DORSAL FINS
SCALE ROWS BELOW THE LATERAL LINE
INCOMPLETE LATERAL LINE
BROKEN LATERAL LINE

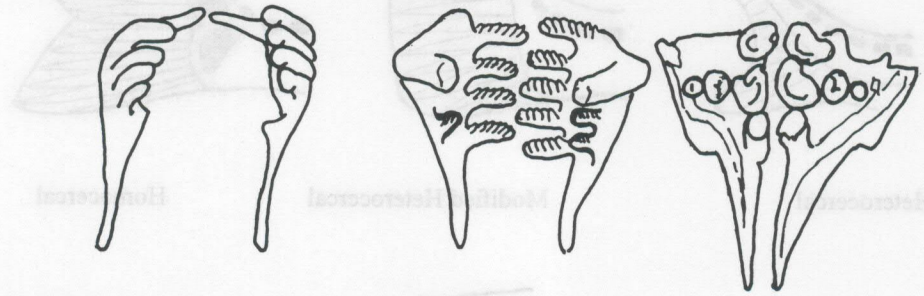
SPINE AND RAY COUNTS



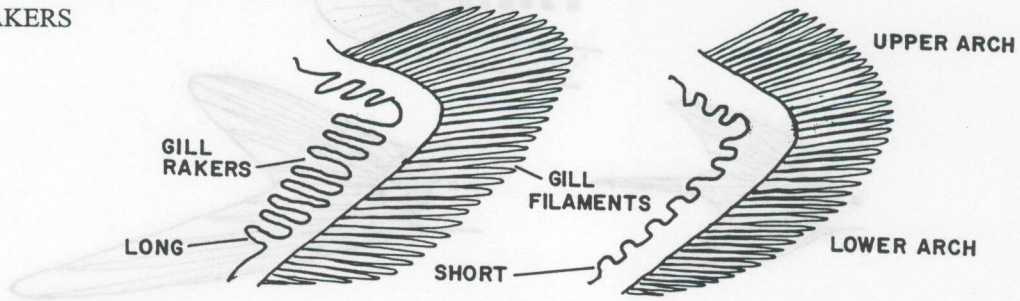

GILL ARCHES




PHARYNGEAL TEETH



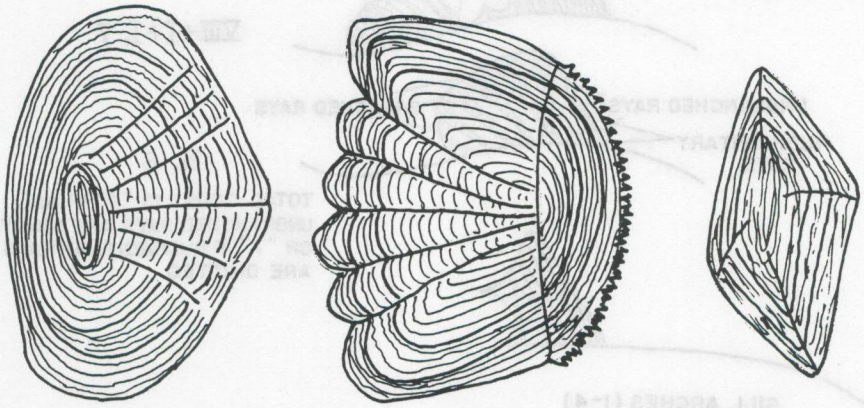

GILL RAKERS




COUNTS: 8 ON LOWER ARCH
11 TOTAL

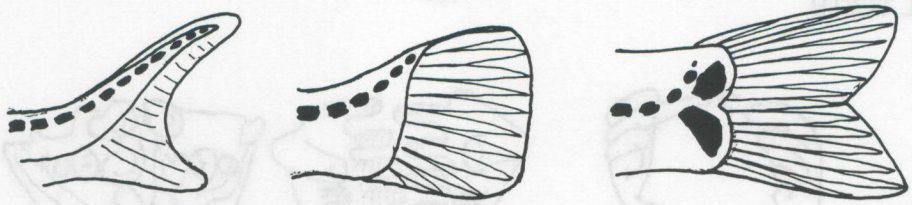
7 ON LOWER ARCH
10 TOTAL

SCALE TYPES

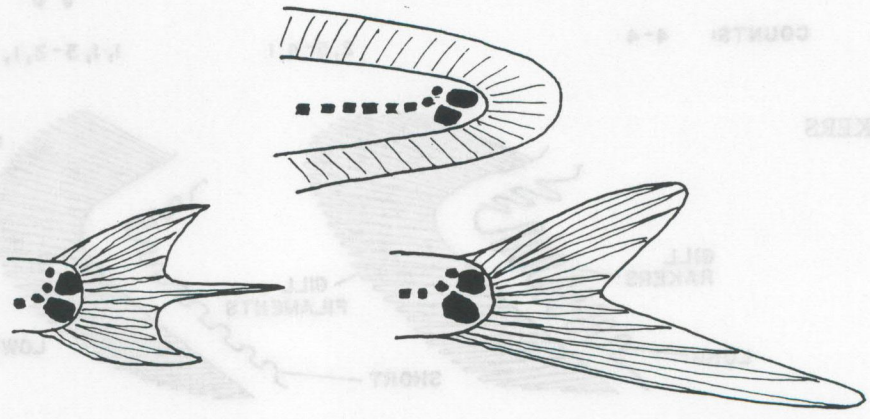


Cycloid Scale  Ctenoid Scale  Ganoid Scale

TAIL TYPES



Heterocercal  Modified Heterocercal  Homocercal



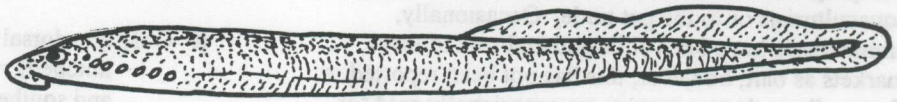
Homocercal

# LAMPREYS

## Family: Petromyzontidae

### All Species Except
### Chestnut Lamprey *Ichthyomyzon castaneus* and
### Southern Brook Lamprey *I. gagei*

Chestnut Lamprey
*Ichthyomyzon castaneus*



Southern Brook Lamprey
*Ichthyomyzon gagei*

**Other Names:**
Lamprey-eel, lamper eel, river lamprey, lamper, blood sucker, seven-eyed cat.

**Specifics:**
All lampreys (about 30-35 total species) are restricted except two species native to Texas. Family has also been spelled Petromyzonidae.

**Note: Chestnut and southern brook lampreys are unrestricted; all other lampreys are restricted (most other species accounts in this guide describe those species that are restricted).**

**Range:**
Lampreys are found in North America, Chile, Argentina, northern Europe and Asia, southeastern Australia, Tasmania and New Zealand. Chestnut lamprey ranges up the Mississippi Valley into Canada, including extreme East Texas river systems. Southern brook lamprey is found from East Texas (Neches and Sabine rivers) and Oklahoma, east to Florida and Georgia, and north to Missouri and Tennessee.

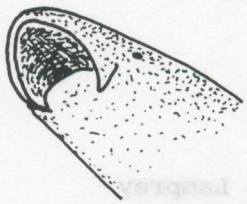
**Description:**
Lampreys are eel-like, but with no jaws, a sucker-like mouth, no paired fins, no true bone, no true teeth (although horny spines in the mouth are called teeth), seven gill openings on each side and small but well developed eyes in adults.

Chestnut lamprey: Adults are 4-13 inches (102-330 mm) in length (larvae to 6 inches/152 mm); coloration is yellowish-tan to brown, more olive on belly; the mouth when expanded is wider than head; disc teeth are well developed, with the inner-most (circumoral) teeth with two points; muscle bands between last gill opening and vent are 49-56 (usually 52-54); the dorsal fin is shallowly notched but not divided. It is parasitic.

Southern brook lamprey: Adults are 4.5-7 inches (102-145 mm) in length (larvae to 7 inches/145 mm); coloration is olive-brown above, yellowish below; the mouth is less wide than the head; disc teeth are moderately well developed except posteriorly, inner-most (circumoral) teeth have two points; muscle bands between last gill opening and vent number 52-54; the dorsal fin is shallowly notched but not divided. It is nonparasitic.

Larvae: Larval lampreys, called ammocoetes, are similar to adults in shape, often pale in color, and have poorly developed eyes covered by skin. The mouth is a horseshoe-shaped hood and a horizontal groove connects gill openings.

**Biology:**
Adult lampreys may be either nonparasitic (often nonfeeding) or parasitic, preying on other fishes by attaching with their suction cup-like mouth and rasping into tissue to obtain blood and other fluids. They migrate upstream to nest and spawn on gravel areas. Hatched larvae drift downstream to soft sediment areas where they burrow and may remain as filter-feeders for several years (2-3 years or more in native species). Upon transformation to adults, nonparasitic species may only live long enough to spawn and die; however, parasitic species may live several years (18 months in chestnut lamprey) during which time they feed on other fishes before spawning and also dying. Both native species are small, relatively uncommon and are held in check by predators so that even parasitism by chestnut lampreys has little or no impact on other fish populations.



Mouth

Lamprey Ammocoete Larva

**Commercial Importance:**
Lampreys have no commercial importance to either aquaculturists or to the pet trade. Occasionally, ammocoetes have been collected and sold in local markets as bait; however, this has not been reported in Texas. Some larger species are occasionally sold for human consumption in old-world fish markets, but rarely in the U.S.

**Reasons For Restriction:** Parasitic lampreys can cause major damage to native fish populations in some situations. Damage to commercial and sport fisheries when parasitic sea lampreys *Petromyzon marinus* invaded the Great Lakes is well documented. Nonparasitic species would likely have little environmental impact if introduced in Texas waters, but were restricted to avoid confusion with more potentially problematic parasitic forms.

**Similar Species:**

Northern and Southern Hemisphere species:

Northern Hemisphere (Family Petromyzontidae, including chestnut and southern brook lamprey):

- Upper margin of central mouth has only a single anterior dental plate.
- Margin of mouth with both smooth and fringed papillae (finger-like projections) which are not arranged in alternating large and small sizes.

Southern Hemisphere (Family Mordaciidae and Geotriidae, genera and species from Australia, Tasmania, New Zealand, Chile and Argentina):

- Upper margin of central mouth with two anterior dental plates (Mordaciidae) or with a spatula-like prong on each side and two pointed central cusps (Geotriidae).
- Margin of mouth with only smooth papillae (Mordaciidae) or alternating large and small papillae (Geotriidae).

Northern Hemisphere genera (North America, Europe, Asia):

- Only one dorsal fin (may be slightly notched) = *Ichthyomyzon* including chestnut and southern brook lamprey as well as other species.
- Two dorsal fins or nearly two (deep notch) = other restricted genera (e.g., *Petromyzon, Entosphenus*, *Caspiomyzon, Lampetra*).

Genus *Ichthyomyzon* lampreys (adults):

- Parasitic species-mouth wider than head:
  - Circumoral teeth (on each side of the mouth) with only one point=silver lamprey *I. unicuspis* (Restricted).
  - Circumoral teeth with two points and 51-54 muscle segments between last gill opening and vent=chestnut lamprey *I. castaneus* (Unrestricted).
  - Circumoral teeth with two points and 55-61 muscle segments between last gill opening and vent=Ohio lamprey *I. bdellium* (Restricted).
- Nonparasitic species-mouth not wider than head:
  - All teeth small and poorly developed, circumoral teeth not with two points=northern brook lamprey *I. fossor* (Restricted).
  - Teeth moderately well developed, circumoral teeth with two points, 51-54 muscle segments between last gill opening and vent=southern brook lamprey *I. gagei* (Unrestricted).
  - Teeth moderately well developed, circumoral teeth with two points, 55-61 muscle segments between last gill opening and vent=Allegheny brook lamprey *I. greeleyi* (Restricted).

**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.**

**Technical Notes:**

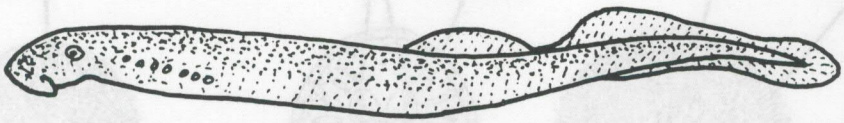
(1) American eel *Anguilla rostrata* is the only other eel-like fish found in fresh water in Texas. It has true jaws (not a sucker-like mouth as in lampreys), a pair of gill openings (lampreys have seven pairs), pectoral fins (absent in lampreys) and a continuous dorsal, caudal and anal fin that is not notched (notched or separated in lampreys).

(2) The American Fisheries Society places the genus *Entosphenus* under *Ichthyomyzon*; it has been retained separately here to aid in differentiating some species and to be consistent with other published literature sources.

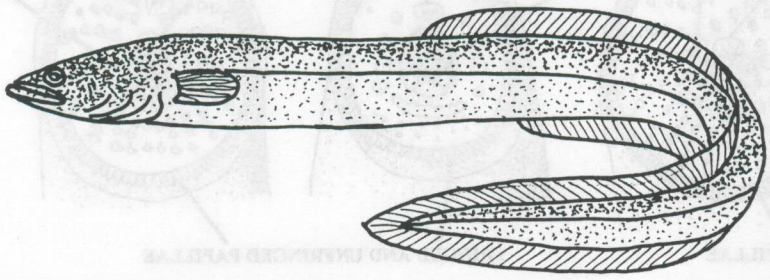
**References:**

Axelrod et al. 1989; Beemish and Thomas 1984; Berg 1948; Blanc et al. 1971; Eddy 1969; Fowler 1940; Frank 1971; Hardisty and Potter 1971; Hardy 1978a: Hubbs 1961; Hubbs and Lagler 1974; Jones et al. 1978; Knapp 1953; Lee et al. 1980; Merrick and Schmida 1984; Muus 1967; Scott and Crossman 1973; Sterba 1967.

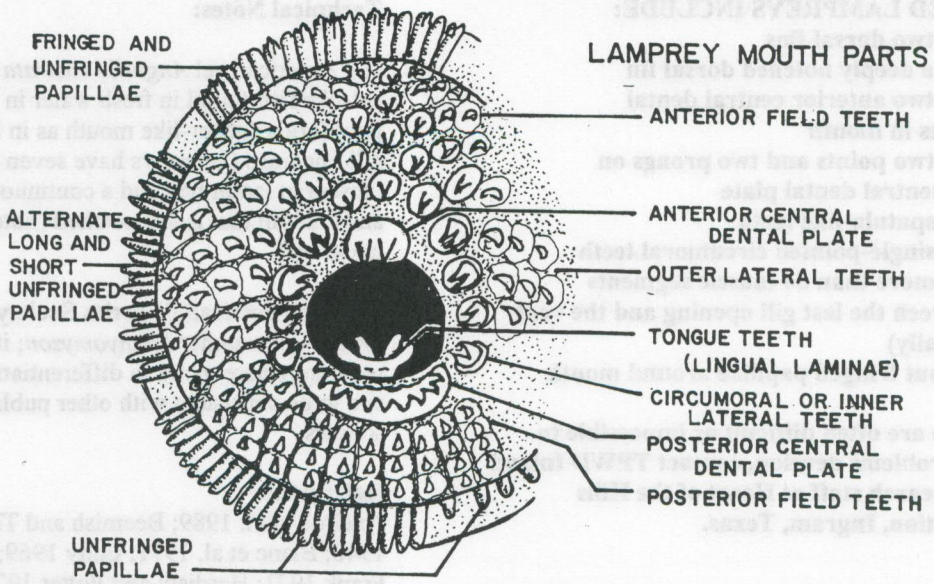
Danube Lamprey
*Eudontomyzon mariae*



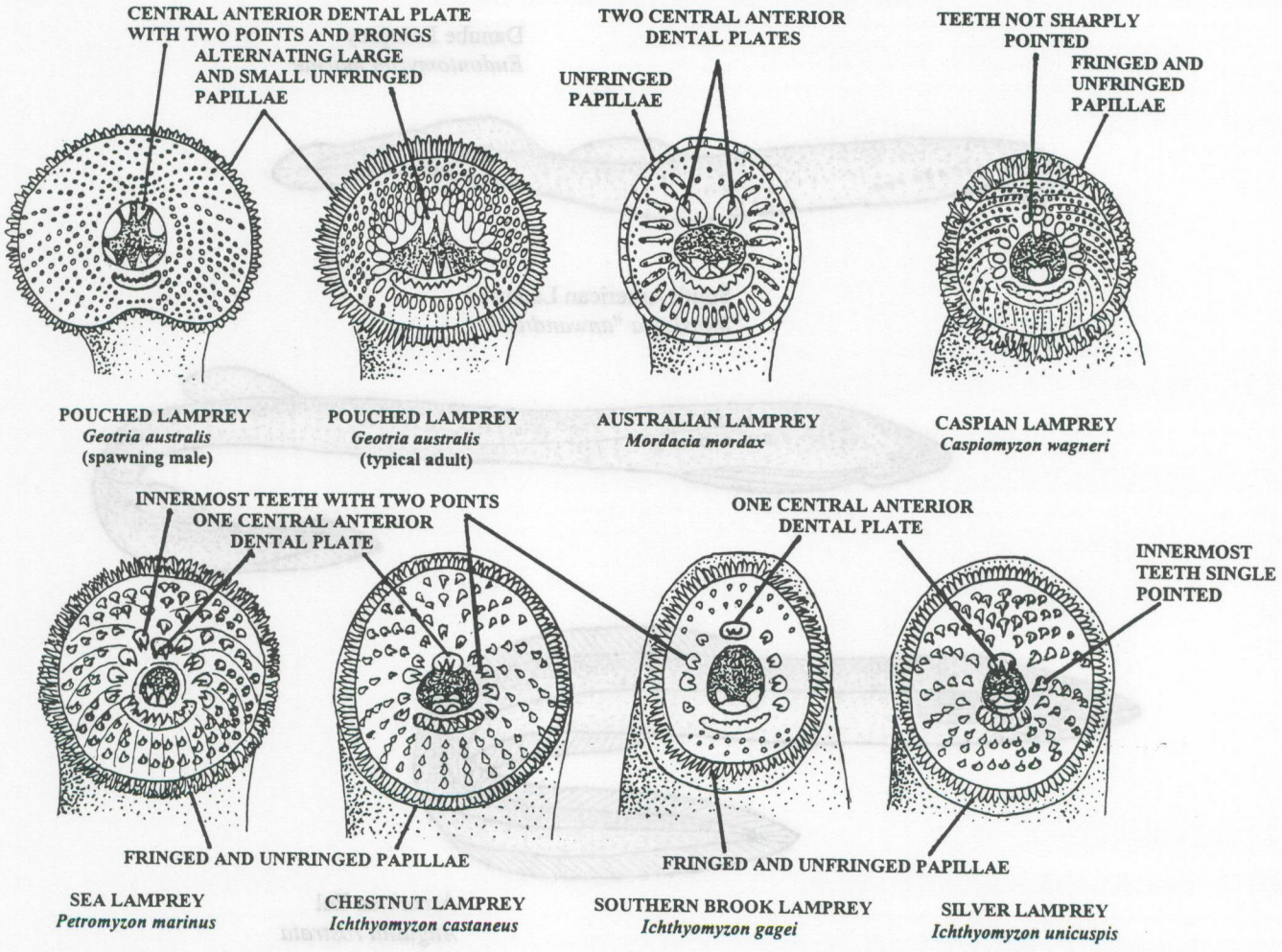
South American Lamprey
*Mordacia "anwandteri"*



American Eel
*Anguilla rostrata*

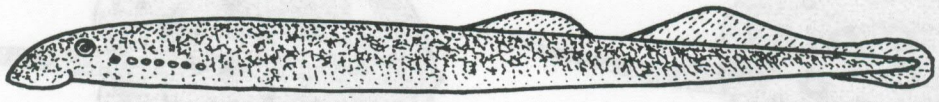



## LAMPREY MOUTH STURCTURES

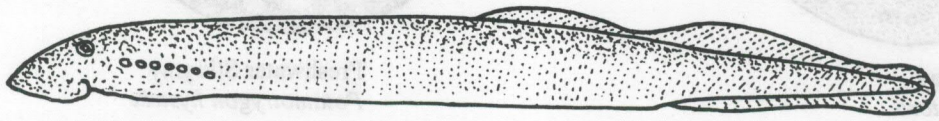


Pacific Lamprey *Entosphenus (Lampetra) tridentata*

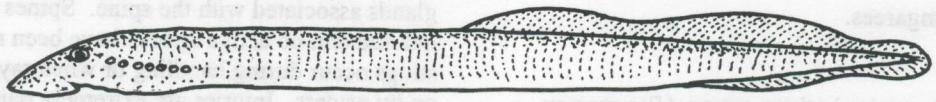
Sea Lamprey *Petromyzon marinus*



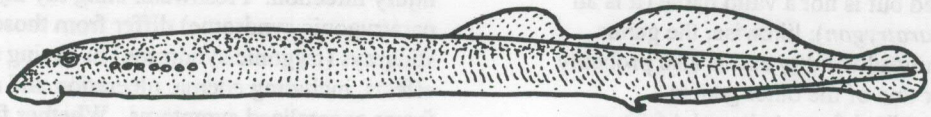
Silver Lamprey *Ichthyomyzon unicuspis*



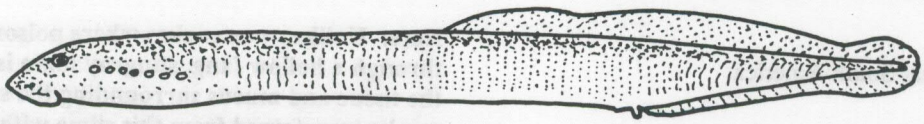
Ohio Lamprey *Ichthyomyzon bdellium*



American Brook Lamprey *Lampetra aepyptera*

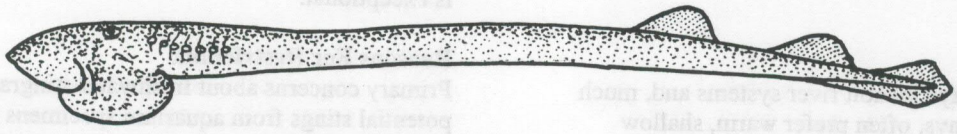


Northern Brook Lamprey *Ichthyomyzon fossor*

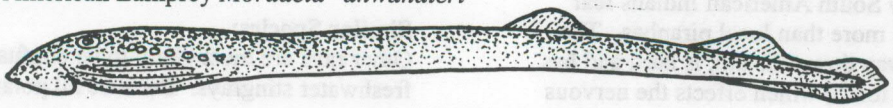


Arctic Lamprey *Lampetra japonica*

Pouched Lamprey *Geotria australis*



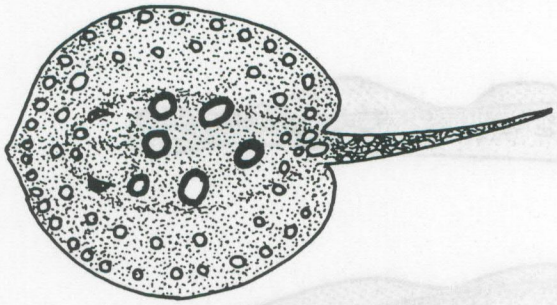
South American Lamprey *Mordacia "anwandteri"*



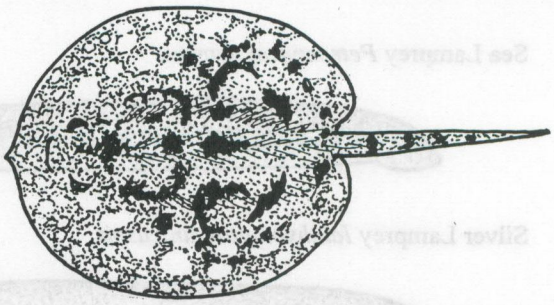
# FRESHWATER STINGRAYS

## Family: Potamotrygonidae

**All Species**



Freshwater Stingray
*Potamotrygon motoro*



Freshwater Stingray
*Potamotrygon hystrix*

**Other Names:**
River stingrays, stingarees.

**Specifics:**
There are about 20 species in three genera (*Paratrygon* with one species, *Potamotrygon* with 18 species and *Plesiotrygon* with one species). The genus *Disceus* has been frequently used but is not a valid name (it is an old synonym for *Paratrygon*); likewise, the genus *Elipesurus* is of doubtful validity and is also probably only a synonym for one of the other genera. Freshwater rays described from Asia and Africa are now considered to be in the marine stingray family Dasyatidae, as are freshwater rays from Australia.

**Range:**
They occur in tropical South America.

**Description:**
Freshwater stingrays have a body flattened into a rounded or slightly oval disc (never diamond-shaped), without a strongly projecting snout and with a whip-like tail (short to long in length) which is equipped with one or more poisonous spines. Disc diameter may reach 3-4 feet (0.9-1.2 m) in some species. Coloration is variable, typically brownish or grayish with lighter or darker spots; some have large numbers of ocellus-like spots (contrasting center and edge colors) and others appear speckled.

**Biology:**
Freshwater stingrays inhabit river systems and, much like marine stingrays, often prefer warm, shallow waters where they feed on mollusks and other invertebrates. Many South American Indians fear freshwater stingrays more than local piranhas. The spine, located part way down the tail, is hard and has serrated edges. The toxin, which effects the nervous system and causes protein break-down, is produced in glands associated with the spine. Spines are used for defense and no active attacks have been reported; most stings occur during handling or when rays are stepped on by waders. Injuries are extremely painful and involve not only the effects of the toxin, but tissue damage from the serrated edges of the spine and post-injury infection. Freshwater sting ray injuries (called paratrygonic syndrome) differ from those of other stingrays (trygonic syndrome) in having stronger local effects, including edema, ulceration and necrosis, and fewer generalized symptoms. Whether freshwater stingray injuries are inherently more lethal as suggested by some is open to debate.

**Note: Unlike some snakes where poison is injected through a hollow fang, stingray toxin is present in the tissue and mucus surrounding the spine; poison can be transferred from this slime without an actual spine puncture (be careful of cuts on hands during handling).**

**Commercial Importance:**
Limited numbers of freshwater stingrays are imported and sold in the pet trade; however, they are generally intolerant of poor water quality and often not long lived. Pet store specimens are typically wild-caught imports; although captive breeding has been reported, it is exceptional.

**Reasons For Restriction:**
Primary concerns about freshwater stingrays relate to potential stings from aquarium specimens and possible survival in heated power-plant reservoirs if released.

**Similar Species:**
Other rays are most likely to be confused with freshwater stingrays. Because all potamotrygonid

stingrays are restricted, it is not actually necessary to identify a specimen in question to genus and species. There is no simple way to positively distinguish restricted potamotrygonid stingrays from similar unrestricted species based on external characteristics. Freshwater stingrays have a pointed process on the pelvic girdle, reduced rectal glands and low tissue urea levels unlike other rays that have no pelvic process, well developed rectal glands and high urea levels.

Marine stingrays (Family Dasyatidae) -
Includes several species that may enter fresh water and (recently) at least one freshwater-acclimated species being sold in the pet trade.

- Disc diamond- or heart-shaped (round in freshwater stingrays), or if rounded, then pointed anteriorly. At least one marine species, *Himantura schmardae*, from the West Indies has a generally rounded disc and only a slight (but definite) anterior point.

Round stingrays (Family Urolophidae) -
Considered a subfamily of Dasyatidae by some authors.

- Disc round, typically with hint of a pointed snout (little or no snout in freshwater stingrays).
- Tail typically fairly heavy (typically thinner in freshwater stingrays).
- Tail with well developed caudal finfold extending around the end of the tail (never in freshwater stingrays).
- Marine (freshwater stingrays are never marine).

Butterfly rays (Family Gymnuridae) -

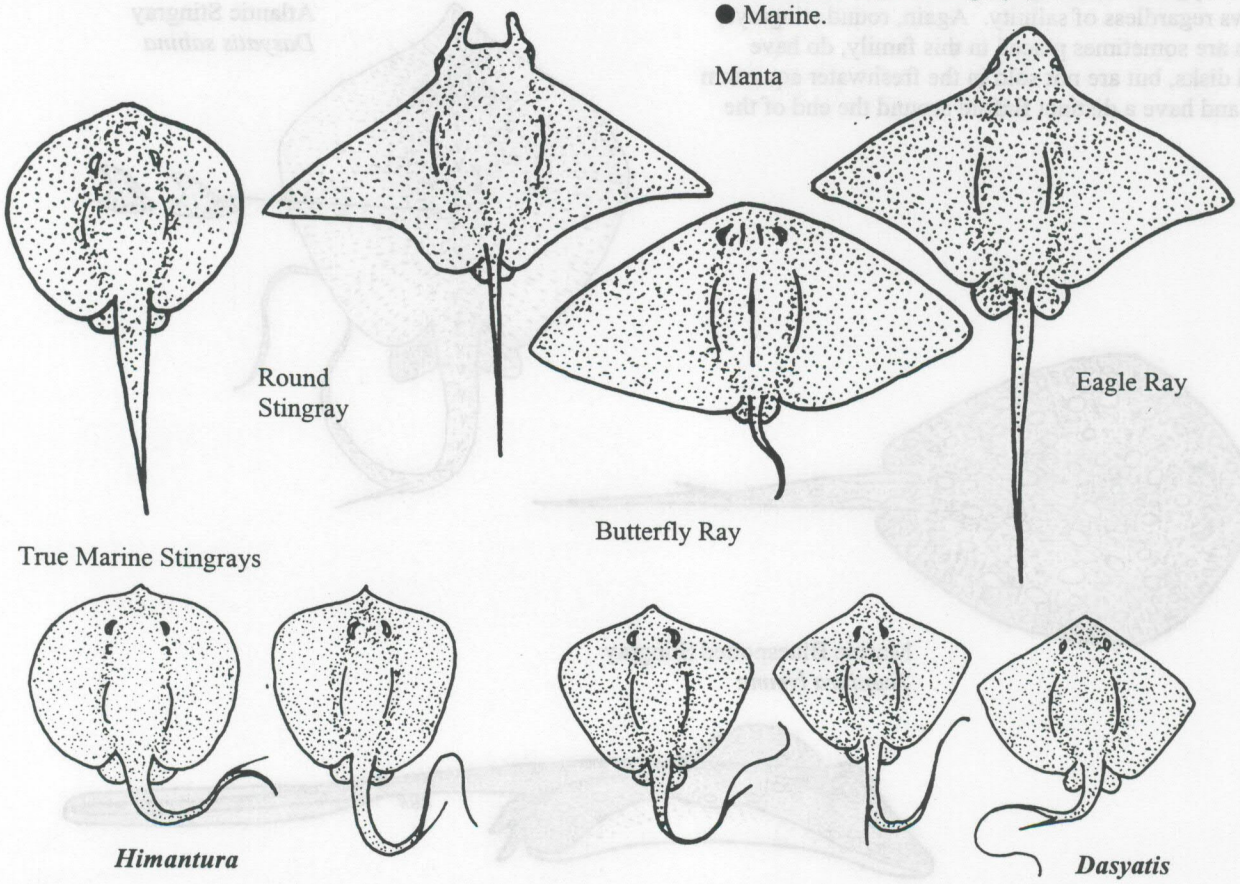
- Very wide disc (round in freshwater stingrays).
- Tail very short (short to long in freshwater stingrays).
- Marine.

Eagle rays (Family Myliobatidae)

- Snout protrudes (does not protrude in freshwater stingrays).
- Marine.

Mantas (Family Mobulidae)

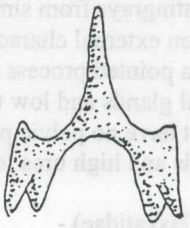
- Two finlike projections on head (absent in freshwater stingrays).
- Marine.



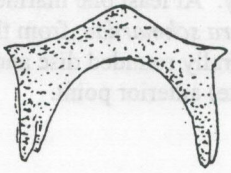
**Technical Notes:**

(1) The first edition of this book reported "Pet store rays being maintained in fresh water are almost certainly restricted freshwater stingrays and those in salt water almost certainly unrestricted species" like the marine bluespotted stingray *Taeniura* spp. This was generally true at the time. However, confusion arose in 1993 when TPWD Law Enforcement officers encountered stingrays for sale in local pet stores called "freshwater stingrays," but upon examination of some of these specimens, they were found to be a marine stingray (Atlantic stingray *Dasyatis sabina*). Further inquiry found that this species was apparently being reared in Florida, acclimated to fresh water, and shipped around the country for sale in the pet trade as a freshwater stingray. In Texas and in other states, true South American freshwater stingrays of the family Potamotrygonidae are prohibited, but freshwater-acclimated marine stingrays of the family Dasyatidae are not (regardless of the name under which they are being sold). A number of species of the family Dasyatidae do enter freshwater along coastal rivers around the world and one of these species is now being sold for freshwater aquarium culture (others could appear in the future as well). However, all dasyatiids have diamond- or heart-shaped disks (not round as in Potamotrygonidae) and guidelines to their identification follows regardless of salinity. Again, round stingrays, which are sometimes placed in this family, do have round disks, but are not sold in the freshwater aquarium trade and have a distinct finfold around the end of the tail.

STINGRAY PELVIC GIRDLES

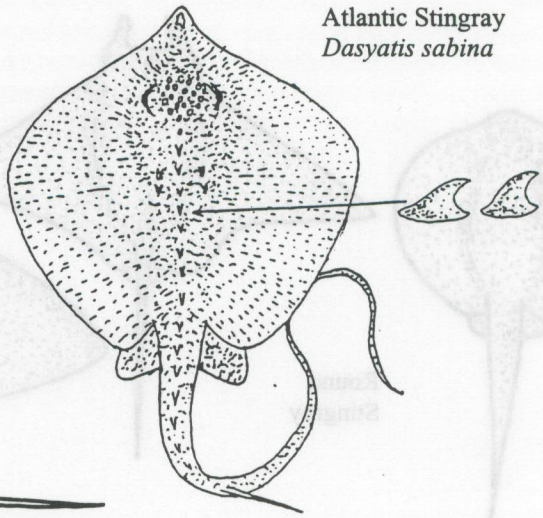


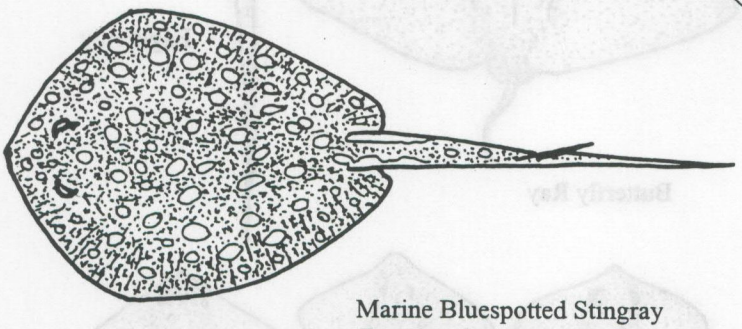
Freshwater Stingray
Potamotrygonidae



Marine Stingray
Dasyatidae

Atlantic Stingray
*Dasyatis sabina*





Marine Bluespotted Stingray
*Taeniura lymma*

(2) African freshwater dasyatiids like *Dasyatis garouaensis* have not been considered here, but would probably not be expected in the pet trade. A recently described family of marine six-gilled stingrays, Hexatrygonidae (*Hexatrygon bickelli* and *H. longirostris*), from South Africa and Japan (respectively) have heart-shaped discs and six gill openings (five in all other rays).

(3) Freshwater stingray genera:

*Paratrygon*
- Distance from mouth to anterior margin of disc long (2.6-3.3 times into disc width).
- No dorsal or ventral finfolds on tail.
- Tail short (1.1-1.9 times into disc width).
- Tail not filament-like at end.
- Knob-shaped projection on spiracle edge.

*Potamotrygon*
- Distance from mouth to anterior edge of disc short (3.6-5.6 times into disc width).
- Dorsal and ventral finfolds on tail.
- Tail short (less than 2 times into disc width).
- Tail not filament-like at end.
- No knob-shaped projections on spiracle edge.

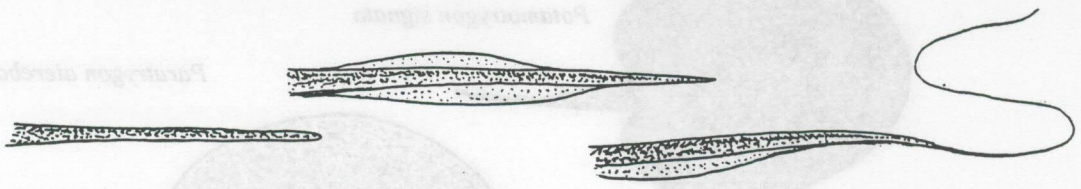
*Plesiotrygon*
- Distance from mouth to anterior margin of disc short (3.6-5.6 times into disc diameter).
- Ventral finfold on tail only.
- Tail long and slender (more than 2 times disc width).
- With tail filament-like at end.
- No knob-shaped projection on spiracle edge.

**References:**

Axelrod et al. 1976, 1989; Burgess et al. 1988; Campagno and Roberts 1982; Caras 1974; Howells 1985; Mackley 1983; McCormick and Allen 1978; Rosa 1985; Rosa et al 1987; Thorson et al. 1974; Thorson and Watson 1975; Weber and De Beaufort 1916.

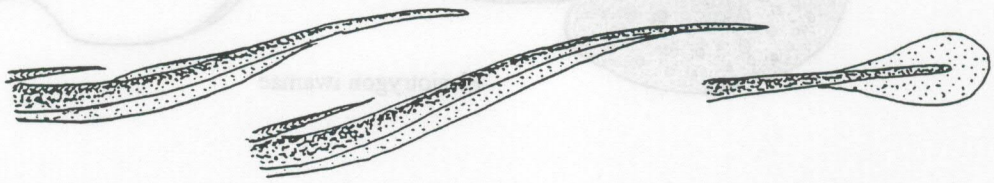
TAIL AND FINFOLD SHAPES

South American Freshwater Stingrays (Potamotrygonidae) : Prohibited



*Paratrygon* *Potamotrygon* *Plesiotrygon*

True Marine Stingrays (Dasyatidae - Urolophidae): Unprohibited (Even in Fresh Water)

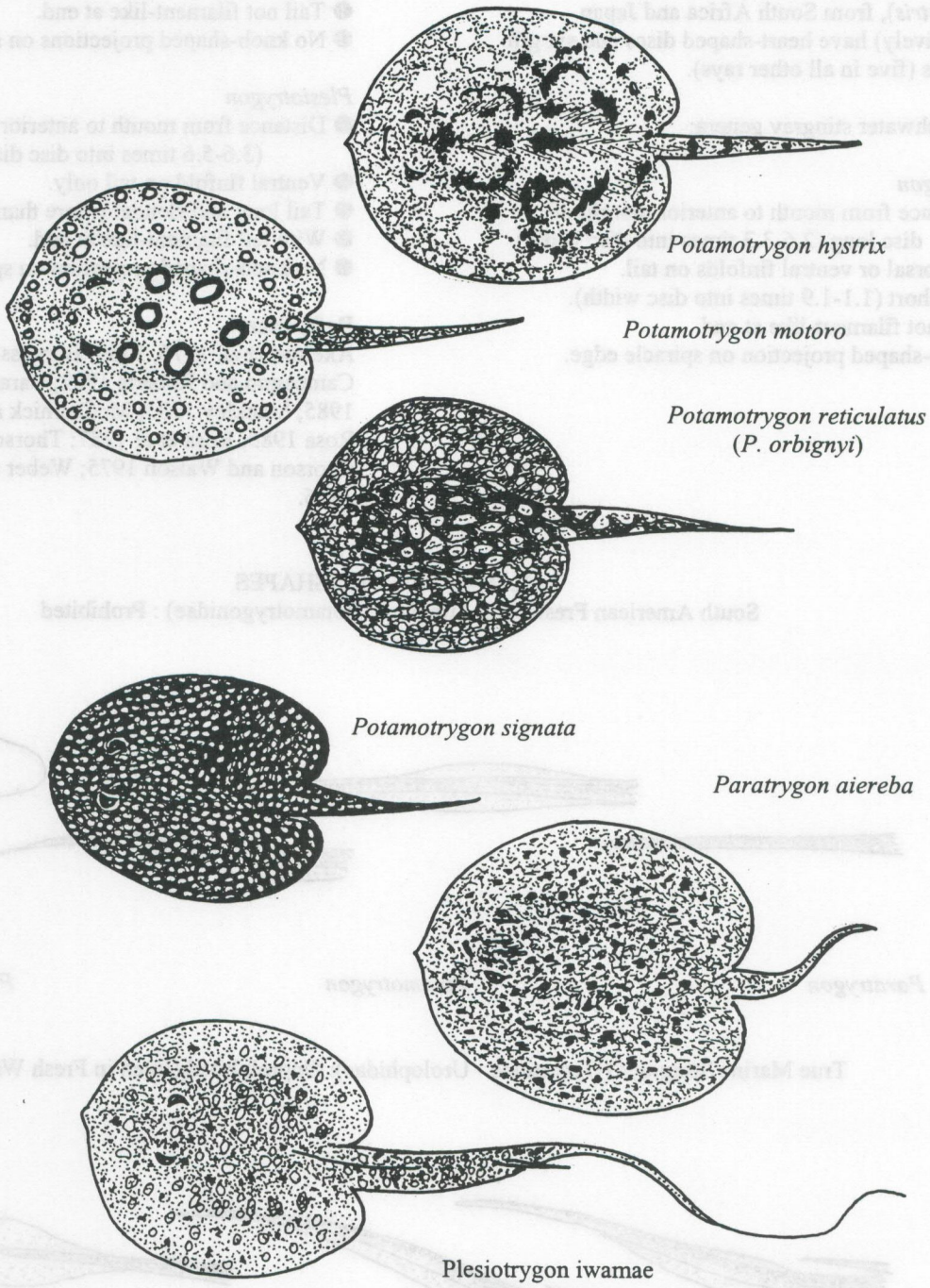


Atlantic Stingray
*Dasyatis sabina*

Southern Stingray
*Dasyatis americana*

Round Stingray
*Urolophus* sp.

FRESHWATER STINGRAYS
Potamotrygonidae



*Potamotrygon hystrix*

*Potamotrygon motoro*

*Potamotrygon reticulatus*
(*P. orbignyi*)

*Potamotrygon signata*

*Paratrygon aiereba*

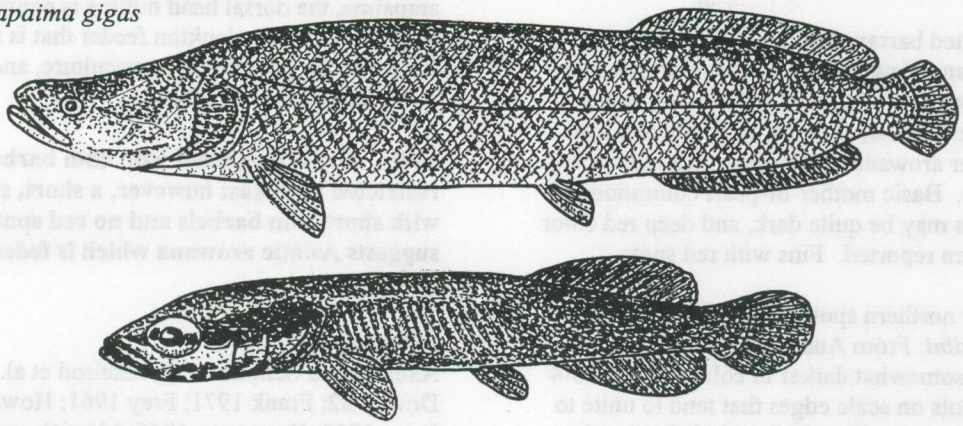
Plesiotrygon iwamae

# ARAPAIMA

## Family: Osteoglossidae

***Arapaima gigas***

Arapaima *Arapaima gigas*
adult



juvenile

**Other Names:**
Pirarucu.

**Specifics:**
One species.

**Range:**
It occurs in tropical South America. A reported introduction in Mexico apparently failed due to cold.

**Description:**
Arapaima are large (possibly approaching 10 feet/3 m), bony-tongued fishes. They are elongate in shape with large scales. Coloration is usually dark grey or black, with large specimens developing a greenish or brassy sheen. Imported specimens are typically 6- to 10-inch (152-254 mm) juveniles; large individuals are usually only seen at public aquaria.

**Biology:**
They are predatory, feeding on fishes and crustaceans; they nest and spawn in sandy areas near banks with brood care by the male. Juveniles especially are very active and capable of jumping. Arapaima occasionally rise to the surface to gulp air.

**Commercial Importance:**
Small specimens are occasionally imported through the pet trade, but high cost, fast growth and need for live food limits popularity even where legal. They are commercially taken in South America as a food fish.

**Reasons For Restriction:**
Originally arapaima were restricted because of large size and predatory habits. They are maintained as restricted, in part, because Brazil has banned export to help protect depleted stocks from over fishing (although they are still legally exported from Ecuador and Peru).

**Similar Species:** Only other osteoglossids are likely to be confused with arapaima. Two species are commonly seen in the pet trade and others are offered for sale occasionally.

Silver arowana *Osteoglossum bicirrhosum*: From tropical South America. Elongated body (to about 3 feet/0.9 m in length) with heavy scales, and distinctive barbels on chin. Mother-of-pearl in color both in adults and juveniles. The species is a mouthbrooder whose young are sometimes taken by tropical fish collectors from the female while still possessing orange yolk sacs. Common in the pet trade. Sometimes called green arowana in European literature.

Black arowana *Osteoglossum ferreirai*: From tropical South America. Similar to silver arowana in habits, color and appearance except that juveniles less than about 6-10 inches/152-254 mm are boldly marked with black and white markings (as illustrated); adult silver and black arowanas are nearly identical in appearance. Common in the pet trade.

Asiatic arowana or barramundi *Scleropages formosus*: From Southeast Asia. Body somewhat less elongate than in South American arowanas (to nearly 3 feet/0.9 m) and chin barbels somewhat shorter; shorter dorsal and anal fins; similar mother-of-pearl coloration but with a hint of brassy red or gold in some individuals. Fins may show faint mother-of-pearl banding but do not have red spots.

**Note: Although sometimes sold in the pet trade as red or gold arowana, and while not restricted under Texas law, this species is listed on the federal endangered species list and cannot be possessed without an appropriate federal permit.**

Saratoga or spotted barramundi *Scleropages leichardti*: From Australia and New Guinea. More elongate body than Asiatic arowana (to nearly 3 feet/0.9 m), heavy scales, short chin barbels, and shorter dorsal and anal fins than in silver arowana. Scales have 1-2 pink or red spots at the base. Basic mother-of-pearl coloration but some individuals may be quite dark, and deep red color morphs have been reported. Fins with red spots.

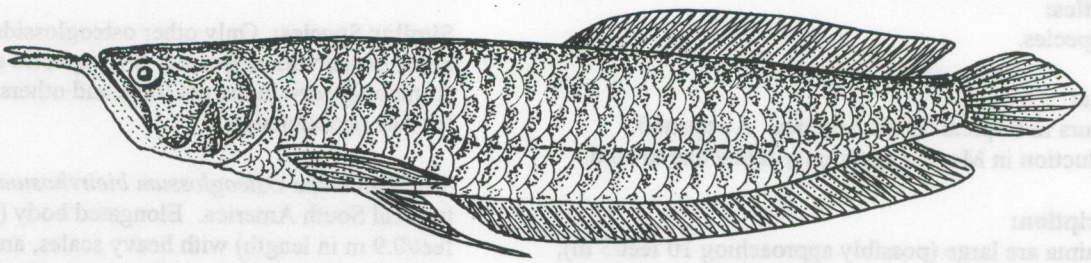
Gulf saratoga or northern spotted barramundi *Scleropages jardini*: From Australia. Similar to spotted barramundi but somewhat darker in color and with 3-4 orange or red spots on scale edges that tend to unite to form a crescent pattern. Fins dark with definite red spots.

African bony-tongue *Heterotis niloticus*: From Africa where it is occasionally cultured as a food fish. Dark brown in color with an underlying rose tint in some specimens. Lacks chin barbels; body somewhat stouter than arapaima. Although superficially most similar to arapaima, the dorsal head outline is convex (concave in arapaima). It is a plankton feeder that is not imported for either the pet trade or aquaculture, and is not likely to be encountered in Texas.

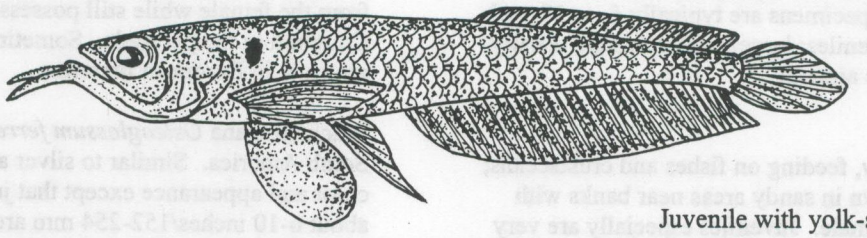
**Note: Any osteoglossid with chin barbels is not restricted in Texas; however, a short, stout body with short chin barbels and no red spots in fins suggests Asiatic arowana which is federally endangered.**

**References:**

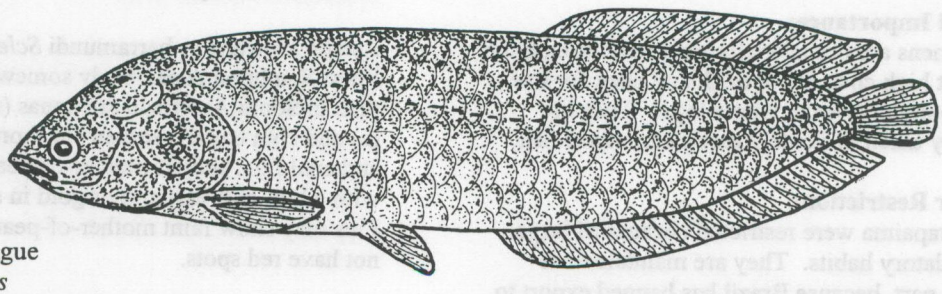
Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Dow 1982; Frank 1971; Frey 1961; Howells 1985; Innes 1966; Kanazawa 1966; Merrick and Schmida 1984; Swing and Ramsey 1989.



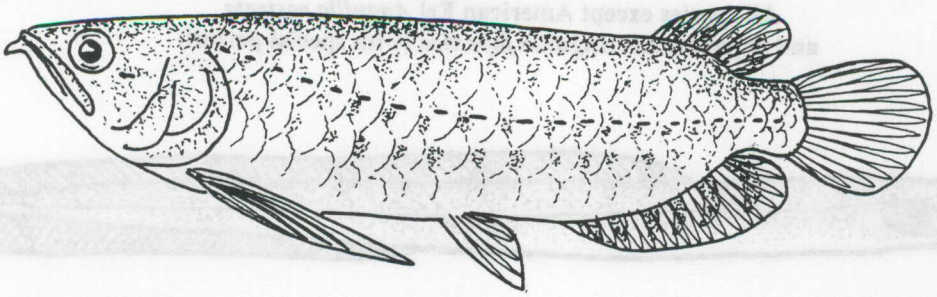
Silver Arowana *Osteoglossum bicirrhosum*



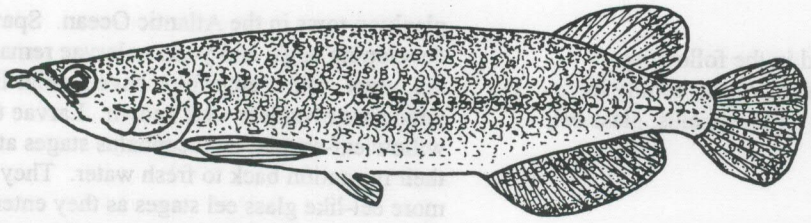
Juvenile with yolk-sac



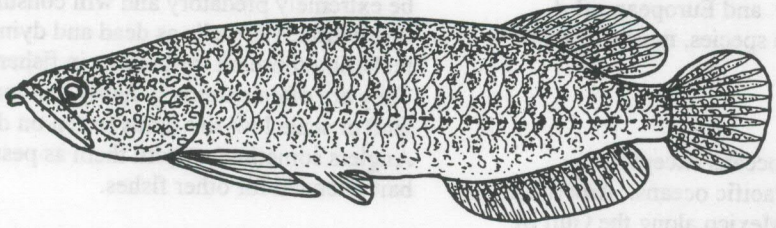
African Bony-tongue
*Heterotis niloticus*



Asian Arowana
*Scleropages formosus*



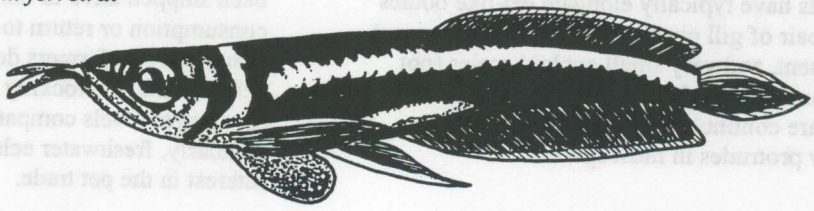
Saratoga (Spotted) Barramundi
*Scleropages leichardti*

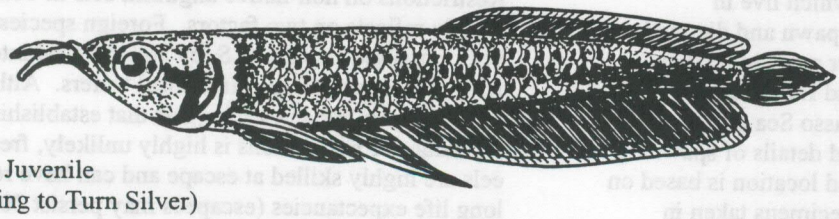


Gulf Saratoga
*Scleropages jardini*

Black Arowana *Osteoglossum ferreirai*

Juvenile with yolk-sac



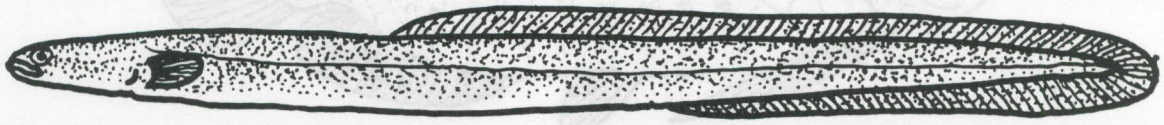


Older Juvenile
(Starting to Turn Silver)

# FRESHWATER EELS

## Family: Anguillidae

**All species except American Eel *Anguilla rostrata***
**and Japanese Eel *Anguilla japonica* (with special permit)**



American Eel *Anguilla rostrata*

**Other Names:**
Other common names are noted in the following discussion. Additionally, members of this family have a series of life stages known as leptocephalus, glass eel, and elvers.

**Specifics:**
This family contains a single genus *Anguilla* with about 15 species. Although some have suggested the native American eel *Anguilla rostrata* and European eel *A. anguilla* may represent a single species, most scientists still treat both as valid taxa.

**Range:**
Anguillid eels are found in all oceans except the southern Atlantic and eastern Pacific oceans. American eels ranges from northeastern Mexico along the Gulf of Mexico and eastern U.S. into northeastern Canada. European eel occurs from Iceland and northern Scandinavia south to northern Africa and the Mediterranean Sea. Ranges for other species are noted below.

**Description:**
Freshwater eels have typically elongate eel-like bodies with a single pair of gill openings, pectoral fins present, pelvic fins absent, and very small cycloid scales (not scaleless as sometimes believed). The dorsal, caudal, and anal fins are continuous and rayed in all species. The lower jaw protrudes in most species.

**Biology:**
American and European eels are used as the classic examples of catadromous fishes which live in freshwater, but migrate to sea to spawn and die, with young then returning to freshwater areas to feed and grow. In the case of American and European eels, both are reported to spawn in the Sargasso Sea northeast of Cuba; however, exact location and details of spawning remain obscure. Spawning ground location is based on the size of leptocephalus-stage specimens taken in plankton tows in the Atlantic Ocean. Spawning adults, developing eggs, and yolksac larvae remain essentially unknown. Other anguillids have similar life cycles which are even less well known. Larvae transform to willowleaf-shaped leptocephalus stages at sea during their migration back to fresh water. They transform to more eel-like glass eel stages as they enter coastal waters and then darken in color to become elvers as they initiate entry into fresh water. Freshwater eels can be extremely predatory and will consume other fish and invertebrates as wells as dead and dying animals, including those on trotlines or in fishermen's nets. They are often extremely hardy and may even cross land or scale low-rise dams (often on damp nights). Anglers sometimes regard them as pests when they take bait intended for other fishes.

**Commercial Importance:**
American eels are taken by both sport and commercial fishermen for local consumption; however, this and other species are often more highly regarded as food fishes in Europe and Asia. Elvers have been collected in U.S. waters and shipped to Japan and elsewhere for subsequent grow-out. Similarly, other species have been shipped alive to the U.S. for grow-out for local consumption or return to Europe or Asia. Some American fish farmers do occasionally offer American eels for sale for stocking in private waters, but usually at minimal levels compared to many other species. Similarly, freshwater eels are usually of little or no interest in the pet trade.

**Reasons For Restriction:**
Restrictions on non-native anguillid eels in Texas largely reflects on two factors. Foreign species have been imported into the U.S. by aquacultural interests with subsequent escapes into local waters. Although their complex life cycles suggest that establishing reproductive populations is highly unlikely, freshwater eels are highly skilled at escape and can have relatively long life expectancies (escapees may persist 20-30

years) with potential for negative impacts on local ecosystems. Further, imported European eels have already been implicated in the introduction of a harmful parasite which is now threatening economically-valuable American eel populations. As freshwater eels are transported throughout the world by aquaculturists both the species of eel and potential for disease are often ill considered. Finally, the exemption for Japanese eels under a special permit in Texas largely reflects a non-native species already being imported by a local aquaculture operation when restrictions on anguillids were enacted.

**Similar Species:**
Among the eel-like fishes most frequently encountered in the field in the U.S. is conger eel *Conger oceanicus* and its relatives, all of which are marine species. Conger eel has a much longer dorsal fin than anguillid eels and a protruding upper jaw (lower jaw protrudes in *Anguilla*). No other eels should be encountered in freshwater areas in the U.S. except for cases of non-native anguillids which may have escaped captivity or been released and an exotic swamp or rice eel *Monopterus alba* (Family Synbranchidae) established in the Southeast. Swamp eels have only a single gill opening on the throat (two laterally in anguillids), jaws which are nearly equal in length or the upper jaw protruding slightly, no pectoral fins, and very short rayless dorsal and anal fins (if fin rays are present at all they are restricted to the caudal fin).

In the freshwater pet trade, swamp eels are occasionally available as is a species of brackish-water moray eel *Gymnothorax polyuranodon* (Family: Muraenidae). A variety of other moray eels are also sold for marine aquaria; all have very long dorsal fins which reach nearly to the back of the head, strongly projecting upper jaws, no pectoral fins, and tubular nostrils (very much enlarged in ghost morays). Other species of eel-like fishes occasionally seen in the marine aquarium trade or encountered in coastal waters often have distinctive color patterns, long dorsal fins, and overhanging upper jaws.

In the U.S. among the anguillid eels, native American eel is most likely to be confused with European and Japanese eels. American eel has 103-111 vertebrae, lacks a long groove in its band of maxillary teeth, and has a preanal length (without the head) of 30.0-30.3% TL (i.e., the distance from the back of the head to the origin of the dorsal fin). European and Japanese eels have more vertebrae (110-119 and 111-119, respectively). Japanese eel has a long groove in its band of maxillary teeth and a preanal length of 27% TL. Additionally, vertical lines drawn at the origin of the dorsal and origin of the anal fins are 9.1% apart in American eel and 11.2% apart in European eel.

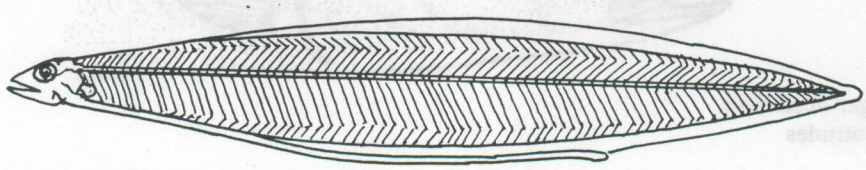
Among other anguillids, *A. ancestralis* (known only from elvers), mottled eel *A. nebulosa nebulosa*, African marbled eel *A. n. marmorata*, and speckled longfinned eel *A. reinhardti* are heavily mottled and not uniformly colored as in American eel.

Among the other uniformly colored anguillids, Borneo eel *A. borneensis*, Mozambique eel *A. mossambica*, and New Zealand long-finned eel *A. dieffenbachi* have larger mouths (gape 32-33% head length); American eel has a smaller mouth (25-27% HL). The distance between vertical lines drawn through the dorsal fin origin and the vent is much greater in American eel (9.1-14.6% TL) than in many non-mottled anguillids (0.2-3.6% TL) including Pacific eel *A. bicolor pacifica*, northern Pacific eel *A. b. bicolor*, southern Pacific eel *A. obscura*, shortfinned eels *A. australis australis* and *A. a. schmidti*, and largemouth eel *A. macrostoma*. Finally, preanal length (excluding the head) is shorter (25.9-27.2%) in Celebes longfin eel *A. celebesensis* and in *A. inferioris* than in American eel (30.0-30.3%).

**Technical Note:**
American eel, European eel, and shortfinned eel have all been captured in California waters where no anguillids occurred naturally. Japanese eel is being imported into Texas at present, but without reported field collections to date.

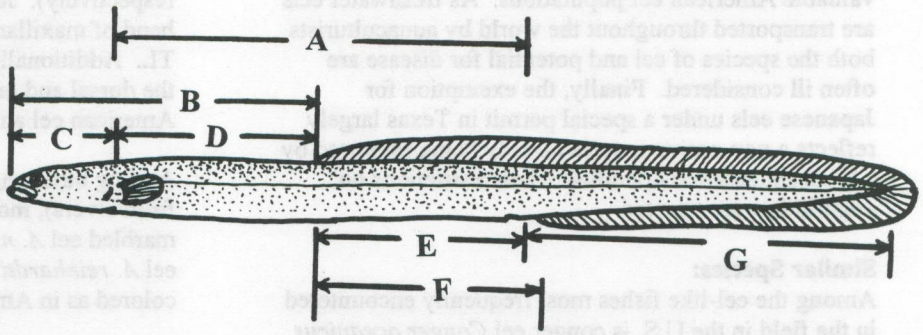
**References:**
Balon 1974; Blanc et al. 1971; Eddy 1969; Fahay 1978; Frank 1971; Howells 1981; Hubbs 1961; Jayaram 1981; Lindberg and Legeza 1965; Masuda et al. 1984; McCosker 1989; Merrick and Schmida 1984; Munshi and Srivastava 1988; Muus 1967; Nichols 1943; Scott and Crossman 1973; Smith 1945; Smith 1979; Sterba 1967; Weber and De Beaufort 1916.

Leptocephalus Larva

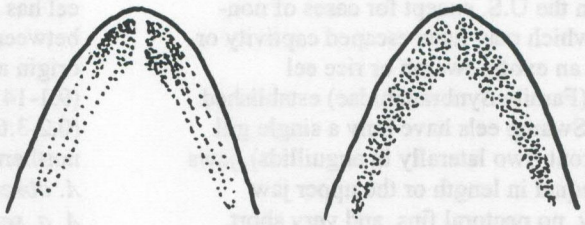


**EEL MEASUREMENTS**

A. Nape to anal origin.
B. Snout to dorsal origin.
C. Head length.
D. Nape to dorsal origin.
E. Dorsal origin to vent.
F. Dorsal origin to anal origin.
G. Tail length.

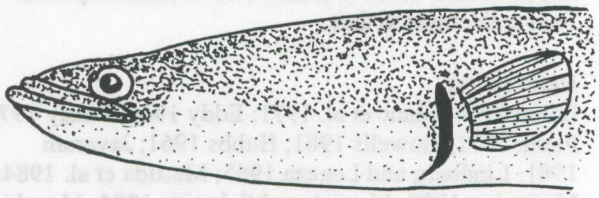



VOMERINE TEETH

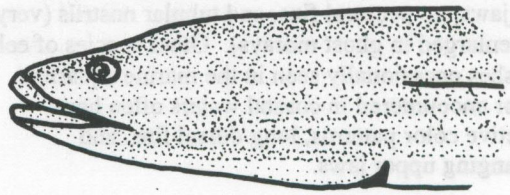


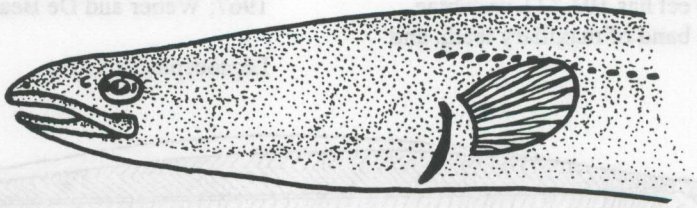
Grooved Ungrooved

American Eel *Anguilla rostrata*
Lower Jaw Protrudes

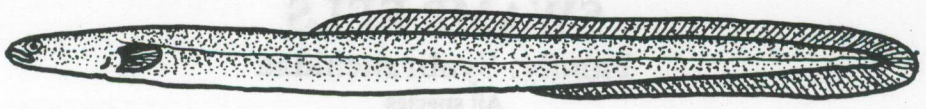


Swamp Eel *Monopterus albus*
Jaws Near-equal Length

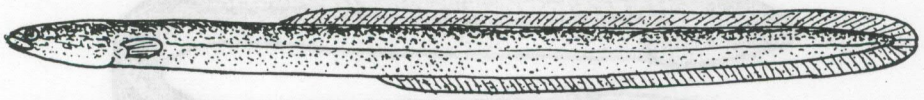




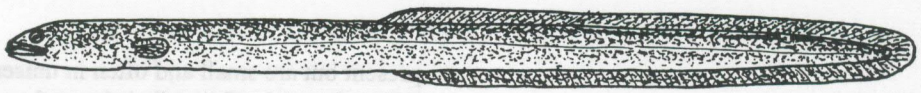
Conger Eel *Conger oceanicus*
Upper Jaw Protrudes



American Eel *Anguilla rostrata*



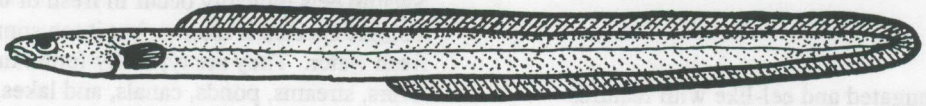
Japanese Eel *Anguilla japonica*



Pacific Eel *Anguilla bicolor*

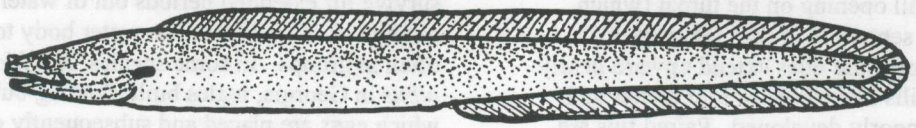
Marbled Eel *Anguilla marmorata*

Mottled Eel *Anguilla nebulosa*

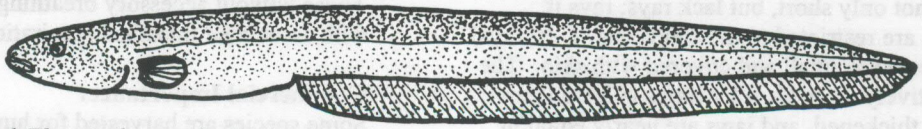


Conger Eel *Conger oceanicus*

Swamp Eel *Monopterus albus*



Freshwater Moray Eel *Gymnothroax polyuranodon*



Electric Eel *Electrophorus electricus*

# SWAMP EELS

## Family: Synbranchidae

**All species**

Swamp Eel
*Monopterus albus*

**Other Names:**
Rice eels, one-gilled eels.

**Specifics:**
This is a poorly studied family with five genera and 8-15 species. Genera include *Macrotrema*, *Monopterus* (*Fluta*), *Furmastix* (*Pluto*), *Synbranchus*, and *Typhlosynbranchus*. Some sources in the past have placed Flutidae as a distinct family. The taxonomic position of this family is unclear, but they are not closely related to true eels.

**Range:**
Africa, Asia, Australia, and Central and South America. One species, *Monopterus albus*, ranges from northern Australia to northern China, Korea, Japan, and Russia (Vladivostok), with introductions in Hawaii, Georgia, and Florida.

**Description:**
Swamp eels are elongated and eel-like with features described as degenerate (rather than primitive). Bodies are typically naked, but some may have a limited number of very small scales posteriorly. Although descriptions in scientific literature vary, they apparently may or may not have an accessory breathing sac associated with the pharynx or gill chamber. A lateral line is present and well developed. Swamp eels have only a single small gill opening on the throat (which may be divided by a septum internally); however, in one species, the gill opening does extend upward nearly to the lateral line. Gills have three or four arches and filaments which are poorly developed. Paired fins are lacking and the dorsal, caudal, and anal fins are united in a single continuous finfold posteriorly. Dorsal and anal fins are not only short, but lack rays; rays if present at all, are restricted to the caudal fin (8-10 rays). Eyes (if present) are small and covered with skin. The mouth is relatively large (2.4-2.7 times in head length), lips are often thickened, and jaws are nearly equal in length (upper jaw may protrude slightly). Teeth are present but are small and often in uniserial or biserial rows. One pair of nostrils is located on the snout and a second pair is present in oval pits above the eyes. The head may appear proportionally rather small (10-13 times in SL). Some figures show specimens with slightly elevated foreheads, but specimens observed in the Texas pet trade have not displayed this trait. The tail is short (2.5-3.0 times in snout to vent length). Coloration is olive, yellow-brown, reddish-brown, dark brown, or green, either unpatterned or with darker spots; some species may be yellow or white ventrally. Juveniles may have a dark bar on the snout and be light brown with darker spots. One marine species has been described as pinkish-purple with carmine fins. Lengths reach 1.5 m (4.9 feet), but are usually much less.

**Biology:**
Swamp eels typically occur in fresh or brackish waters; a single species is marine, but it too sometimes enters fresh water. They are typically found in slow-moving rivers, streams, ponds, canals, and lakes, but can occur in areas with swift flows or to altitudes to 3,000 feet (9,848 feet). Several species (Yucatan, Australia, Africa) are blind, subterranean forms. Swamp eels are predatory, often aggressive, and will consume other fishes. They tolerate stagnant waters with low dissolved oxygen levels and can burrow into the substrate to aestivate during dry periods. They can survive for extended periods out of water and may migrate over land from one water body to another, often in groups. In some species, like *Monopterus albus* in Georgia, males build floating bubble nests in which eggs are placed and subsequently guard the nest and hatchlings. Swamp eels may rise to gulp air or stand on their tails to reach vertically to the surface. Those without accessory breathing sacs may gulp air with associated intestinal respiration.

**Commercial Importance:**
Some species are harvested for human consumption in their native waters. Several species appear occasionally

in the U.S. pet trade, but they are not economically significant species in the industry.

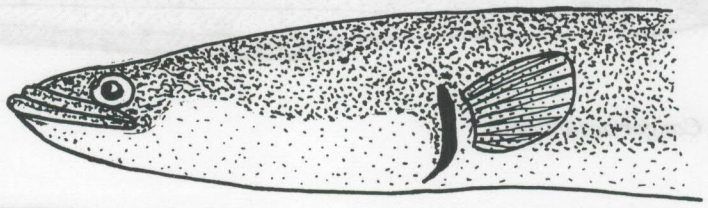
**Reasons For Restriction:**
Shortly after reports that swamp eels (rice eels) had become established and ecologically problematic in Georgia, specimens were found for sale in Texas pet stores. TPWD requested dealers voluntarily refrain from importation and sales of these eels and later passed regulations formally prohibiting them. It might be noted that established populations in Hawaii have not been considered to have had negative ecological impact; however, it should also be noted that Hawaii lacks a native freshwater fish fauna to impact.

**Similar Species:**
Swamp eels can readily be distinguished from nearly all other eel-like fishes by their extremely short and rayless dorsal and anal fins, nostril shape and positions, and single gill slit. Freshwater eels (Anguillidae) and conger eels (Congridae) have much longer dorsal and anal fins which are rayed and have paired pectoral fins. Morays (Muraenidae) not only have much longer dorsal fins, but have tubular nostrils. Electric eels and knifefishes (several families, genera, and species) sometimes seen in the pet trade have long, rayed anal fins.

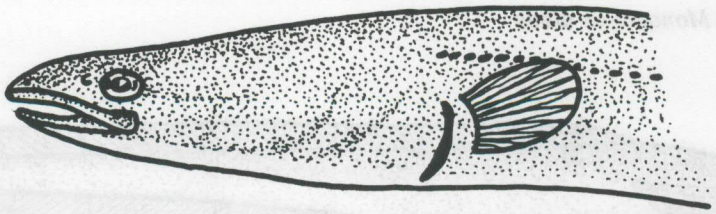
**Technical Note:**
A species of moray being sold in the pet trade as freshwater moray eel *Gymnothorax polyuranodon* from brackish waters in the East Indies, New Guinea, and Fiji might be confused with swamp eels (similar size and color in pet trade specimens). However, its long, rayed dorsal fin and tubular nostrils will readily distinguish it.

**References:**
Berg 1949b; Jayaram 1981; Merrick and Schmida 1984; Munshi and Srivastava 1988; Nelson 1976; Nichols 1943; Smith 1945; Sterba 1967; Weber and De Beaufort 1916.

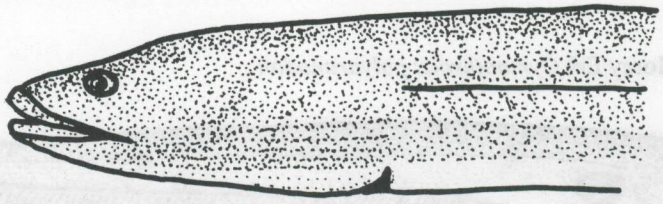
American Eel
*Anguilla rostrata*
Lower Jaw Protrudes



Conger Eel
*Conger oceanicus*
Upper Jaw Protrudes

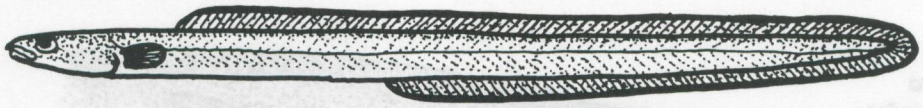


Swamp Eel
*Monopterus albus*
Jaws Near-equal Length



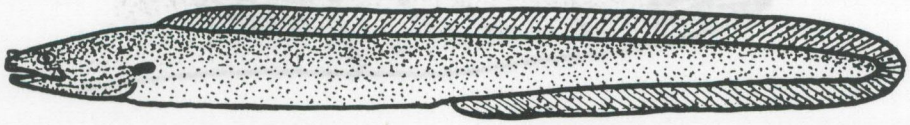
American Eel *Anguilla rostrata*

Pacific Eel *Anguilla bicolor*

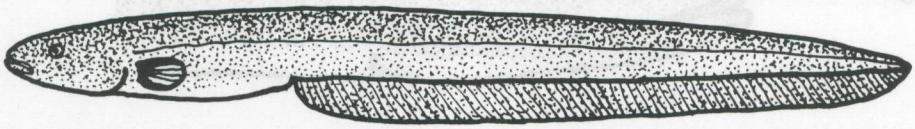


Conger Eel *Conger oceanicus*

Swamp Eel *Monopterus albus*



Freshwater Moray Eel *Gymnothroax polyuranodon*



Electric Eel *Electrophorus electricus*

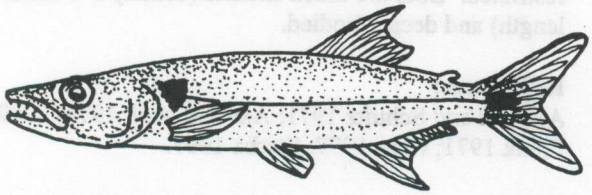
# SOUTH AMERICAN PIKE CHARACOIDS

## Family: Characidae

**All Species of the Genus *Acestrorhynchus***

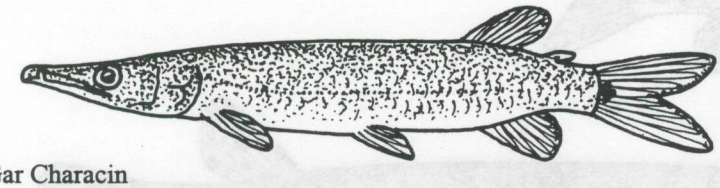
## Family: Ctenolucidae

**All Species of the Genera *Ctenolucius* and *Luciocharax* (*Boulengerella*)**



Pike Characoid
*Acestrorhynchus falcatus*

Spotted Pike Characoid
*Luciocharax maculata*



Gar Characin
*Ctenolucius hujeta*

**Other Names:**
Pike tetra, gar-pike.

**Specifics:**
*Acestrorhynchus* (listed in older literature as *Acestrorhamphus*) is a complex group of about 10 or more species. *Ctenolucius* contains a single species with three subspecies. *Luciocharax* (also known as *Boulengerella, Spixostoma* and *Hydrocinus*) contains three species and several subspecies.

**Range:**
All occur in tropical South America.

**Description:**
All three genera are elongated pike-like fishes with elongated snouts, forked tails, adipose fins and dorsal fins set far back on the body.

*Acestrorhynchus* has no chin or jaw extensions, heavy canine teeth, no cuspid teeth (all single pointed), tiny scales, a long anal fin, and spiny gill rakers; it may reach 11-12 inches (279-305 mm) in length; coloration is generally silvery with some species showing black caudal or gill cover spots, or golden lateral stripes.

*Ctenolucius* has fleshy flaps on the chin which project upward, a short second row of teeth in the lower jaw, strongly ctenoid scales, 42-50 lateral line scales, and a short anal fin without filament-like extensions; it reaches about 10 inches (254 mm) in length but is sometimes reported twice that length; coloration is silvery-olive with a spot at the base of the caudal fin.

*Luciocharax* has no jaw barbels but possess fleshy flaps on the tip of the upper jaw, a single row of teeth in both jaws, 78-110 lateral line scales (complete or incomplete), scales which are ctenoid but with only fine denticulations, and a short anal fin with filament-like extensions (at least in young); it reaches from eight to nearly 40 inches (201-1,016 mm) in length; coloration is silvery-olive, often with a dark caudal spot and dusky lateral band, and occasionally with spots on the body.

**Biology:**
All South American pike characoids are aggressive, fish predators that fill an ecological niche similar to American pickerel *Esox* spp. Most are relatively shy in captivity and generally intolerant of rough handling.

**Commercial Importance:**
Until recently, few were imported for sale in the pet trade due to high mortalities in collection, shipping and holding. However, improved techniques may result in increased availability in the pet trade.

**Reasons For Restriction:**
Because of their piscivorous habits, moderate to large

sizes and possible increasing availability, South American pike characoids are restricted.

**Similar Species:**
South American pike characoids are superficially most similar to African pike characoids which are also restricted (see the African pike characoids species description). They are also somewhat similar to gars *Lepisosteus* spp., pikes and pickerels *Esox* spp., pike killifish *Belonesox belizanus,* and needlefishes (several genera); however, none of these possess the adipose fin that is present in South American pike characoids.

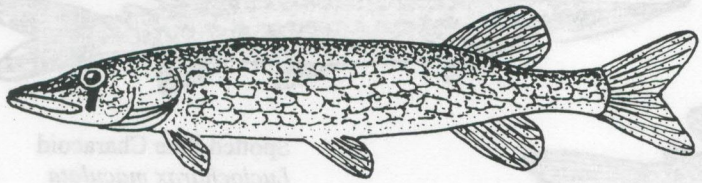
**Technical Notes:**

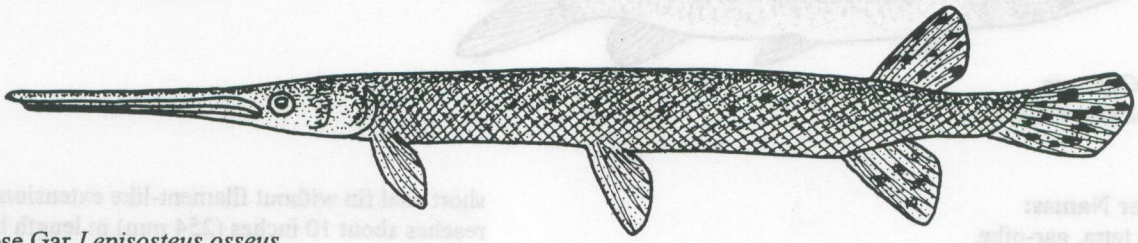
(1) Identification to species, or even genus is not required; all South American pike characoids are restricted.

(2) Two genera related to *Acestrorhynchus* including *Paroligosarcus* and *Oligosarcus* have not been restricted. Both are much smaller (usually 3-4 inches in length) and deeper bodied.

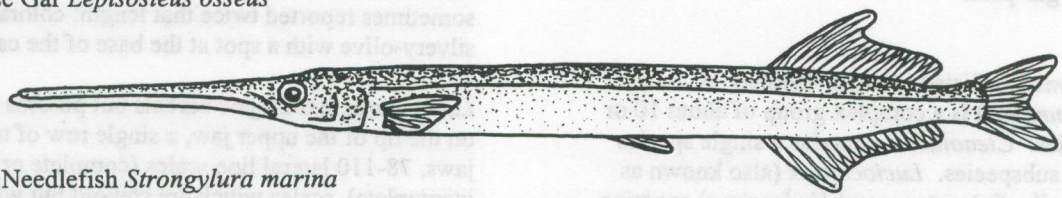
**References:**
Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Frank 1971; Gery 1977; Sterba 1967.

Chain Pickerel *Esox niger*



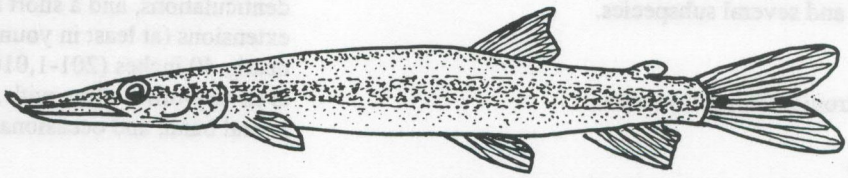


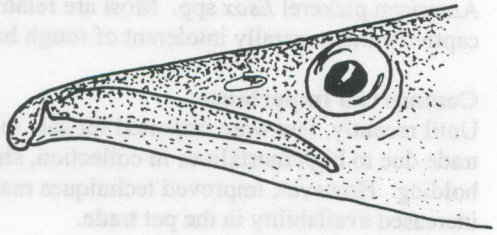
Longnose Gar *Lepisosteus osseus*



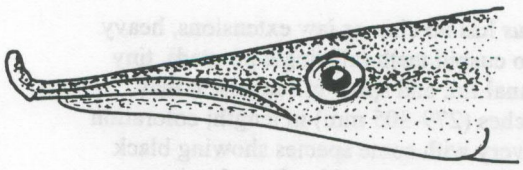
Atlantic Needlefish *Strongylura marina*

Golden Pike Characoid
*Luciocharax lucia*





*Ctenolucius*
Lower Jaw Flap



*Luciocharax*
Upper Jaw Flap

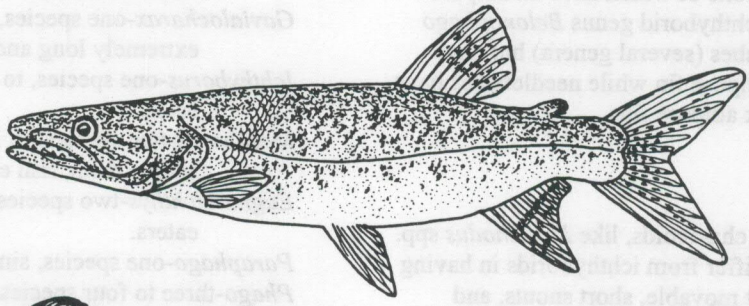
# AFRICAN PIKE CHARACOIDS

## Family: Hepsetidae

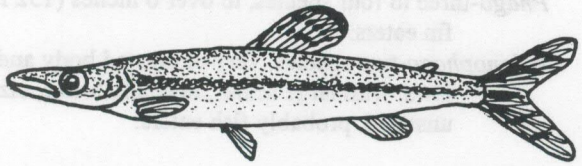
**All Species of the Genus *Hepsetus***

## Family: Ichthyboridae

**All Species**



Kafue Pike
*Hepsetus odoe*



African Pike Characoid
*Phago* sp.

**Other Names:**
Pike tetra, gar pike, phago (some species), African pike.

**Specifics:**
The family Hepsetidae contains a single species *Hepsetus odoe* (previously listed as *Sarcodaces* and *Hydrocynoides*). The family Ichthyboridae (sometimes considered the subfamily Ichthyborinae under the family Citharinidae) contains nine genera (e.g., *Phago*) and about 15-17 species. The spelling "*Ichthyoborus*" refers to a genus of birds.

**Range:**
All occur in tropical Africa.

**Description:**
African pike characoids are generally elongated and pike-like with protruding snouts and adipose fins.

*Hepsetus* has large cycloid scales, well developed teeth including strong canine teeth, no movable teeth, an upper jaw which is entirely toothed, a large supraopercle with a lateral line canal, and a dorsal fin that is set back on the body; it reaches 11-12 inches (279-305 mm) in length; coloration is a silvery-brown with indistinct bars, spots on fin and a bright orange and black adipose fin in some specimens.

Ichthyborids have ctenoid scales (typically small), teeth which are small and often movable, an upper jaw that can move upwards (scissor-like jaws) with cutting teeth and often canine teeth; size varies with species but is often 8 inches or less; coloration is variable but most are a brown- or silvery-olive with a bold pattern of horizontal black bands in the caudal fin. One ichthyborid genus *Belonophago* is very slender and elongated (similar to needlefishes) and has large scales.

**Biology:**
*Hepsetus* is an aggressive fish-eater which occupies a niche similar to American pickerel *Esox* spp. Among the ichthyborids are species which feed largely by tearing fins off other fishes and others which consume whole fishes. One genus *Hemistichodus* may feed on insects. Another genus *Phago* has been described as extremely vicious and reportedly may kill far more than it can eat. Some species may be shy and fragile in captivity. Many species are poorly studied.

**Commercial Importance:**
In the past, *Phago* and several related genera were imported for sale in the pet trade, though rarely if ever in large numbers. Political unrest in many of the areas in Africa where these species were most abundant as well as sensitivity to capture and transport has largely limited importations. Improvements in techniques and development of more African exporters in recent years suggests possible increased availability in the future.

**Reasons For Restriction:**
Piscivorous habits and possible increased numbers of imports suggested a need for restriction.

**Similar Species:**
African pike characoids are most similar to the South American pike characoids which are also restricted (see the South American pike characoids description). They are also somewhat similar to gars *Lepisosteus* spp., pikes and pickerels *Esox* spp., and pike killifish *Belonesox belizanus*, none of which have an adipose fin. Members of the ichthyborid genus *Belonophago* are similar to needlefishes (several genera) but have larger scales and an adipose fin while needlefishes have smaller scales and lack adipose fins.

**Technical Notes:**

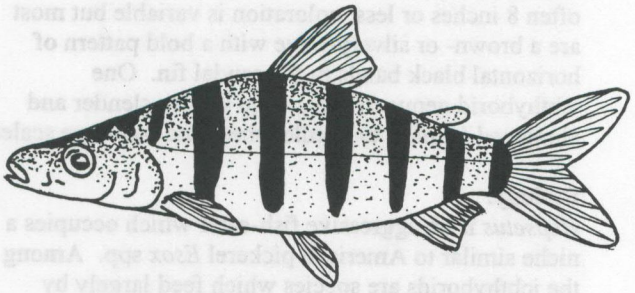
(1) African citharinid characoids, like *Distichodus* spp. and *Citharinus* spp., differ from ichthyborids in having upper jaws that are not movable, short snouts, and bodies that are often deeper.

(2) Among the ichthyborids, two species of *Hemistichodus* are apparently small (2-4 inches/51-102 mm) and largely insectivorous. None the less, they have been restricted because of similarity to other more piscivorous species.

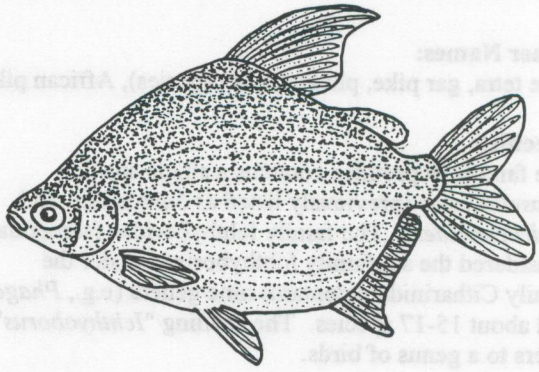
(3) Genera of Ichthyboridae:

*Hemistichodus*-two or three species, 2-4 inches (51-102 mm), insect eaters.
*Phagoborus*-one or two species, to 8 inches (203 mm), with orange and black banded caudal lobes, has canine teeth.
*Gavialocharax*-one species, to 8 inches (203 mm), with extremely long and slender jaws.
*Ichthyborus*-one species, to 8 inches (203 mm), a fin eater.
*Mesoborus*-two species, to 10 inches (254 mm), has canine teeth, fish eaters.
*Eugnathichthys*-two species, to 12 inches (305 mm), fin eaters.
*Paraphago*-one species, similar to Phago, fin eaters.
*Phago*-three to four species, to over 6 inches (152 mm), fin eaters.
*Belonophago*-two species, very elongated body and jaws, with large scales, needlefish-like, size unstated, probably fish eaters.

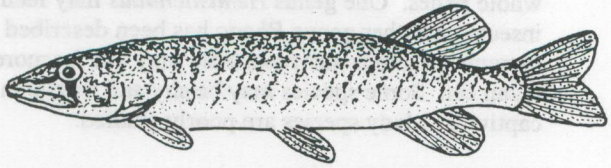
**References:**
Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Balon 1974; Frank 1971; Gery 1977; Sterba 1967.



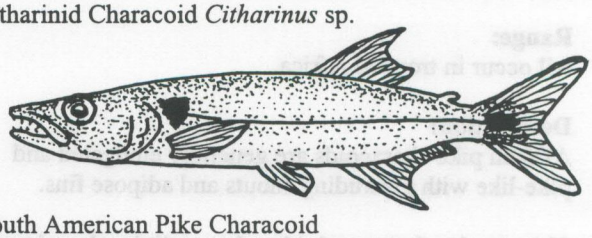
Citharinid Characoid *Distichodus* sp.



Citharinid Characoid *Citharinus* sp.

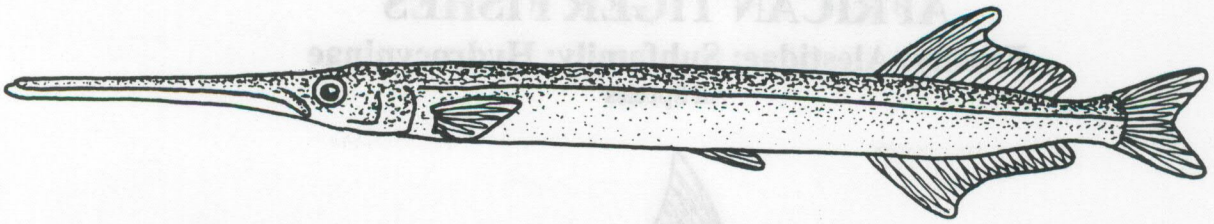


Redfin Pickerel *Esox americanus*

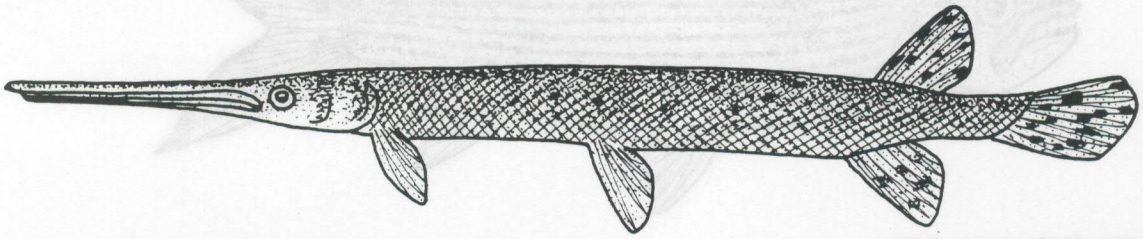


South American Pike Characoid
*Acestrorhynchus falcatus*

Gar Characin
*Ctenolucius hujeta*



Atlantic Needlefish *Strongylura marina*

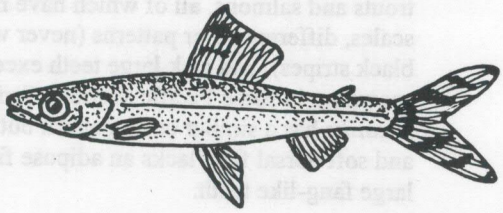


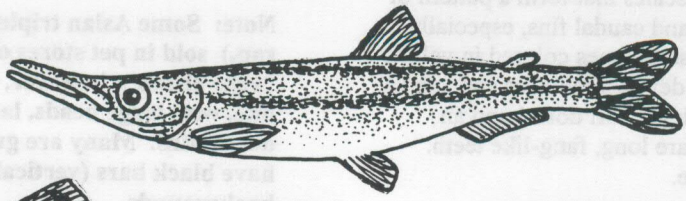
Longnose Gar *Lepisosteus osseus*

AFRICAN PIKE CHARACOIDS

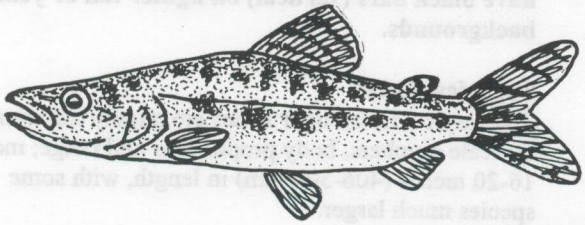
African Gar *Belonophago* sp.

African Pike Characoid *Hemistichodus* sp.



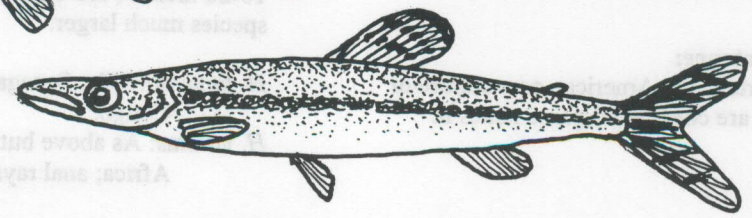


African Pike Characoid *Gavialocharax* sp.



African Pike Characoid *Mesoborus* sp.

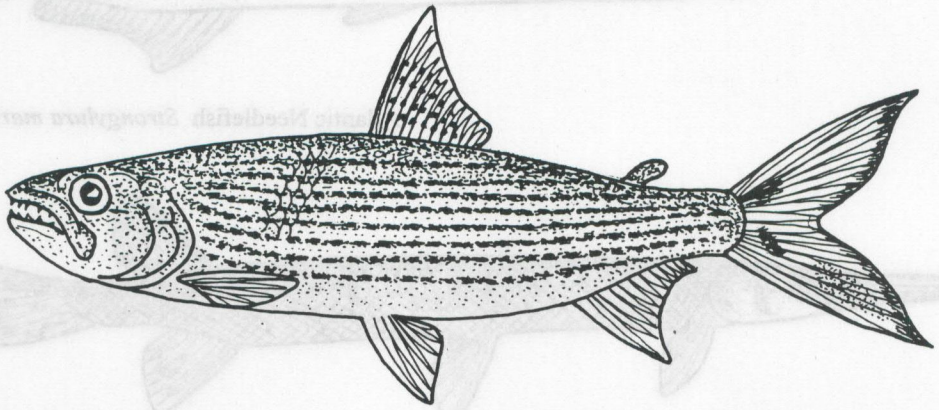
African Pike Characoid *Phago* sp.



# AFRICAN TIGER FISHES

## Family: Alestidae; Subfamily: Hydrocyninae

**All Species**



African Tiger Fish *Hydrocynus vittatus*

**Other Names:**
Tiger fish, great tiger fish.

**Specifics:**
This subfamily includes a single genus *Hydrocynus* (sometimes misspelled *Hydrocyon*) with six species. The genus *Hydrocinus* refers to certain South American pike characoids.

**Range:**
All occur in tropical Africa.

**Description:**
African tiger fishes are large characoids; some species may exceed 4 feet (1.2 m) in length and 100 pounds (45 kg). Coloration is usually brownish above and silvery below with black spots on scales that form a pattern of horizontal stripes. Dorsal and caudal fins, especially the lower caudal lobe, are sometimes colored in yellow or red. Some species may develop red eyes and ventral fins during spawning. A single soft dorsal and an adipose fin are present, as are long, fang-like teeth. Scales are moderately large.

**Biology:**
These fishes have been described as "the most formidable fish-killers in African waters" and as "pelagic roamers with a fantastic appetite." Adult fish may live in pairs.

**Commercial Importance:**
They have no importance in American aquaculture or the pet trade. They are considered game fishes in African waters.

**Reasons For Restriction:**
Large size, predaceous feeding habits and aggressive behavior indicate reason for concern. Attacks on man have been reported; however, such incidents are almost certainly cases of mistaken prey identity by the fish in turbid waters.

**Similar Species:**
African tiger fishes superficially resemble American trouts and salmons, all of which have much smaller scales, different color patterns (never with horizontal black stripes), and lack large teeth except during spawning in some Pacific salmon. Striped bass *Morone saxatilis* has a similar color pattern but has both spiny and soft dorsal fins, lacks an adipose fin and never has large fang-like teeth.

**Note: Some Asian tripletailed fishes (*Datnioides* spp.) sold in pet stores often appear under the name "tiger fishes"; however, these are somewhat bass-like, with large heads, large mouths, and spiny dorsal fins. Many are grey or brown in color; some have black bars (vertical) on lighter tan or yellow backgrounds.**

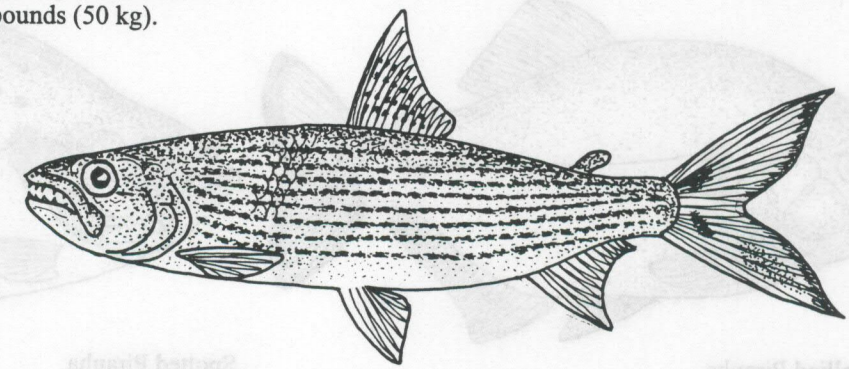
**Technical Note:**
Species of African tiger fishes are largely differentiated by scale numbers, body proportions and range; most are 16-20 inches (406-508 mm) in length, with some species much larger.

*H. forskalii*: Nile, Senegal and Niger rivers south to the Congo.

*H. vittatus*: As above but also extending to South Africa; anal rays iii, 10-13; gill rakers 8-10; to

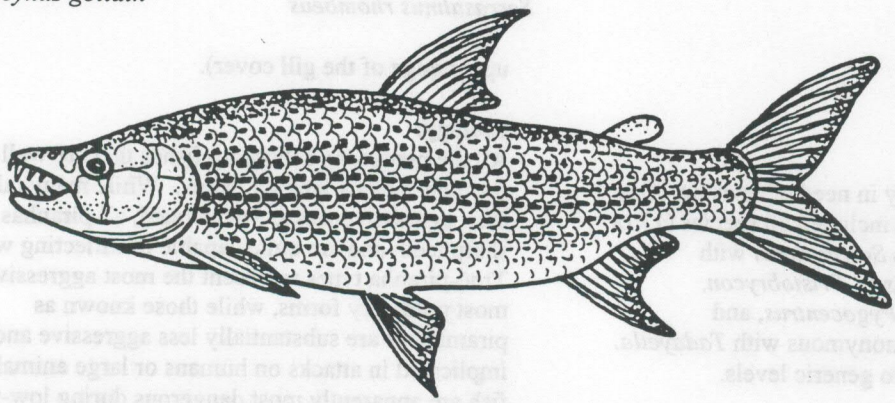
32 inches (0.8 m).
*H. brevis*: Niger and Tchad; to about 28 inches.
*H. somonorum*: Niger and Tchad.
*H. vittiger*: Congo.
*H. goliath*: Congo, Lake Tanganyika; anal rays iii, 13-16; gill rakers 10-12; largest species, to 60 inches (1.5 m) and 110 pounds (50 kg).

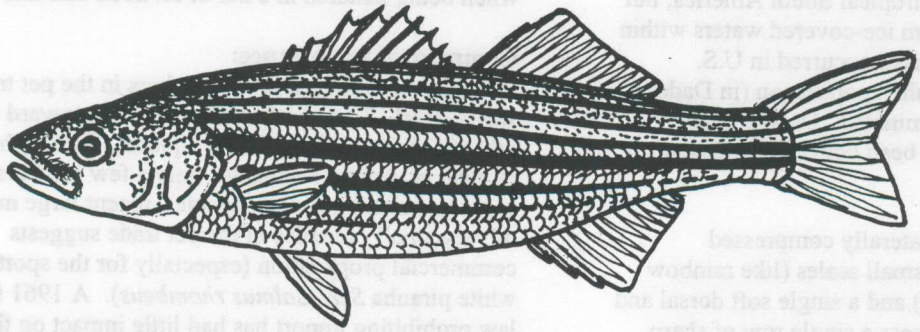
**References:**
Axelrod et al. 1989; Balon 1974; Brichard 1978; Gery 1977; Sterba 1967.



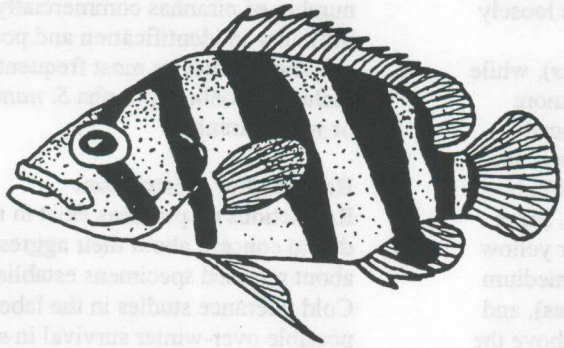
African Tiger Fish
*Hydrocynus vittatus*

African Tiger Fish
*Hydrocynus goliath*





Striped Bass
*Morone saxatilis*

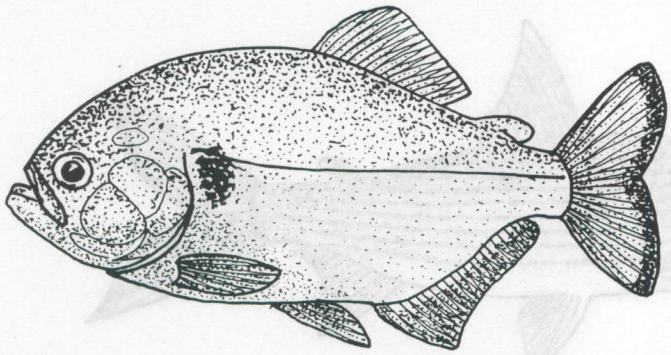


Asian Tiger Fish
(Tripletail)
*Datnioides* sp.

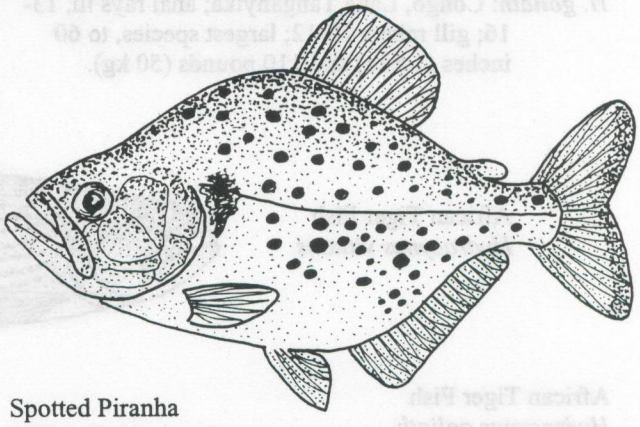
# PIRANHAS AND PRIAMBEBAS

## Family: Serrasalmidae; Subfamily: Serrasalminae

**All Species**



Redbellied Piranha
*Serrasalmus nattereri*



Spotted Piranha
*Serrasalmus rhombeus*

**Other Names:**
Caribe, piraya.

**Specifics:**
Piranha classification is badly in need of revision. One recent authority (Gery 1977) included all species (17 or more) under the single genus *Serrasalmus* with subgenera including *Pygopristis, Pristobrycon, Serrasalmus, Taddyella* and *Pygocentrus*, and considered *Rooseveltiella* synonymous with *Taddyella*. Other authorities elevate all to generic levels.

**Range:**
Piranhas typically occur in tropical South America, but have also been reported from ice-covered waters within their range. Introductions have occurred in U.S. waters, but the only established population (in Dade County, Florida) was exterminated. Only a single specimen is known to have been collected in Texas.

**Description:**
Piranhas are deep-bodied, laterally compressed characoid fishes with very small scales (like rainbow trout *Oncorhynchus mykiss*) and a single soft dorsal and adipose fin. Both jaws possess a single row of sharp, interlocking teeth. The term "true-piranha" is loosely applied to snub-nosed, heavy-bodied forms (*Pygopristis, Taddyella* and some *Serrasalmus*), while the term "pirambebas" is given to types with more elongated snouts, often with concave dorsal head outlines and less heavily built bodies (*Pristobrycon, Pygopristis,* and other *Serrasalmus*). Coloration is often dark above and silvery below; however, some may be nearly black. Some species are red or yellow on the throat and belly. Many have small to medium black spots on the body (especially in juveniles), and many have a large, black humeral spot (just above the upper edge of the gill cover).

**Biology:**
All are predatory, schooling fishes that are well known for their vicious feeding habits. While many tales of their aggressiveness are over-rated, all piranhas have sharp teeth and are quite capable of inflecting wounds. True-piranha types represent the most aggressive and most predatory forms, while those known as pirambebas are substantially less aggressive and rarely implicated in attacks on humans or large animals. Wild fish are apparently most dangerous during low-water periods when prey is scarce. Any individuals may bite when being handled in a net or on hook and line.

**Commercial Importance:**
Piranhas are sold in limited numbers in the pet trade where legal. They tend to be aggressive toward each other in close confinement in aquaria. Although published literature indicates only a few instances of captive spawning for any species, recent large numbers of very small juveniles in the pet trade suggests commercial propagation (especially for the spotted or white piranha *Serrasalmus rhombeus*). A 1961 federal law prohibiting import has had little impact on the number of piranhas commercially available because of difficulty in identification and possible domestic spawning. Species most frequently seen in the pet trade include redbellied piranha *S. nattereri* and the spotted or white piranha.

**Reasons For Restriction:**
Restrictions on piranhas exist in many states largely due to concern about their aggressive natures and fears about released specimens establishing in U.S. waters. Cold tolerance studies in the laboratory that suggest possible over-winter survival in some American waters,

and collections of piranhas in the field, have served to reinforce these concerns.

**Similar Species:**
Piranhas most closely resemble three other groups of characoids which are seen in aquarium culture including: silver dollars and metynnids (*Myleus, Mylossoma, Metynnis*; numerous species), pacus (*Colossoma*, especially juveniles; three species), and wimple piranha (*Catoprion mento*).

- Subfamily Myleinae (silver dollars and pacus):
  - Silver dollars are very deep-bodied with very small silvery scales; they are largely vegetarian. Many species are very common in the pet trade. Some are evenly silver in color; others possess black spots similar to those in some piranhas.
  - Pacus are deep-bodied with small scales; some may reach 24 inches (610 mm) or more in length. Although adults are reported to be largely vegetarian, juveniles are highly omnivorous and may even aggressively attack other fishes.

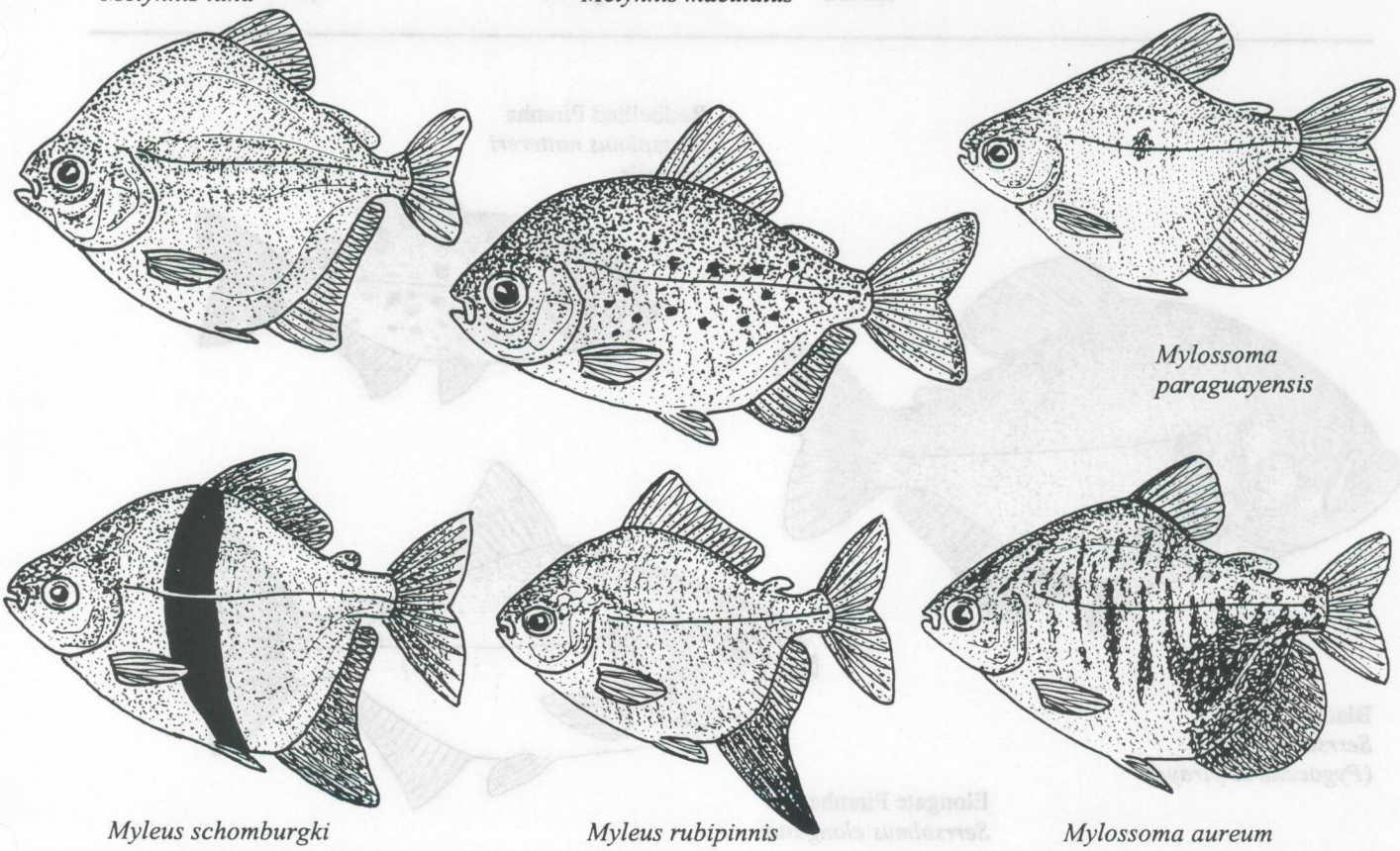
Two specimens held at TPWD's Heart of the Hills Research Station repeatedly attacked a spotted gar *Lepisosteus oculatus* twice their size housed in the same aquarium. Historically, only large adults were seen in public aquaria; however, in recent years large numbers of small juveniles have appeared in the pet trade. These juveniles are more likely to be confused with piranhas than any other fishes. The influx of small pacus in the aquarium trade corresponded with numerous collections of large pacus from many areas in Texas.

- Subfamily Catoprioninae (wimple piranha):
  - Wimple piranha is commonly described in the aquarium literature; however, it has until recently been known to science from only a few preserved specimens and photographs. Although additional specimens have now been collected, it is rarely, if ever, available to aquarium culture. Wimple piranha is a scale-eater and was so named because of a long, pennant-like dorsal fin extension (wimple means flag or pennant). Although it could be considered an undesirable exotic, its extreme rarity precluded serious concern.

SILVER DOLLARS

*Metynnis luna*

*Metynnis maculatus*



*Mylossoma paraguayensis*

*Myleus schomburgki*

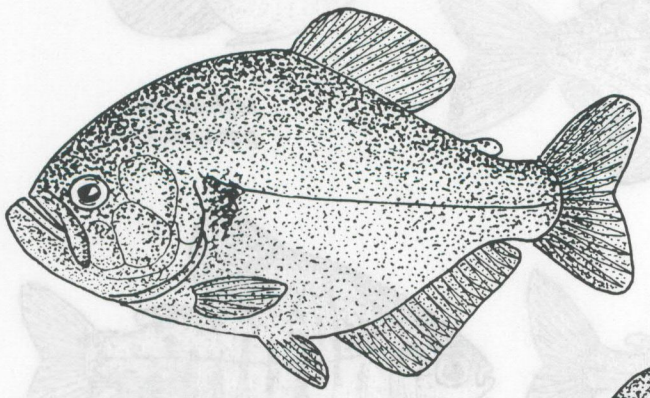
*Myleus rubipinnis*

*Mylossoma aureum*

# Identification Techniques

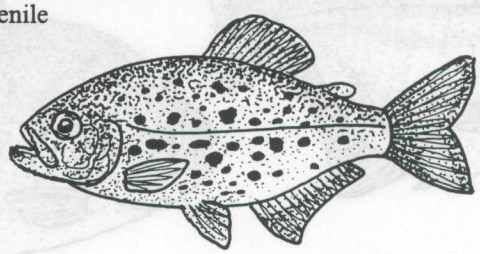
| | Silver Dollars | | |
|---|---|---|---|
| | ***Metynnis*** | ***Myleus*** | ***Mylossoma*** |
| Jaws | near equal | near equal | near equal |
| Adipose fin | elongated | typical | typical |
| Anal fin | deepest anteriorly | deepest anteriorly | deepest in mid-section |
| Dorsal fin | typical | elongated | typical |
| Tooth rows (upper jaw) | double row | double row | double row |

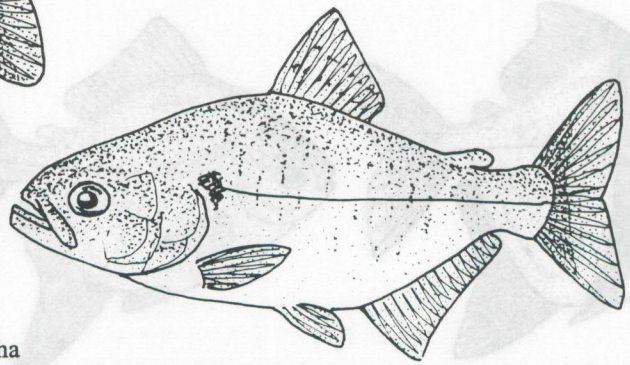
| | **Piranhas** | **Pacus** | **Wimple Piranha** |
|---|---|---|---|
| | ***Serrasalmus*** | ***Colossoma*** | ***Catoprion*** |
| Jaws | lower jaw projects | near equal or lower projects slightly | lower jaw strongly projects slightly elongate |
| Adipose fin | typical | typical | |
| Anal fin | deepest anteriorly | deepest anteriorly | deepest anteriorly |
| Dorsal fin | typical | typical | very long anterior rays |
| Tooth rows (upper jaw) | single row close spaced | double row not close spaced | single row not close spaced |



Black Piranha
*Serrsalmus niger*
(*Pygocentrus piraya*)

Redbellied Piranha
*Serrsalmus nattereri*
Juvenile





Elongate Piranha
*Serrsalmus elongatus*

**Technical Notes:**

(1) Numerous pacus (all three species) have been taken by anglers in Texas waters in recent years; however, only a single piranha (apparently *S. nattereri*), which was taken by an angler from Boerne City Reservoir in the early 1980's, has been reported or identified.

(2) One silver dollar species (*Myleus pacu*) which is dull brown in color should not be confused with true pacus *Colossoma* spp.

(3) Pacus of the genus *Colossoma* (identification based upon unpublished keys prepared by J.N. Taylor for the U.S. Fish and Wildlife Service, Gainesville, Florida) includes three species:

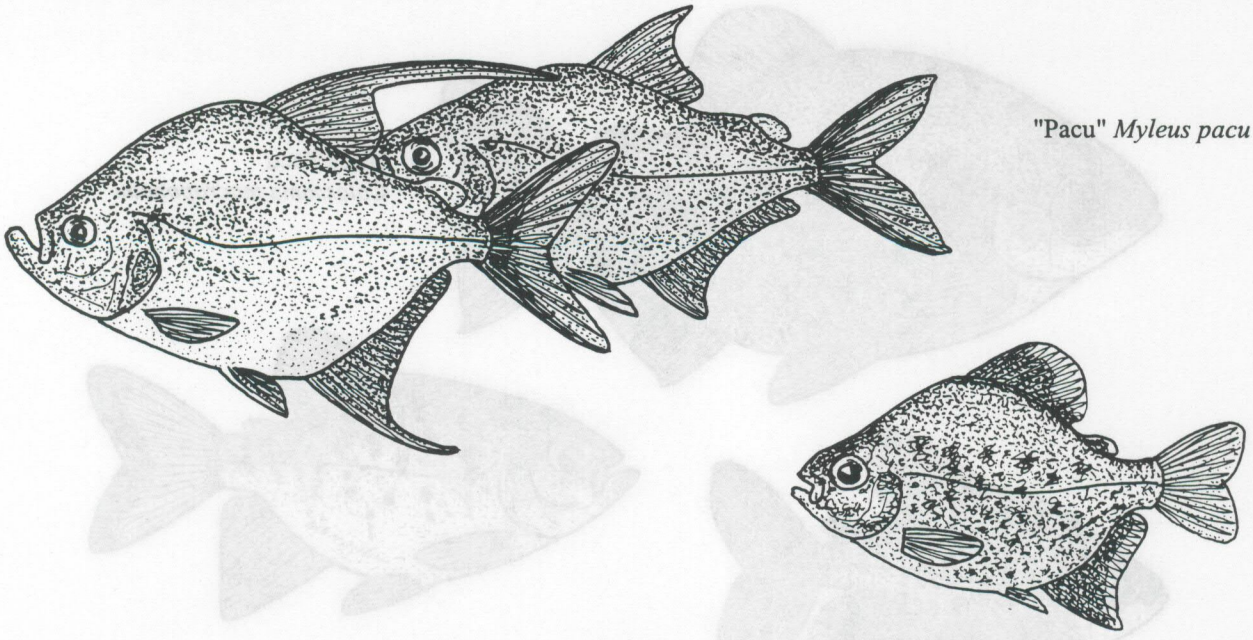
*C. macropomum* (black pacu): Also called blackfin pacu and *C. nigripinnis*, with some published photographs incorrectly identifying this species as *C. brachypomum*; has over 80 total gill rakers; a long head (HL goes 3.0 or fewer times into SL); 60-85 lateral line scales; adipose fin is rayed in adults; no opercular blotch; juveniles have black spots on a silvery background with black pelvic, anal and caudal fins; spots fade in adults and coloration is black (often darker ventrally) over the body and fins.

*C. brachypomum* (redbellied pacu): Also called *C. bidens* and *C. oculus* in the aquarium literature and confused with other pacus; has less than 40 total gill rakers; a short head (HL goes 3.0 or more times into SL); 85-105 lateral line scales; adipose fin is not rayed in adults; 50-65 ventral serrae; opercular blotch is well developed (some piranhas have a humeral but not opercular spot); juveniles have black spots on a silvery background and red pectoral, pelvic and anal (and sometimes caudal) fins with a black edge on the caudal fin; black spots and red fin color fades in older specimens and they become dusky (but usually not as black as *C. macropomum*).

*C. mitrei*: Also called *C. edulis, C. mesopotamicus* and *C. canterai*; a small-scaled form of *C. brachypomum*; has less than 40 total gill rakers; a short head (HL goes 3.0 or more times into SL); more than 105 lateral line scales; adipose fin is rayed in adults; 60-75 ventral serrae; opercular blotch is well developed; coloration is similar to *C. brachypomum.*

(4) A pacu sold as redfinned pacu *C. oculus* in the pet trade has coloration similar to *C. brachypomum* but is morphologically similar to *C. macropomum*. Whether this fish is a red variant of *C. macropomum* (possibly the case), *C. mitrei* or yet another species is unclear.

Wimple Piranha *Catoprion mento*

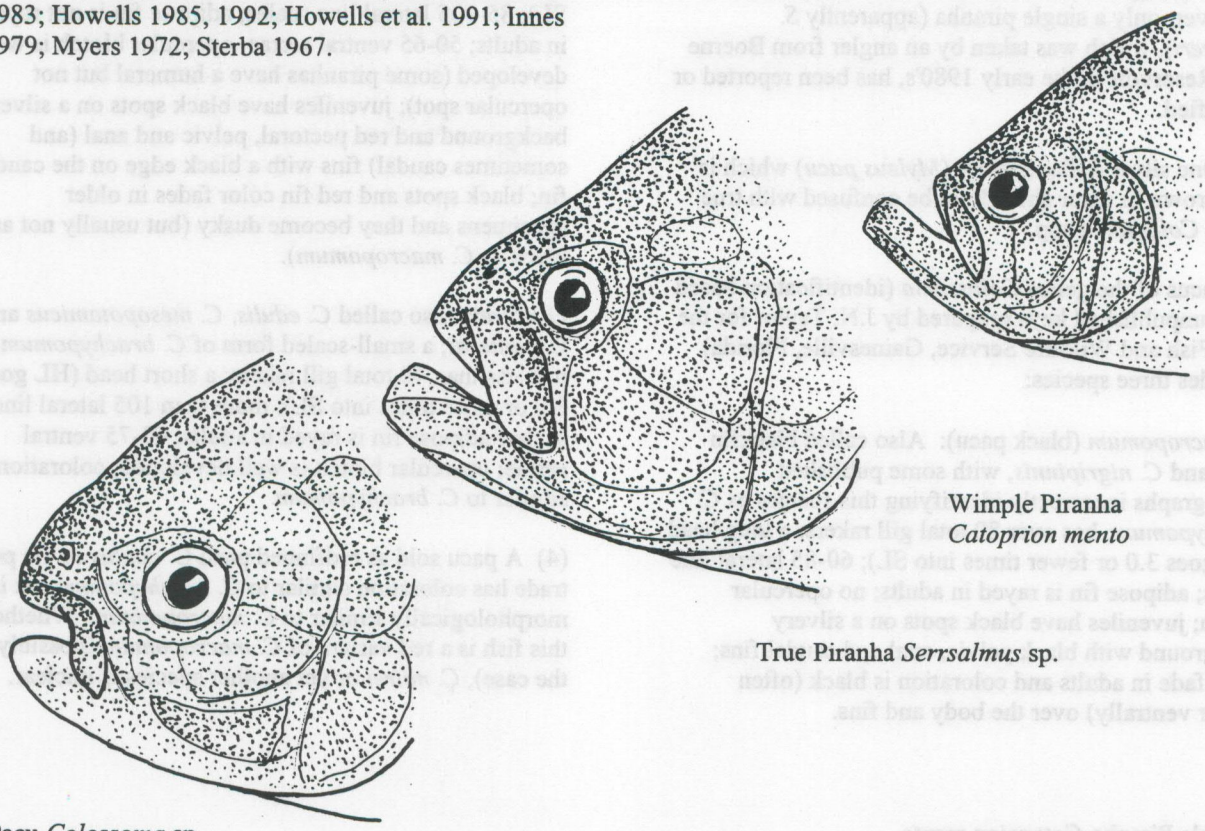


"Pacu" *Myleus pacu*

**References:**

Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Bleher 1983; Courtenay et al. 1984; Courtenay and Robins 1973; Frank 1971, 1980; Gery 1977; Gilliland 1983; Howells 1985, 1992; Howells et al. 1991; Innes 1979; Myers 1972; Sterba 1967.

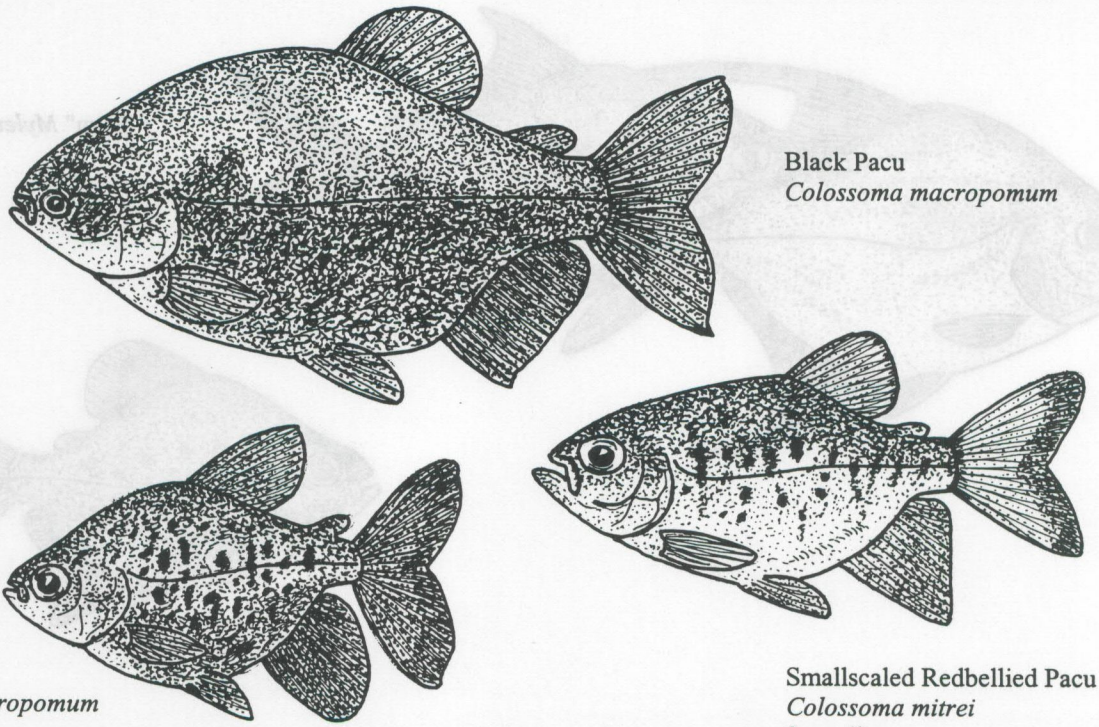
UPPER AND LOWER JAWS
AND UPPER LIP



Wimple Piranha
*Catoprion mento*

True Piranha *Serrsalmus* sp.

Pacu *Colossoma* sp.



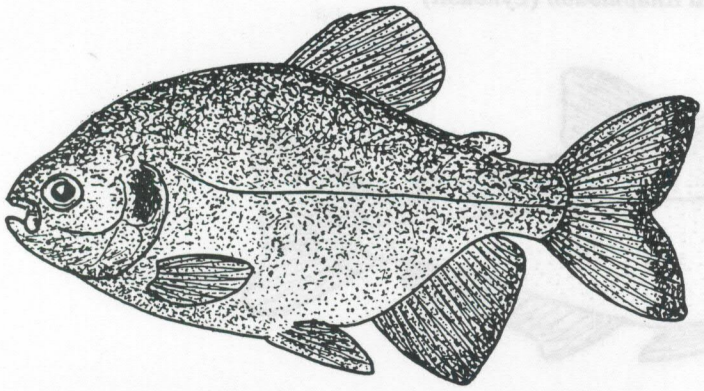
Black Pacu
*Colossoma macropomum*

Black Pacu
*Colossoma macropomum*
Juvenile

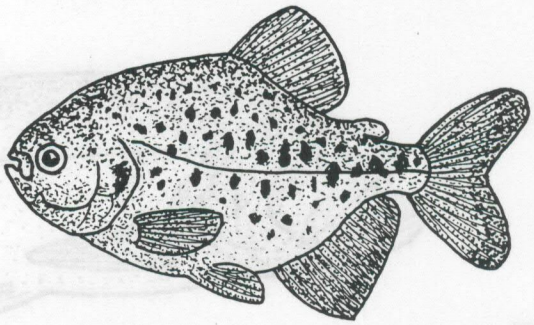
Smallscaled Redbellied Pacu
*Colossoma mitrei*
Juvenile

Redbellied Pacu *Colossoma brachypomum*

Adult

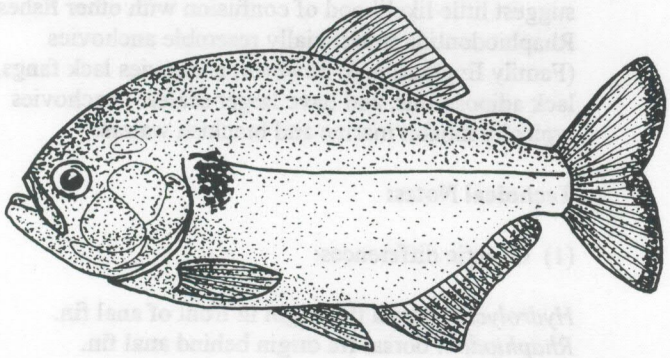


Juvenile

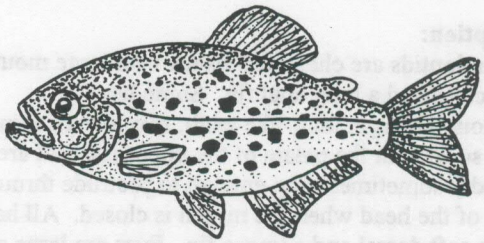


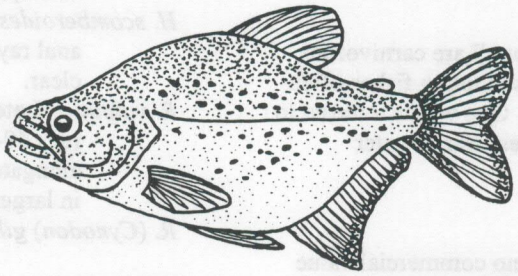
Redbellied Piranha
*Serrsalmus nattereri*

Adult



Juvenile



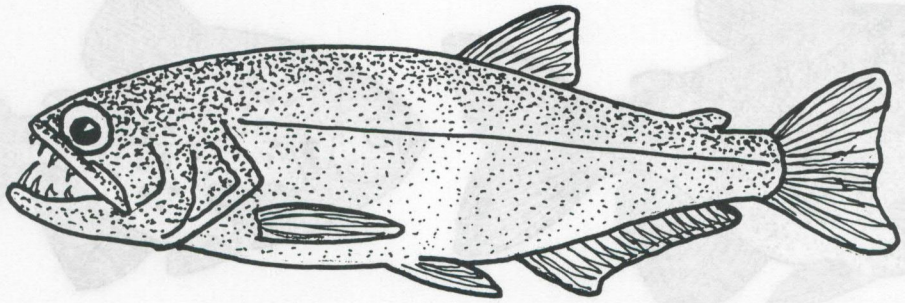


Spotted Piranha
*Serrsalmus rhombeus*

# RHAPHIODONTID CHARACOIDS

## Family: Characidae; Subfamily: Rhaphiodontinae

**All Species of the Genera**
***Hydrolycus* and *Rhaphiodon* (*Cynodon*)**



Payara
*Hydrolycus scomberoides*

**Other Names:**
Payara; also spelled *Hydrolicus*.

**Specifics:**
The genus *Hydrolycus* contains two species and *Rhaphiodon* contains two. *Rhaphiodon* and *Cynodon* are considered synonymous here, although some experts consider them to be separate genera.

**Range:**
All occur in tropical South America.

**Description:**
Rhaphiodontids are characoid fishes with large mouths, small scales and a long anal fin. Some have exceptionally large, fang-like teeth; two lower canines fit into sockets in the palate of the upper jaw and are reportedly sometimes long enough to protrude through the top of the head when the mouth is closed. All have a single soft dorsal and adipose fin. Eyes are large and the mouth extends back well beyond the eye. Coloration is brown or tan above and silvery below. Some reach 28 inches (711 mm) in length. They have a strong ventral keel and reduced pectoral fins.

**Biology:**
Their biology is poorly known but all are carnivorous (probably fish eaters). They are schooling fishes often found associated with fast water. One writer referred to *H. scomberoides* as "one of the best warm-water freshwater game fish...."

**Commercial Importance:**
Rhaphiodontids apparently have no commercial value in the U.S. They are not imported by aquaculturists or the pet trade.

**Reasons For Restriction:**
Size and predatory habits in conjunction with poor understanding of these species suggested caution over potential import and possible introduction until more information about them is available.

**Similar Species:**
The large fang-like teeth and general appearance suggest little likelihood of confusion with other fishes. Rhaphiodontids superficially resemble anchovies (Family Engraulidae); however, anchovies lack fangs, lack adipose fins, and have larger scales. Anchovies typically inhabit marine and brackish waters.

**Technical Notes:**

(1) Generic differences:

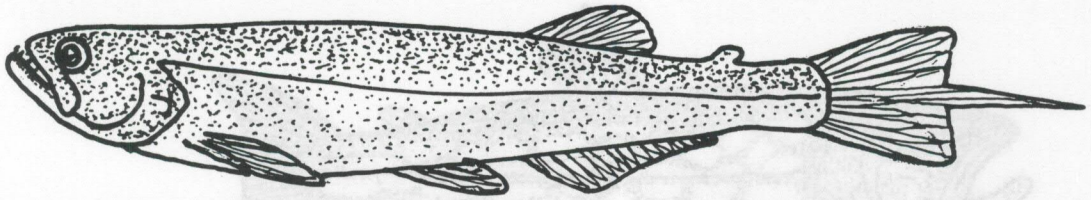
*Hydrolycus*: dorsal fin origin in front of anal fin.
*Rhaphiodon*: dorsal fin origin behind anal fin.

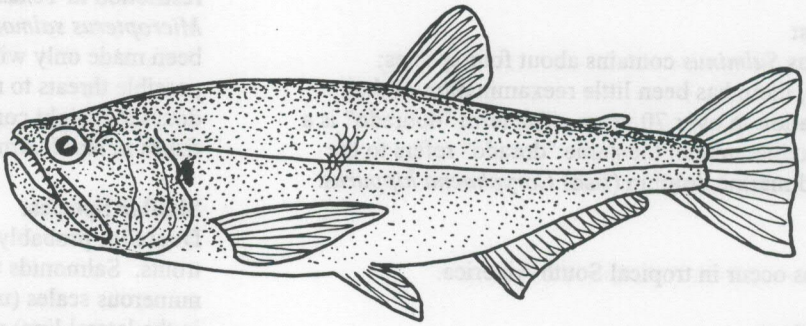
(2) Species differences:

*H. pectoralis*: Lateral line scales 90, branched anal rays 43-46, caudal fin clear, tips of pectorals black.
*H. scomberoides*: Lateral line scales 100-125, branched anal rays 31-40, caudal fin black, pectoral fins clear.
*R. vulpinus:* Lateral line scales 125-130, branched anal rays 40-45, with median caudal fin lobe, elongated body, fins clear (darkened caudal tip in larger specimens.
*R.* (*Cynodon*) *gibbus*: shortened body.

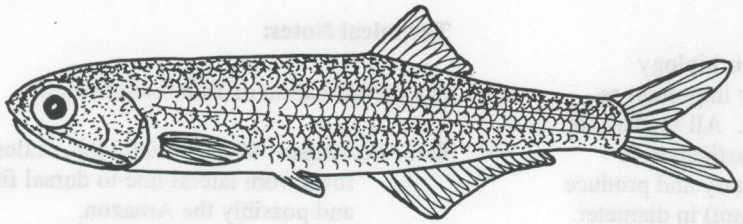
**References:**
Axelrod et al. 1989; Gery 1977.

Biara
*Rhaphiodon vulpinus*





Rhaphiodotid Characoid
*"Cynodon hydrocyon"*
Redrawn from Maglaas (1931)

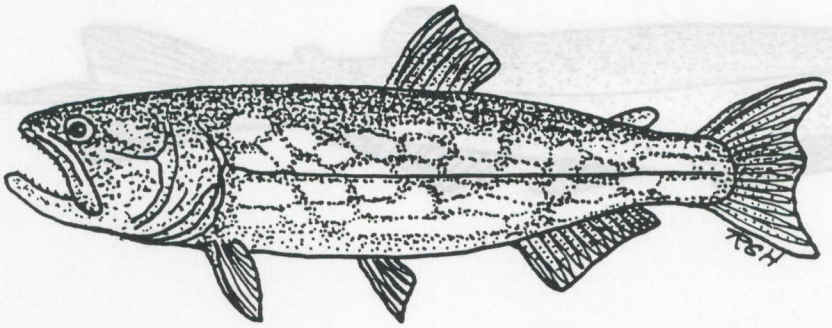


Bay Anchovy
*Anchoa mitchelli*

# Dourados

## Family: Characidae; Subfamily: Bryconinae

### All Species of the Genus *Salminus*



Dourado
*Salminus maxillosus*

**Other Names:**
South American salmon, South American trout.

**Specifics:**
The genus *Salminus* contains about four species; however, there has been little reexamination of their classification in over 70 years. The term "dourado" is a local Brazilian name; the name "dorado" refers to the unrelated marine dolphin (fish) *Coryphaena hippurus*.

**Range:**
Dourados occur in tropical South America.

**Description:**
Basic features are very trout- or salmon-like. They have large mouths with two rows of teeth in both jaws. Coloration is often a greenish gold; *S. maxillosus* may have a reticulated (chain-like) pattern similar to American chain pickerel *Esox niger*; *S. hilarii* appears dark above and light below without the reticulate pattern. At least one species, *S. maxillosus*, has been illustrated with a trilobed tail. They may exceed 24 inches (610 mm) in length and 40 pounds (18 kg) in weight.

**Biology:**
There is very little information on their biology available even though they are locally important as food and game fish in South America. All species are predatory. A Brazilian species, *S. brasiliensis*, is reported to spawn November to February and produce yellow eggs 0.08-0.10 inch (2.0-2.5 mm) in diameter.

**Commercial Importance:**
Although important in South America, they are not handled by either North American aquaculturists or the pet trade.

**Reasons For Restriction:**
Large size and predatory habits prompted early restriction in Texas and elsewhere. Largemouth bass *Micropterus salmoides* introductions in Brazil have been made only with great caution due to concerns over possible threats to native dourados. Conversely, dourados might compete with bass or other predatory fishes in North America if imported and released.

**Similar Species:**
Dourados probably most closely resemble salmon and trouts. Salmonids typically have smaller, more numerous scales (usually over 100 and often over 150 in the lateral line) and dourados have somewhat larger scales (less than 105 and often less than 80 lateral line scales). Salmonids never develop a reticulate pattern seen in some dourados, or a trilobed tail. Other characoids in the subfamily Bryconinae are vaguely similar in appearance; South American trouts *Brycon* spp. rarely appear in the pet trade (usually as juveniles). *Salminus* has conical or weakly tricuspid teeth in two rows on both jaws; *Brycon* has multicuspid teeth with three rows on the upper jaw and two rows on the lower jaw.

**Technical Notes:**

(1) Identification of *Salminus* species:

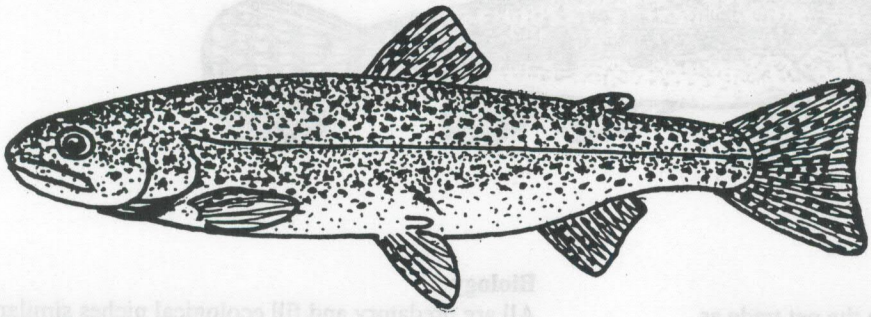
- *S. maxillosus*: 90-105 lateral line scales; 14-18 scale rows from lateral line to dorsal fin; La Plata and possibly the Amazon.
- *S. brasiliensis* (*brevidens*): 77-79 lateral line scales; 10-12 scale rows above the lateral line; 27-30 anal rays; Rio S. Francisco, Rio Parana.
- *S. hilarii* and *S. affinis*: 66-73 lateral line scales and 10-12 scale rows above the lateral line, with *S.*

*affinis* with slightly higher counts; 24-26 anal rays; Amazon Basin and Rio Apure.

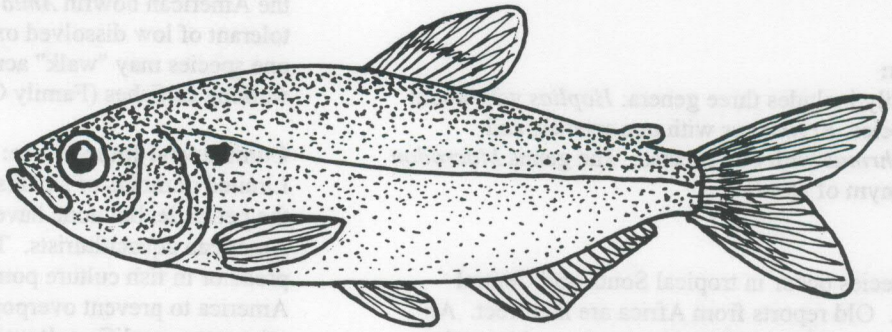
(2) A closely related species, *Catabasis acuminatus*, is known only from a single 6.5-inch (165-mm) specimen collected before 1900 and not seen since. It has conical teeth and a more elongated snout; *Salminus* have weakly tricuspid teeth and more blunt snouts. Small size and extreme rarity precluded the need for restriction at this time.

**References:**

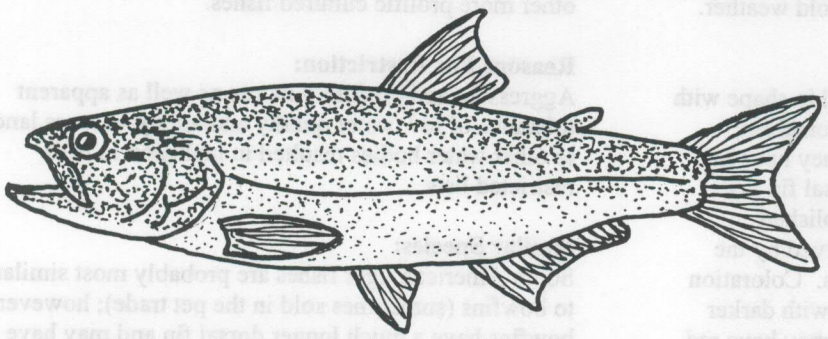
Axelrod et al. 1989; Gery 1977.



Rainbow Trout
*Oncorhynchus mykiss*

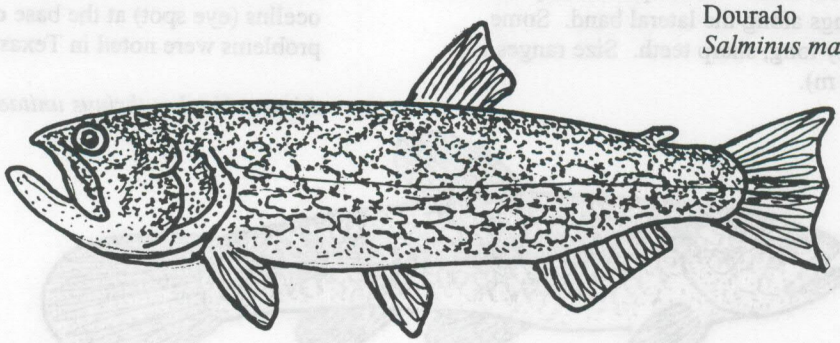


Bryconid Tetra
*Brycon* sp.



Dourado
*Salminus hilarii*

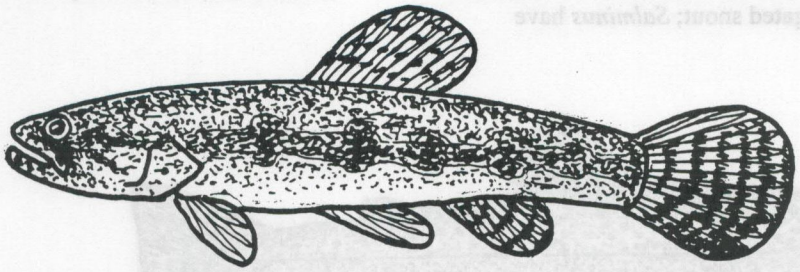
Dourado
*Salminus maxillosus*



# SOUTH AMERICAN TIGER FISHES

## Family: Erythrinidae

**All Species**



Trahira
*Hoplias malabaricus*

**Other Names:**
Trahiras, houri, sometimes sold in the pet trade as wolffish.

**Specifics:**
This family includes three genera: *Hoplias* with about three species, *Erythrinus* with one species, and *Hoplerythrinus* with one species. The genus *Macrodon* is a synonym of *Hoplias*.

**Range:**
These species occur in tropical South and Central America. Old reports from Africa are incorrect. An introduction in Florida failed to survive cold weather.

**Description:**
South American tiger fishes are elongated in shape with large mouths and a centrally positioned dorsal fin; however, unlike most other characoids, they have no adipose fin. Some illustrations show dorsal fin ray extensions on anterior rays; however, published photographs at hand and specimens observed by the TPWD staff do not show these extensions. Coloration is usually an earthy grey or brown, often with darker blotches or a lateral band. Some species may have red or yellow markings along the lateral band. Some possess extremely long, sharp teeth. Size ranges to about 3 feet (0.9 m).

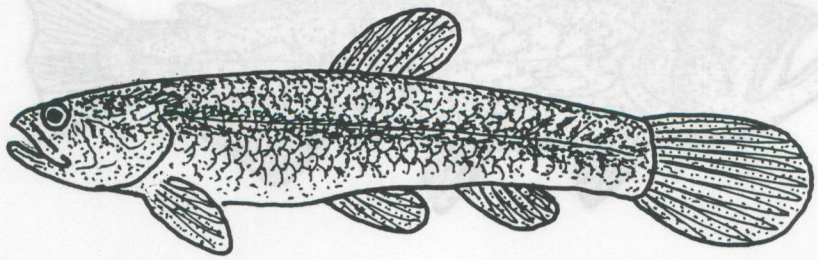
**Biology:**
All are predatory and fill ecological niches similar to the American bowfin *Amia calva*. Reportedly, they are tolerant of low dissolved oxygen conditions and at least one species may "walk" across damp ground much like walking catfishes (Family Clariidae).

**Commercial Importance:**
Limited numbers of small specimens are imported for the pet trade, but none have been of interest to North American aquaculturists. They have been used as a predator in fish culture ponds in South and Central America to prevent overpopulation and stunting of other more prolific cultured fishes.

**Reasons For Restriction:**
Aggressive and predatory nature as well as apparent tolerance of low water quality and ability to cross land to other water bodies resulted in inclusion in early restricted lists.

**Similar Species:**
South American tiger fishes are probably most similar to bowfins (sometimes sold in the pet trade); however, bowfins have a much longer dorsal fin and may have an ocellus (eye spot) at the base of the tail. Previously, problems were noted in Texas where both pet stores

Aimara *Hoplerythrinus unitaeniatus*



and state and federal Law Enforcement officers confused South American tiger fishes with certain larger gobies (Family Gobiidae) and sleepers (Family Eleotridae). Although some gobies and sleepers are similar in size and color to tiger fishes, both have spiny dorsal fins (absent in tiger fishes) and both have pelvic fins placed far foreword near the throat (positioned midbody on tiger fishes).

**Technical Note:**
Identification of Erythrinid genera and species:

*Hoplias*: dorsal fin with ii-iii, 11-15 rays; 37 or more lateral line scales; maxillary bone with 2-3 canine teeth.

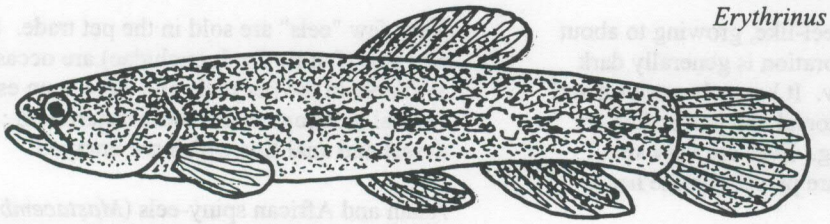
- *H. macrophthalmus*: eye large (14-15 times into body length); abdomen flattened and colored; large (to 3 feet/0.9 m); giant trahira.
- *H. microlepis*: eye small (18-20 times into body length); abdomen rounded and colored; smaller (to about 10 inches/254 mm); lateral line scales 43-47; dorsal rays ii, 13-15.
- *H. malabaricus* (*lacertae*): eye small; abdomen rounded and colored; to about 2 feet; lateral line scales usually 37-43; dorsal rays iii, 11-12(13).

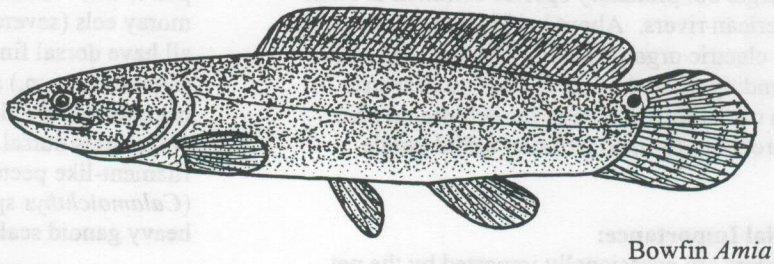
*Erythrinus erythrinus*: dorsal fin rays iii, 8-9; 32-37 lateral line scales; maxillary bone without canine teeth; maxillary bone reaches posterior margin of eye; eye small (22-25 times into body length); caudal fin spotted; color pattern usually marbled.

*Hoplerythrinus unitaeniatus*: dorsal fin rays iii, 32-37; 32-37 lateral line scales; maxillary bone without canine teeth; maxillary extends past eye; eye small (19 times into body length); caudal fin plain (not spotted or marbled); with dark lateral band; reported with a caudal spot and opercular ocellus (eye spot), but published photographs often fail to show these.

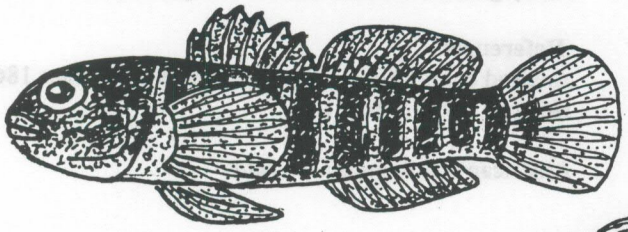
**References:**
Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Frank 1971; Gery 1977; Sterba 1967.

South American Tiger Fish
*Erythrinus erythrinus*

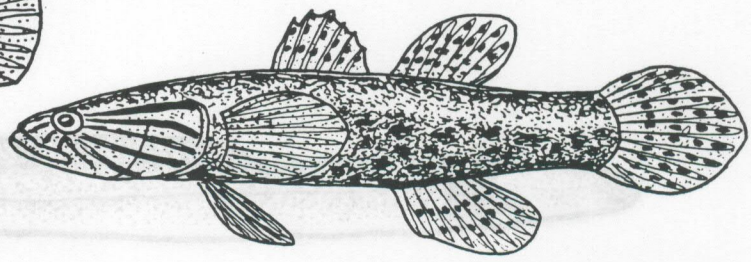




Bowfin *Amia calva*



Naked Goby
*Gobiosoma bosci*

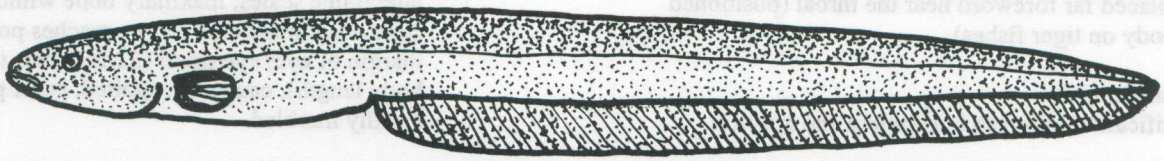


Spinycheek Sleeper *Eleotris pisonis*

# ELECTRIC EEL

## Family: Electrophoridae

*Electrophorus electricus*



Electric Eel *Electrophorus electricus*

**Other Names:**
None.

**Specifics:**
Only one species is recognized. It is related to other South American knifefishes.

**Range:**
It is native to tropical South America.

**Description:**
Electric eel is elongated and eel-like, growing to about 6 feet (1.8 m) in length. Coloration is generally dark olive-brown but lighter below. It has only pectoral and united anal and caudal fins; dorsal and pelvic fins are lacking, and scales are lacking. Eyes are very small and small pit-like structures are present on the head.

**Biology:**
It is a lethargic but predatory species common in some South American rivers. About half of its body tissue is devoted to electric organs that can produce 350-650 volts, depending upon the size of the fish. Electric production capabilities are used for defense, to stun prey and probably for navigation in turbid jungle streams.

**Commercial Importance:**
Small numbers are occasionally imported by the pet trade, but high cost, unattractiveness and lethargic nature limits demand.

**Reasons For Restriction:**
Potential hazards associated with exceptionally high electrical voltage production has resulted in restricted listings in many states.

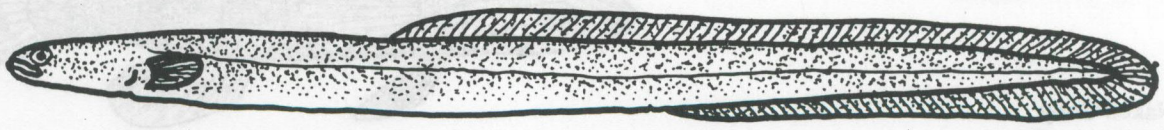
**Similar Species:**
The electric eel is probably most similar to knifefishes, but none grow as large; most do not have continuous anal and caudal fins. Several knifefishes also have dorsal fins which are not present in electric eels.

Very few "eels" are sold in the pet trade. Swamp or rice eels (family Synbranchidae) are occasionally available in the pet trade and have been established at several locations in the southeastern U.S.; all have short dorsal and anal fins which are unrayed.

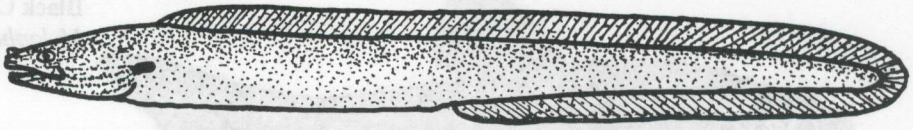
Asian and African spiny-eels (*Mastacembelus* spp.) have elongated snouts, dorsal spines and dorsal and pelvic fins. A number of genera of moray and ribbon moray eels (several genera) are sold for marine aquaria; all have dorsal fins. Lungfishes from South America (*Lepidosiren* sp.) and Africa (*Protopterus* spp.) are occasionally available in the pet trade; these have continuous dorsal, caudal and anal fins as well as filament-like pectoral and pelvic fins. African rope fish (*Calamoichthys* sp. or *Erpetoichthys* sp.), which has heavy ganoid scales, is also sold in pet stores.

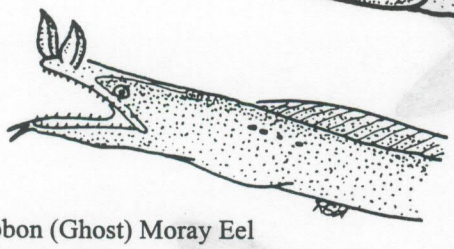
**.References:**
Axelrod et al. 1976, 1989; Gilliland 1983; Gunter 1866; Howells 1985; Sterba 1967.

American Eel *Anguilla rostrata*



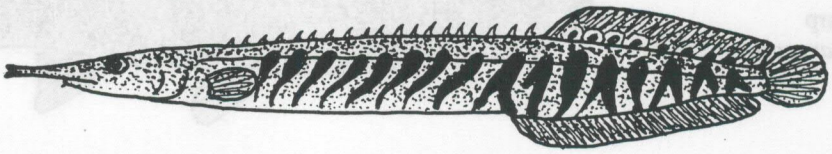
Swamp Eel
*Monopterus albus*



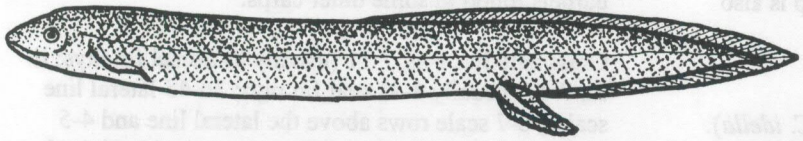


Freshwater Moray Eel
*Gymnothorax polyuranodon*

Ribbon (Ghost) Moray Eel
*Rhinomuraena* sp.

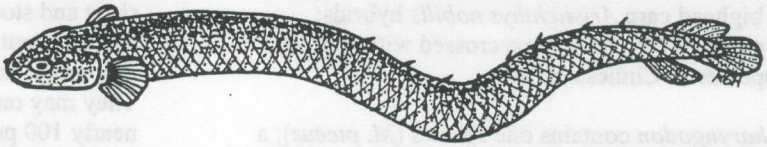


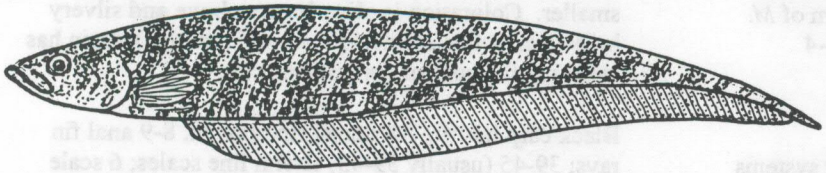
Spiny Eel
*Mastacembelus* sp.



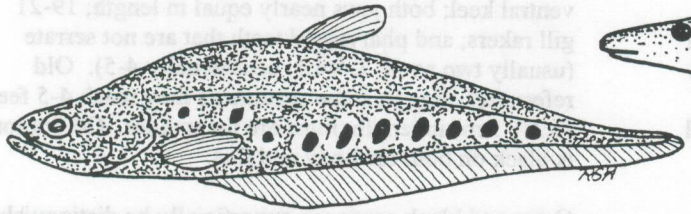
South American Lungfish
*Lepidosiren paradoxus*

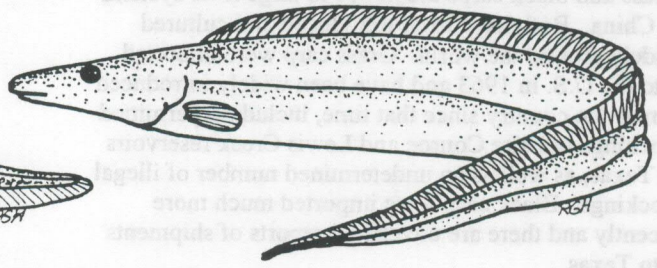
Banded Knifefish
*Gymnotus carapo*





African Reed- or Ropefish
*Erpetoichthys* (*Calamoichthys*)
*calabaricus*





Clown Knifefish *Notopterus chitala*

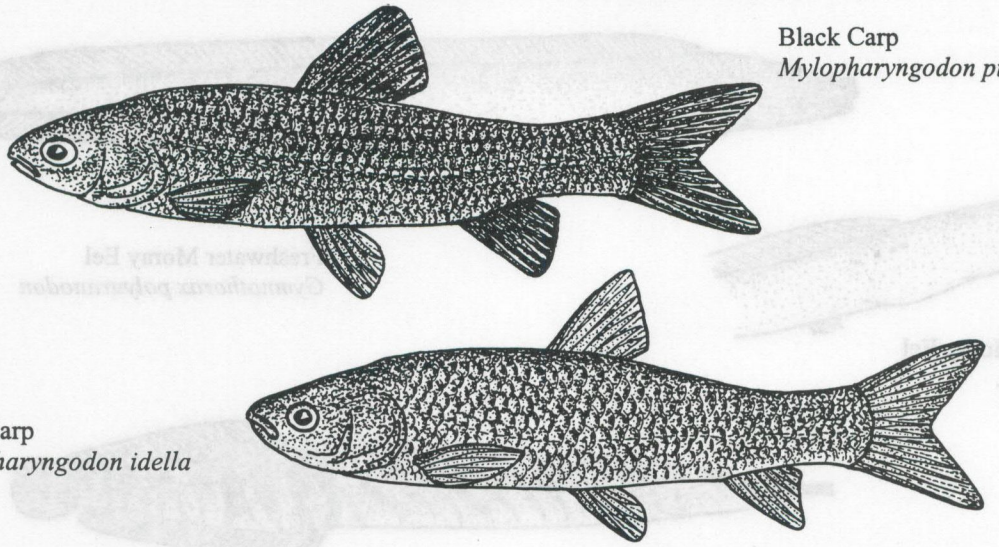
Aba Aba *Gymnarchus niloticus*

# GRASS CARP and BLACK CARP

## Family: Cyprinidae

### All Species of the Genera

### *Ctenopharyngodon* and *Mylopharyngodon*



Black Carp
*Mylopharyngodon piceus*

Grass Carp
*Ctenopharyngodon idella*

**Other Names:**
Grass carp is also called white amur; black carp is also called snail carp and, rarely, Chinese roach.

**Specifics:**
*Ctenopharyngodon* contains a single species (*C. idella*). Triploid grass carp is a domestically produced genetic variant with three sets of chromosomes rather than the normal two. Hybrid grass carp usually refers to grass carp x bighead carp *Aristichthys nobilis* hybrids; however, grass carp have been crossed with several other species of Chinese carps.

*Mylopharyngodon* contains one species (*M. piceus*); a second species, *M. aethops*, may be a synonym of *M. piceus*. Older literature sometimes suggests 3-4 species.

**Range:**
Grass and black carps are native to large river systems in China. Both have been introduced and cultured widely around the world. Grass carp were imported into the U.S. in 1963 and have been widely introduced across the country since that time, including permitted stockings in Lake Conroe and Lewis Creek reservoirs in Texas, as well as an undetermined number of illegal stockings. Black carp were imported much more recently and there are unverified reports of shipments into Texas.

**Description:**
Both grass and black carps are relatively similar in appearance, being slender and elongated. None possess barbels found in some other carps.

Grass carp has i-iii, 7-11 (usually 8) dorsal fin rays; ii-iii, 7-11 (usually 8-9) anal fin rays; 36-45 lateral line scales; 6-7 scale rows above the lateral line and 4-5 scale row below the lateral line; no ventral keel; both jaws of nearly equal length (upper may be slightly longer); pectoral fins that do not reach the pelvic fins; short and stout gill rakers (12-15); and pharyngeal teeth that are stout and well developed with definite serration and compressed crowns (two rows; 2,5-4,1 or 2,4-4,2). They may reach 4-5 feet (1.2-1.5 m) in length and nearly 100 pounds (45 kg) in weight; most are far smaller. Coloration is olive-brown above and silvery below; most fins are dusky. A gold (xanthic) strain has appeared recently in domestic stocks.

Black carp has iii, 7-8 dorsal fin rays; iii, 8-9 anal fin rays; 39-45 (usually 39-43) lateral line scales; 6 scale rows above and 4 scale rows below the lateral line; no ventral keel; both jaws nearly equal in length; 19-21 gill rakers; and pharyngeal teeth that are not serrate (usually two rows, 1,4-4,1; occasionally 4-5). Old references suggest some specimens may reach 4-5 feet (1.2-1.5 m) in length; most are far smaller. Coloration is black on both the body and fins.

Grass and black carps can superficially be distinguished by color, and more definitively by gill raker counts and pharyngeal teeth.

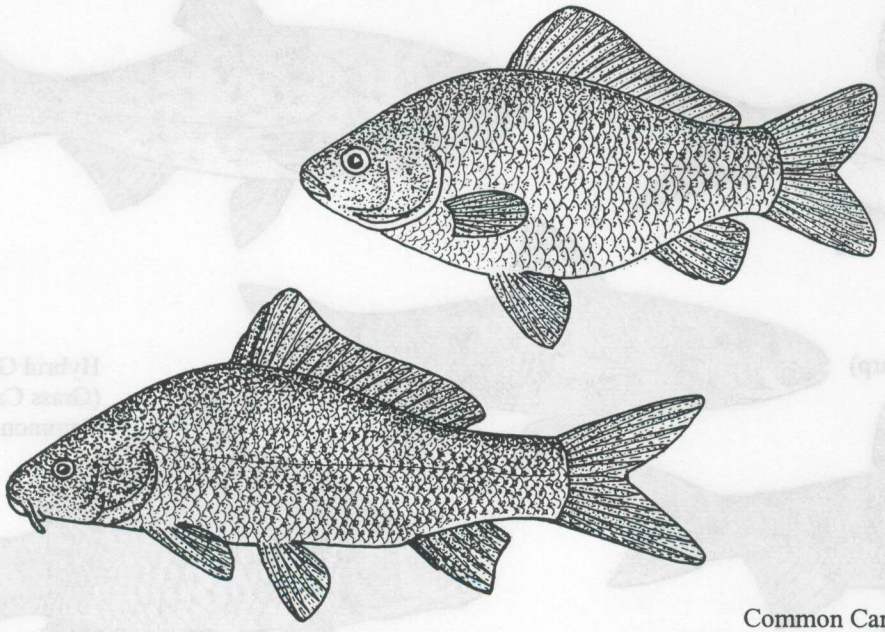
**Biology:**
Both normally inhabit large rivers and may migrate long distances to spawning sites. Their eggs and larvae are planktonic and drift with the current (most American minnows have adhesive eggs). In general, neither successful spawning or egg incubation is likely to occur in ponds or lakes. They are very active and grass carp especially is noted for its ability to jump. Grass carp feeds heavily on larger types of aquatic vegetation; black carp has been reported to eat snails and other mollusks almost exclusively by some, but has also been described as preying upon aquatic insects, snails and prawns (but not on vegetation). Successful feral grass carp spawning has been documented in U.S. waters, including Texas. Both are freshwater fishes, but tolerate brackish waters.

**Commercial Importance:**
Grass carp are produced by American aquaculturists (where legal) and sold largely for control of aquatic vegetation; although some are sold as food fish, they have not gained wide culinary acceptance in the U.S. Black carp are being reared and reportedly sold to some Oriental fish markets as well as to aquaculturists for control of snails (disease vectors) in hatchery ponds. Neither is of interest to the pet trade.

**Reasons For Restriction:**
Grass carp (including triploid grass carp) has long been restricted in Texas because of concerns that if established, large numbers could cause environmental damage by removing too much vegetation and therefore destroying fish and wildlife habitat. Hybrid grass carp (grass carp x bighead carp) became restricted in 1990 because some stocks were found to be contaminated with pure grass carp (and pure bighead carp) and because they were found to possess many genetic anomalies. Grass carp x bighead carp hybrids in possession as of January 25, 1990 and acknowledged by TPWD by June 1, 1990 may be retained (but may not be replaced or supplemented) until January 1, 1995. Hybrids between grass carp and any other carps are also restricted. Black carp were restricted in 1989 because their spawning requirements are similar to those of grass carp (grass carp spawn in U.S. waters, black carp could as well) and concerns over possible competition with native fish and wildlife. Black carp may be possessed if there is documented evidence that the fish were in possession prior to 25 January 1990 or under a TPWD Exotic Fish Permit.

**Similar Species:**
Both species are probably most similar to American carps and minnows. They can be distinguished from native species by comparing the distance from the front of the anal fin to the base of the caudal fin to the distance from the snout to the start of the anal fin. In grass and black carps the anal-to-caudal distance goes three or more times into the head-to-anal distance (less than three times in native minnows). Further, introduced common carp *Cyprinus carpio* and goldfish *Carassius auratus* have a single heavy spine in the dorsal fin which is lacking in grass and black carps (as well as higher dorsal fin ray counts).

Bighead carp and silver carp *Hypophthalmichthys molitrix*, which have also been imported into the U.S., have much smaller scales, a longer anal fin with more branched rays (11-17), and eyes that are set very low on the side of the head (in larger specimens).



Goldfish
*Carassius auratus*

Common Carp *Cyprinus carpio*

**Technical Notes:**

(1) **Triploid Grass Carp:** TPWD has historically considered triploid grass carp to be restricted along with normal diploid grass carp. Although still retained as restricted, TPWD began work in 1989 and 1990 to study triploid grass carp in Texas waters. Triploids are believed to be sterile and incapable of reproduction, hence present less of an environmental threat if released. Indeed, the U.S. Fish and Wildlife Service published a biological opinion that triploids were safe for use in vegetation control. However, some scientists have questioned their sterility (work on viability of eggs from triploid females has not been published; triploid milt was used successfully in one study to fertilize normal diploid eggs) and techniques of triploid production are not always totally effective and every individual must be subjected to a blood test to confirm ploidy. Lastly, triploids cannot be confidently and easily distinguished from diploids using simple external features; laboratory analysis of blood or other tissue is required. Quick field identifications by biologists or Law Enforcement officers are not possible.

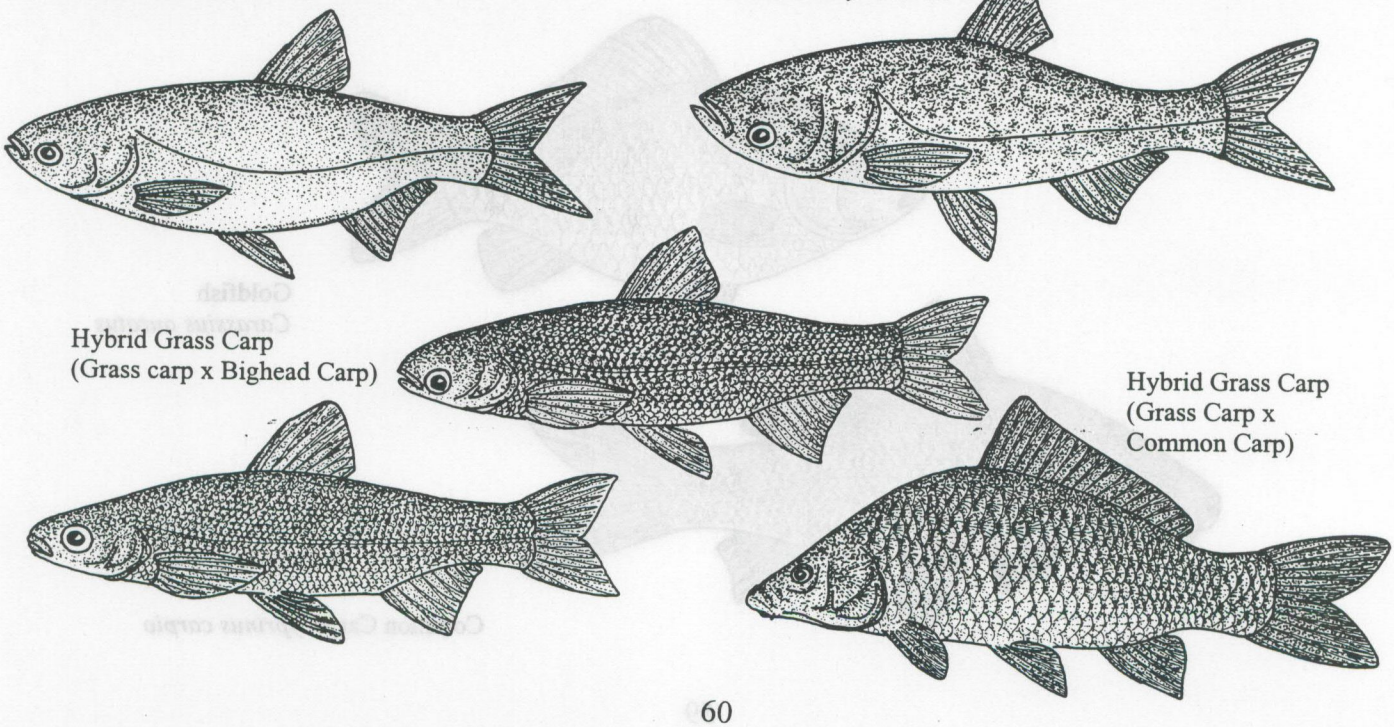
(2) **Hybrid Grass Carp:** Grass carp x bighead carp hybrids are believed to be sterile; however, no published studies have examined this point in detail. All are often believed to be triploids, but although some are in fact triploids, others may be diploids, tetraploids, aneuploids (partial ploidy counts) or mosaics (different cells have different ploidy counts). Apparently triploid hybrids have better survival rates than do diploid hybrids which may have guts that are too short or metabolic problems. Further, the procedures used to enhance the number of triploids among hybrid eggs may also produce occasional pure grass or bighead carps (gynogens) as well. Both the federal government and other states have concluded or terminated hybrid grass carp research programs with rather negative views of hybrids. However, TPWD began research on grass carp x bighead carp hybrids in 1989 with stockings at several locations in the state.

Grass carp x bighead carp hybrids are similar in appearance to pure grass carp but with many features intermediate between both parents. They have ii-iii, 7-8 dorsal fin rays; ii, 10-11 anal fin rays; 42-65 lateral line scales; 8-13 scale rows above and 6-10 rows below the lateral line; jaws nearly equal; pharyngeal teeth that are intermediate between parental types with only slight serration (usually a single row, 5-4); intermediate length gill rakers (18-23); ventral keel present between pelvic (variable in appearance); and anal fins and pectoral fins that reach to or slightly beyond the base of the pelvic fins. Coloration is an olive-brown above and silvery below (often somewhat more brown than grass carp).

A male grass carp x female common carp hybrid has been produced in the U.S., eastern Europe and Asia. It more closely resembles common carp and is deeper bodied than the bighead carp hybrid and has a longer dorsal fin (about 17 branched rays) and fewer lateral line scales (about 35).

Silver Carp
*Hypophthalmuichthys molitrix*

Bighead Carp
*Aristichthys nobilis*



Hybrid Grass Carp
(Grass carp x Bighead Carp)

Hybrid Grass Carp
(Grass Carp x
Common Carp)

(3) **Larval stage:** Work by Russian biologists Soin and Sukhanova in 1972 suggested grass carp larvae could easily be distinguished from larval black, bighead and silver carps on the basis of myomere count. However, subsequent descriptions of larval grass carp and hybrid grass carp in the U.S. and elsewhere indicated larger variation in myomere counts than seen by Soin and Sukhanova in their samples. Grass carp larvae were reported to have 29 or more preanal myomeres while the other three species had 28 or less; however, some grass carp larvae may have fewer than 29 preanal myomeres and hybrid grass carp counts may overlap those of grass carp. Therefore, extreme caution should be used in attempting to distinguish between species in the larval stage.

(4) **Egg stage:** Eggs of grass carp and black carp are largely indistinguishable from each other and from those of bighead and silver carps. They range in diameter from about 0.15 to 0.22 inch (3.8-5.6 mm) and are without oil droplets. American cyprinid eggs are generally much smaller and are adhesive (non-adhesive and pelagic in grass and black carps). Indeed, few American fishes in fresh water have pelagic eggs and those that do contain oil droplets (e.g., striped bass *Morone saxatilis*, 0.05-0.18 inch/1.2-4.6 mm; mooneye and goldeye *Hiodon* spp., 0.16 inch/4.1 mm; and freshwater drum *Aplodinotus grunniens*, 0.04-0.07 inch /1.0-1.8 mm).

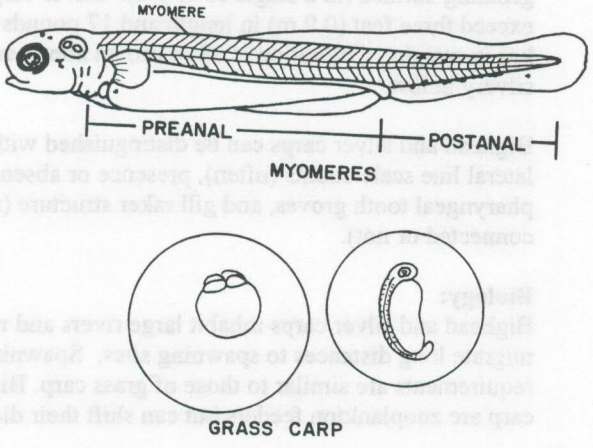
(5) **Confirmed grass carp spawning in Texas:** Since the first edition of this book was published, ichthyoplankton surveys in the lower Trinity River, Texas, confirmed successful spawning of grass carp with the collection of developing eggs and larvae. Subsequent fish sampling ultimately collected juvenile specimens as well. This is the first location in North America outside the Mississippi River Valley where successful grass carp reproduction has been documented. It is believed by some that the adults now spawning below the dam at Lake Livingston may have originated from a stocking of fertile diploid grass carp in Lake Conroe on the San Jacinto River by Texas A&M University in the early 1980s. These fish quickly exited Lake Conroe, moved downstream to Trinity Bay, and ultimately up the Trinity River. Others suggest the spawning adults now observed represent escaped fish which were illegally stocked by local land owners.

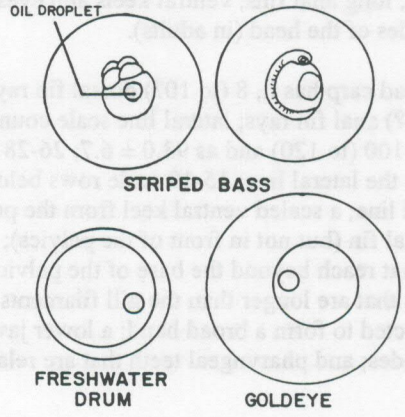
**(6) Grass carp in the Guadalupe River:** Establishment and rapid spread of hydrilla *Hydrilla verticillata* occurred in central reaches of the Guadalupe River between New Braunfels and Gonzales, Texas, in the 1990s. Concern of local landowners and various public agencies over rapid spread of this plant led to release of triploid grass carp as a vegetation-control agent. Cautions that these stocked fish would soon emigrate from the area were ultimately proven correct. Within 18 months during low river flow conditions caused by drought, 10% of stocked grass carp emigrated downstream. During the following 6 months of high river flow conditions, 60% of stocked fish moved downstream from their stocking sites. Some moved over 184 miles (296 km) and passed a maximum of 10 dams.

**References:**

Allen and Wattendorf 1987; Avault and Merkowsky 1978; Bardach et al. 1972; Beck and Biggers 1983; Berg 1949a; Berry and Low 1970; Cassani et al. 1984; Chu 1930; Clugston 1988; Clugston and Shireman 1987; Courtenay et al. 1984; Courtenay and Robins 1973; Howells 1985, 1992; Jennings and McCann 1985; Jhingran and Pullin 1988; Kilambi and Zdink 1981; Nichols 1943; Preja 1984; Prentice et al. (In Press); Provine 1975; Smith 1945; Soin an Sukhanova 1972; Stanley and Jones 1976; Webb et al. 1994; Wiley et al 1987.

GRASS CARP EGGS AND LARVAE

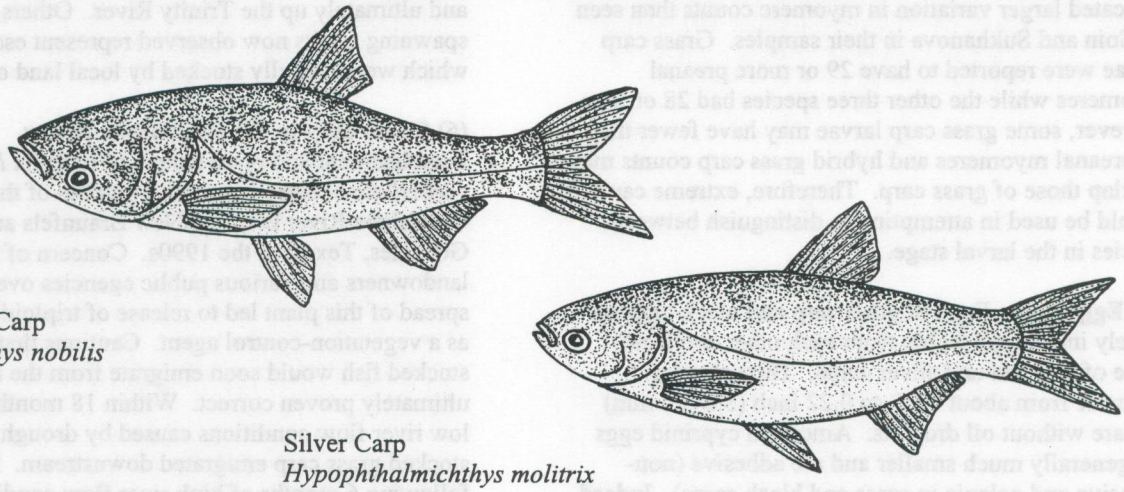


# BIGHEAD CARP AND SILVER CARP

## Family: Cyprinidae

### All Species of the Genera *Aristichthys* and *Hypophthalmichthys*



Bighead Carp
*Aristichthys nobilis*

Silver Carp
*Hypophthalmichthys molitrix*

**Other Names:**
Local Oriental names.

**Specifics:**
*Aristichthys* has only a single species, bighead carp *A. nobilis*; however, some authorities consider it under *Hypophthalmichthys*. *Hypophthalmichthys* includes silver carp *H. molitrix*, a second species (questioned by some) *H. harmandi,* and possibly bighead carp.

**Range:**
Both bighead and silver carps are native to the large river systems in China, but have been introduced at many locations around the world including the U.S. *H. harmandi* is reportedly from Vietnam.

**Description:**
Both bighead and silver carps are elongated, though somewhat deeper bodied than grass carp *Ctenopharyngodon idella*. Both have relatively small scales, long anal fins, ventral keels and eyes set low on the sides of the head (in adults).

Bighead carp has ii, 8 (to 10?) dorsal fin rays; ii, 11-14 (to 16?) anal fin rays; lateral line scale counts reported as 98-100 (to 120) and as 93.0 ± 6.7; 26-28 scale rows above the lateral line; 15-19 scale rows below the lateral line; a scaled ventral keel from the pelvic fins to the anal fin (but not in front of the pelvics); pectoral fins that reach beyond the base of the pelvic fins; gill rakers that are longer than the gill filaments and are not connected to form a broad band; a lower jaw that protrudes; and pharyngeal teeth that are relatively delicate with smooth grinding surfaces (in a single row; 4-4). They may exceed 40 inches (1 m) in length and 88 pounds (40 kg) in weight. Coloration is a dull olive-brown above and silvery below; fins may be dusky.

Silver carp has iii, 7 dorsal fin rays (sometimes given as 8-10 rays); ii-iii, 11-14 anal fin rays (sometimes given as 13-17 rays); 107-125 lateral line scales (reported as low as 83); 28-33 scale rows above the lateral line and 16-28 scale rows below the lateral line; a strong ventral keel extending from in front of the pelvics (scaled) to the anal fin (unscaled behind the pelvics); jaws described in the literature as being nearly equal in length (but with published photographs showing a protruding lower jaw); pectoral fins that reach beyond the base of the pelvic fins; gill rakers that are longer than the gill filaments and united in a single band; and delicate pharyngeal teeth that are grooved on the grinding surface (in a single row; 4-4). Silver carp may exceed three feet (0.9 m) in length and 17 pounds (7.7 kg) in weight. Coloration is olive-brown above and silvery below.

Bighead and silver carps can be distinguished with lateral line scale counts (often), presence or absence of pharyngeal tooth groves, and gill raker structure (rakers connected or not).

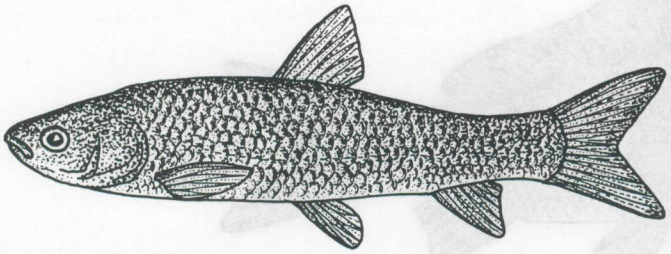
**Biology:**
Bighead and silver carps inhabit large rivers and may migrate long distances to spawning sites. Spawning requirements are similar to those of grass carp. Bighead carp are zooplankton feeders but can shift their diets to

include phytoplankton, larger vegetation or other small organisms; silver carp are largely phytoplankton feeders that may occasionally consume soft macrophytes. Although both species can jump, they apparently do so less readily than does grass carp. Both species have been collected in U.S. waters and confirmed spawning of bighead carp was reported in Missouri in 1989.

**Commercial Importance:**
Both species have been cultured for human consumption, although not widely acclaimed in many American markets. Both have been used in hybridization work with grass carp. More recently, both species have been used either in catfish production ponds to help maintain water quality or in subsequent receiving ponds to improve hatchery waters before discharge. Neither are sold in the pet trade.

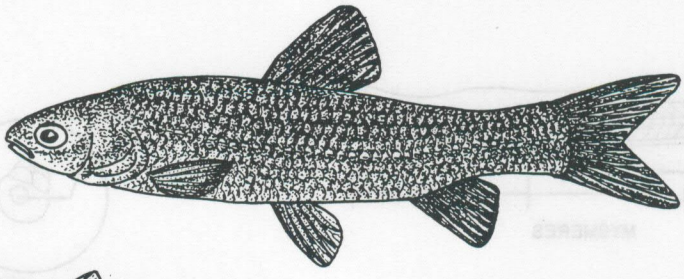
**Reasons For Restriction:**
Both species have already escaped captivity in U.S. waters, and with spawning requirements similar to those of grass carp, successful spawning can probably be expected. Concerns have been voiced concerning potential competition at the lower end of the food chain which might have far reaching consequences for native sport and forage fishes in higher trophic levels. Bighead and silver carps can be possessed with a TPWD Exotic Species Permit or if the fish is documented as having been in possession prior to January 25, 1990 by an owner who obtained a permit before June 1, 1990; however, permitting of bighead carp extended only until January 1, 1995.

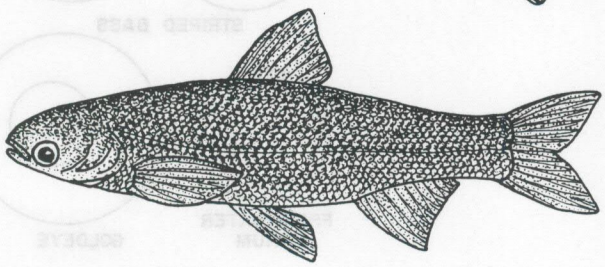
**Similar Species:**
Bighead and silver carps might be confused with grass carp, hybrid grass carp (grass carp x bighead carp) or black carp *Mylopharyngodon piceus* which have larger scales and fewer anal rays, or with common carp *Cyprinus carpio* which differs in having large scales, a sucker-like mouth, barbels, and a dorsal and anal fin spine. None of the native minnows or any of the imported species possess eyes set low on the sides of the head as in bighead and silver carps and most have far larger scales. The high anal fin ray count also distinguishes these two species from most native cyprinids. Few native minnows (and none in Texas) reach the large maximum size seen in bighead and silver carps.



Grass Carp
*Ctenopharyngodon idella*

Black Carp
*Mylopharyngodon piceus*





Hybrid Grass Carp
(Grass Carp x Bighead Carp)

**Technical Notes:**

(1) Bighead carp is used to produce hybrid grass carp which are now restricted for use for vegetation control in Texas (see discussion under grass carp).

(2) Eggs of bighead carp and silver carp are largely indistinguishable from each other and from those of grass and black carps. They range from about 0.13 to 0.20 inch (3.3-5.1 mm) in diameter and are without oil droplets. American cyprinid eggs are generally much smaller and are adhesive (not nonadhesive and pelagic). Indeed, few American fishes in fresh water have pelagic eggs and those that do contain oil droplets (e.g., striped bass *Morone saxatilis*, 0.05-0.18 inch/3.8-5.6 mm; mooneye and goldeye *Hiodon* spp., 0.16 inch/4.1 mm; and freshwater drum *Aplodinotus grunniens*, 0.04-0.07 inch/1.0-1.8 mm). Larval bighead and silver carps are difficult to distinguish from each other and from larvae of grass and black carps (see discussion under grass carp species account) until fin ray counts have developed.

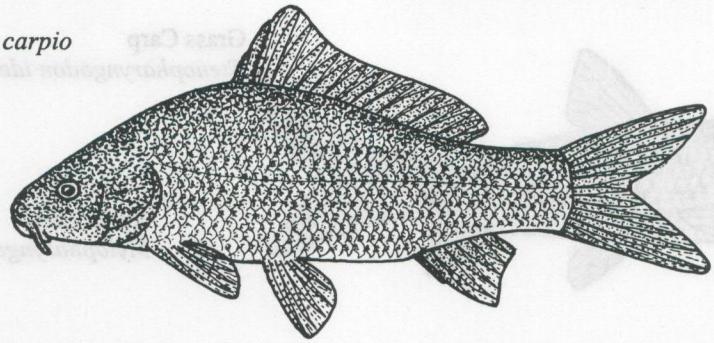
(3) Since the first edition of this book was written, adult bighead carp have been collected in Victor Braunig Reservoir near San Antonio and in the Red River below Lake Texoma, with an additional report of a specimen from Lake Conroe on the San Jacinto River drainage. The Braunig specimens probably entered the reservoir several years earlier when they were sold as live bait and the Conroe specimen likely entered that reservoir when grass carp were stocked in the early 1980s. There is no evidence of riverine populations or spawning in Texas to date.

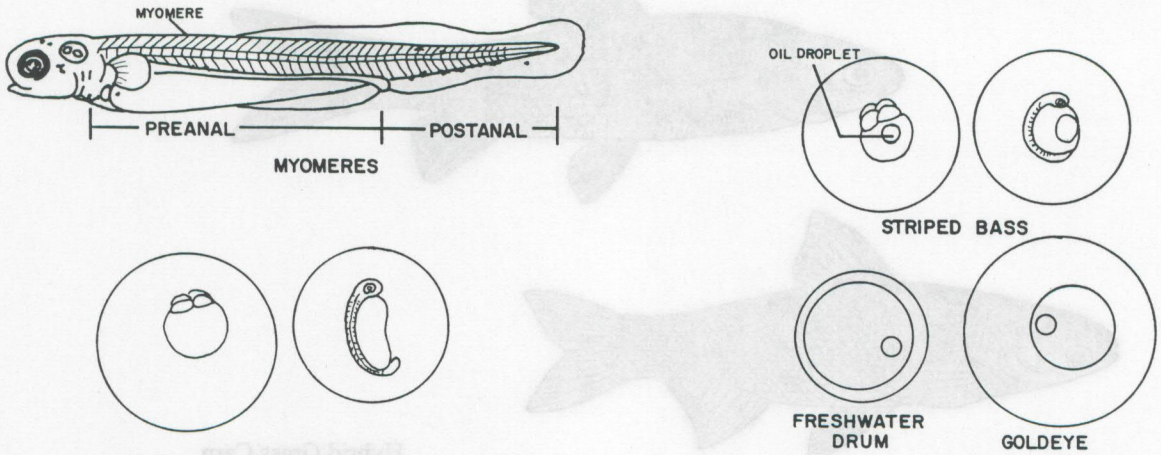
(4) In the mid-1990s, TPWD stocked a bighead carp x silver carp hybrid in Rita Blanca Reservoir in Dallam County, Texas, to control excessive algal growths. These fish reportedly died and current disposition in that reservoir is unclear.

**References:**

Bardach et al. 1972; Beck and Biggers 1983; Berg 1949a: Berry and Low 1970; Freeze and Henderson 1982; Henderson 1979; Jennings 1988; Jhingran and Pullin 1988; Kilambi and Zdink 1981; Nichols 1943; Soin and Sukhanova 1972.

Common Carp *Cyprinus carpio*



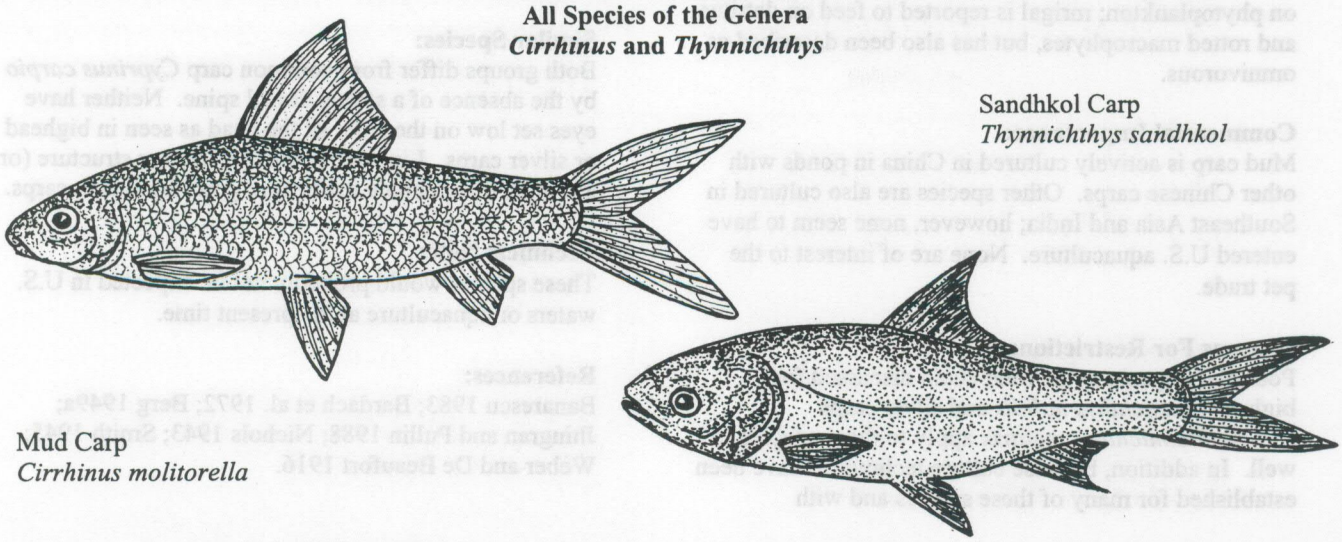



BIGHEAD CARP

# MUD CARP, SANDHKOL CARP, AND RELATED SPECIES

## Family: Cyprinidae

**All Species of the Genera**
***Cirrhinus* and *Thynnichthys***



Sandhkol Carp
*Thynnichthys sandhkol*

Mud Carp
*Cirrhinus molitorella*

**Other Names:**
Local Oriental names.

**Specifics:**
*Cirrhinus* (also spelled *Cirrhina*) includes mud carp *C. molitorella* (from China); mrigal *C. mrigala*, white carp *C. cirrhosa*, *C. horai,* and (apparently) reba *C. reba* (from India); and *C. microlepis* , *C. chandryi* (if valid), and *C. siamensis* (from Southeast Asia). Some sources suggest *C. molitorella* and *C. mrigala* are nearly identical except for range. The present validity of *C. lineata, C. marginipinnis, C. leschenaultii, C. anisura,* and *C. dyochilus* is unclear. *Osteochilus prosemion* from Thailand is believed to be a subspecies of *C. mrigala, O. spilopleurus* is a synonym of *C. jullieni* (in part?) and *C. chinensis* is probably an older name for *C. molitorella.*

*Thynnichthys* includes sandhkol carp T. *sandhkol, T. thynnoides, T. polylepis*, and *T. vaillanti*; however, the present validity of some species is unclear.

**Range:**
Mud carp is native to the rivers of China with related species in southern Asia and India. Sandhkol carp and its relatives are native to India, Southeast Asia (Indo-China), and the East Indian Archipelago. None have apparently been introduced into the U.S.

**Description:**
Cirrhinid carps are moderately elongated and compressed from side to side, and have moderate to large scales; small but broad mouths; lower lips that are thin or absent; may or may not have barbels on the upper lip (4, 2 or 0); pharyngeal teeth which are not molar-like and have been reported as "in three rows" and as 5-4, 4-5 or 3,2-2,3; dorsal fins placed ahead of the pelvic fins; up to iii, 11-12 (to 17?) dorsal rays; no predorsal spines and 5-6 (rarely 7) anal rays; 32-60 lateral line scales; have a scaled, rounded abdomen (not keeled); and gill rakers that are short and conical. Coloration is a silvery-white below and olive above in many species, with at least one species with definite black lateral stripes and a spot at the base of the tail. Mud carp from China may be deeper bodied (depth goes three to four times into body length) than the southern Asian species. Sizes exceed 15 pounds (6.8 kg) in some species.

Thynnichthyid carps have elongated bodies that are almost tuna-shaped in some, and heads that are strongly compressed. They have minute to small scales; mouths with little or no upper lip; no barbels; pharyngeal teeth arrangements of 5-3, 3-5 or 4,2-2,4; about iii, 8-10 dorsal fin rays; iii, and 5 anal rays; 58-77 lateral line scales; 21-30 predorsal scales; and no gill rakers. Coloration is described as a silvery sheen; fins may be clear or dusky. They reach about one foot (304 mm), possibly more, in length.

The genera *Cirrhinus* and *Thynnichthys* can be distinguished from each other on the basis of scale size and number, upper and lower lip development, and the presence or absence of gill rakers, and sometimes by the presence or absence of barbels.

**Biology:**
Both genera represent riverine species with habits similar to those described for Chinese carps. The eggs are probably large and pelagic for all species. Mud

carp is omnivorous, white carp feeds on plankton especially zooplankton, reba consumes phytoplankton and decayed plants and sandhkol carp also feeds largely on phytoplankton; mrigal is reported to feed on detritus and rotted macrophytes, but has also been described as omnivorous.

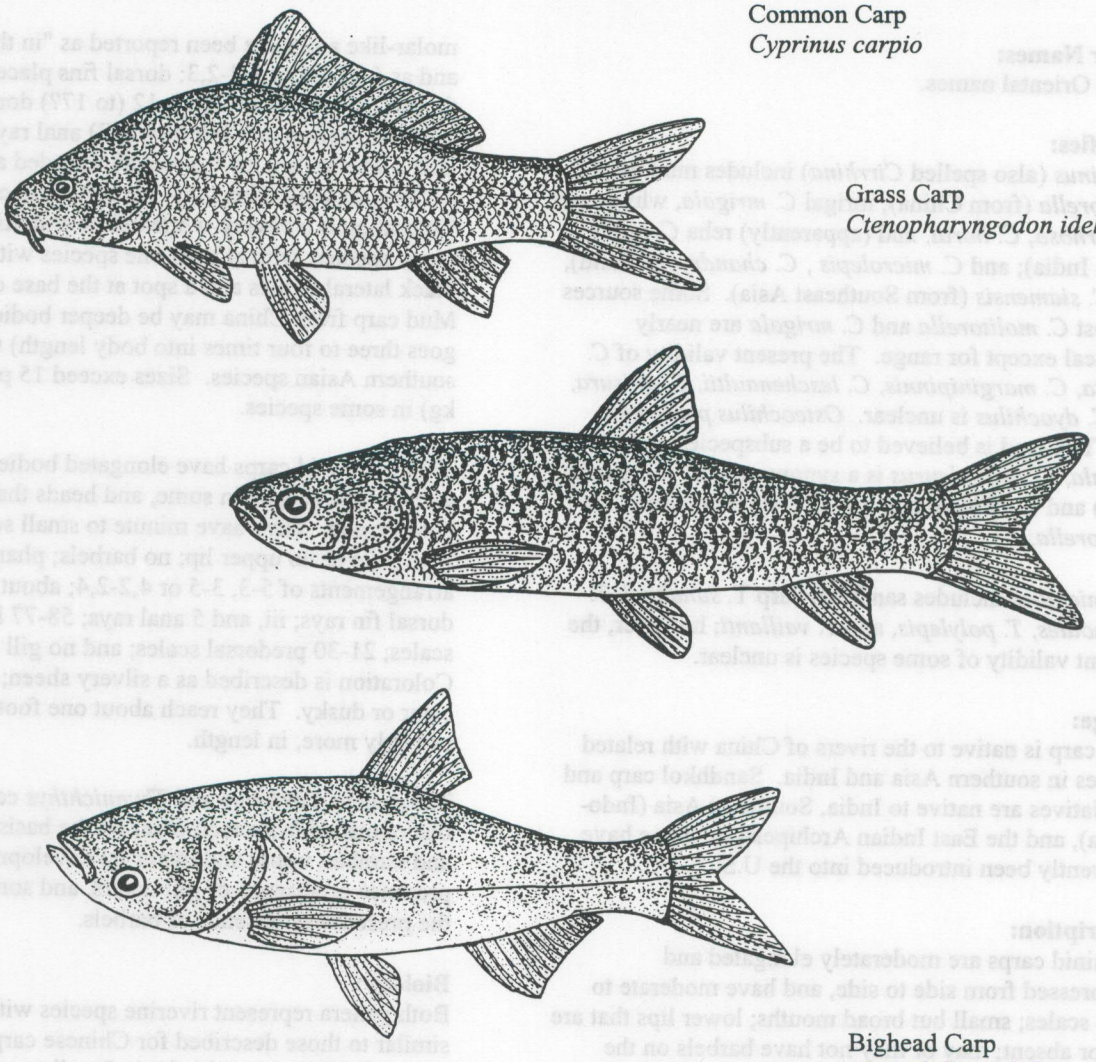
**Commercial Importance:**
Mud carp is actively cultured in China in ponds with other Chinese carps. Other species are also cultured in Southeast Asia and India; however, none seem to have entered U.S. aquaculture. None are of interest to the pet trade.

**Reasons For Restriction:**
Potential impacts to the food chain discussed for bighead *Aristichthys nobilis* and silver carps *Hypophthalmichthys molitrix* apply to these species as well. In addition, because culture techniques have been established for many of these species and with restrictions on other Chinese carps, either group might have been imported as an aquacultural substitute for other restricted carps.

**Similar Species:**
Both groups differ from common carp *Cyprinus carpio* by the absence of a strong dorsal spine. Neither have eyes set low on the sides of the head as seen in bighead or silver carps. Lip structure and gill raker structure (or absence) differentiate them from grass and black carps.

**Technical Note:**
These species would probably not be expected in U.S. waters or aquaculture at the present time.

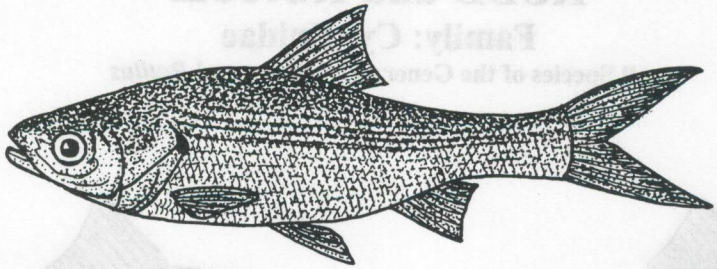
**References:**
Banarescu 1983; Bardach et al. 1972; Berg 1949a; Jhingran and Pullin 1988; Nichols 1943; Smith 1945; Weber and De Beaufort 1916.



Common Carp
*Cyprinus carpio*

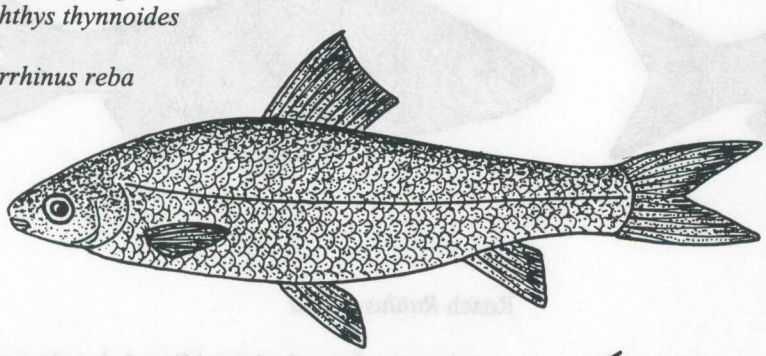
Grass Carp
*Ctenopharyngodon idella*

Bighead Carp
*Aristichthys nobilis*

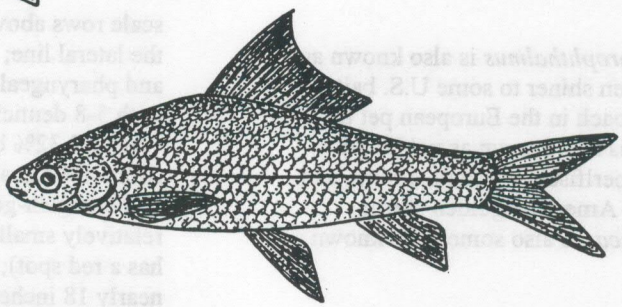


Thynnichthyid Carp
*Thynnichthys thynnoides*

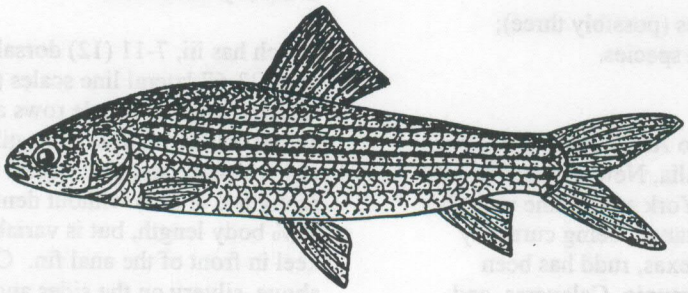
Reba *Cirrhinus reba*

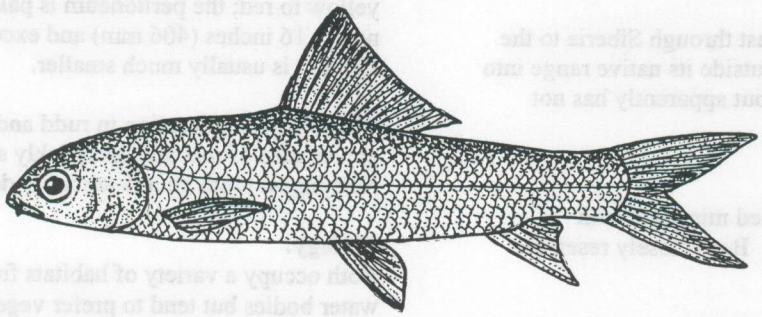


White Carp
*Cirrhinus cirrhosa*



Lined Mud Carp
*Cirrhinus lineata*



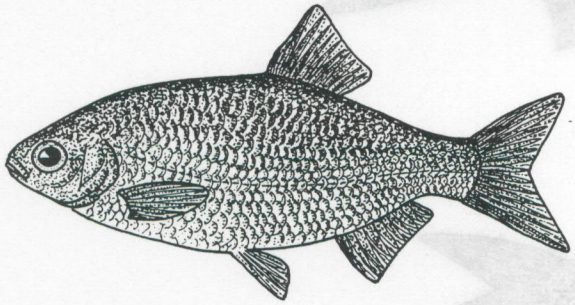


Mrigala
*Cirrhinus mrigala*

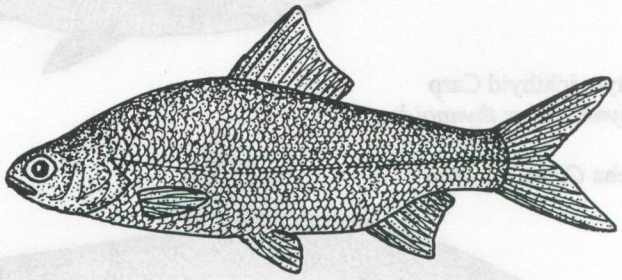
# RUDD and ROACH

## Family: Cyprinidae

**All Species of the Genera *Scardinius* and *Rutilus***



Rudd *Scardinius erythrophthalmus*



Roach *Rutilus rutilus*

**Other Names:**
Rudd *Scardinius erythrophthalmus* is also known as redfin and redfin golden shiner to some U.S. bait dealers, and as pearl roach in the European pet trade. Roach *Rutilus rutilus* is also known as vobla; other species are known as perlfisch, vyrezub, kutum, and roachling. The native American golden shiner *Notemigonus crysoleucas* is also sometimes known as roach.

**Specifics:**
*Scardinius* contains two species (possibly three); *Rutilus* contains seven or eight species.

**Range:**
Rudd is found from France into Asia Minor; it has been introduced into Ireland, Australia, New Zealand and the U.S.; it is established in New York and Maine with fish commercially produced in Arkansas being currently shipped into other states. In Texas, rudd has been collected in Texoma, Victor Braunig, Calaveras, and Whitney reservoirs.

Roach occurs from Europe east through Siberia to the Pacific; it has been stocked outside its native range into Australia and New Zealand, but apparently has not been released in U.S. waters.

**Description:**
Both are relatively deep-bodied minnows with moderate-sized heavy scales. Both closely resemble native golden shiner.

Rudd has iii, 8-9 (rarely 10) dorsal fin rays; iii, 10-11 (rarely 9-12) anal fin rays; 37-45 lateral line scales; 7-8 scale rows above the lateral line; 3-4 scale rows below the lateral line; 9-12 gill rakers that are short and stout; and pharyngeal teeth in two rows (3,5-5,3 or 2,5-5,2) with 5-8 denticles on each tooth. Body depth is usually about 27-32% body length. Rudd has a scaled keel in front of the anal fin. Coloration is olive-green above and orangish-gold below; fins are bright red even in relatively small specimens; the eye is usually red (or has a red spot); the peritoneum is pale. Size ranges to nearly 18 inches (457 mm) and 4.5 pounds (2 kg), but is usually much less.

Roach has iii, 7-11 (12) dorsal fin rays; iii, 7-13 anal fin rays; 33-67 lateral line scales (often 41-46 in *R. rutilus*); often 7-8 scale rows above and 3-4 scale rows below the lateral line; short gill rakers (6-17, about 10 in *R. rutilus*); and pharyngeal teeth in a single row (6-5, rarely 6-6 or 5-5) without denticles. Body depth is 23-33% body length, but is variable. Roach has a scaled keel in front of the anal fin. Coloration is olive-green above, silvery on the sides and white below; fins may be yellow to orange or red; the eye may range from yellow to red; the peritoneum is pale. Size may reach nearly 16 inches (406 mm) and exceed 2 pounds (0.9 kg), but is usually much smaller.

The orangish coloration in rudd and the more silvery appearance of roach helps quickly separate the two; pharyngeal tooth counts are more definitive.

**Biology:**
Both occupy a variety of habitats from small to large water bodies but tend to prefer vegetated areas of lakes and slow-flowing rivers. Some species in both genera may enter brackish water. Rudd and roach feed on

small invertebrates as well as vegetable matter, and rudd may also consume fish eggs and small fishes. Rudd has been known to compete with roach and other fishes. Rudd is reportedly stress-tolerant and therefore survives well in a bait bucket; roach is apparently less tolerant.

**Commercial Importance:**
Culture of rudd as a bait fish has developed dramatically in the last few years, with large numbers produced in Arkansas and sold in Texas and elsewhere. Neither species has been of interest to the American pet trade.

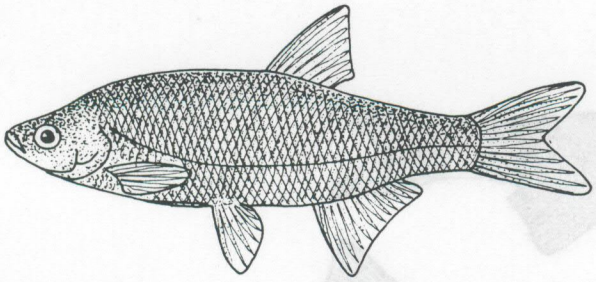
**Reasons For Restriction:**
The use of rudd as a bait fish in Texas in conjunction with several field collections of the species, ability to grow to a relatively large size and prey on other fishes, as well as competitive problems with introduced rudd in other countries, suggested a need to restrict the species. Roach was included as restricted because its ecological impact if released in U.S. waters is unknown, of its similarity to rudd and because it could have been used as a substitute for rudd as a bait fish. Populations established through accidental releases of roach outside its native range in Europe through use as a bait fish have often resulted in its being considered a nuisance.

**Similar Species:**
Golden shiner is more like rudd and roach than other American minnows. Golden shiner has a scaleless keel, but the keel is scaled in both rudd and roach (some roach may lack a keel). Gill rakers in golden shiner are long and slender (and often hooked; 17-19 total on the first arch), but are short in rudd and roach. Reddish fins may develop in larger mature golden shiners, but are bright red at a small size in rudd, and often in roach. Other golden shiner characteristics (compare to rudd and roach descriptions above) include i-ii, 7-9 dorsal fin rays; i-ii, 8-19 anal fin rays; 39-57 lateral line scales; a dusky peritoneum (pale in rudd and roach); and a single row of pharyngeal teeth (0,5-5,0, rarely 0,4-4,0).

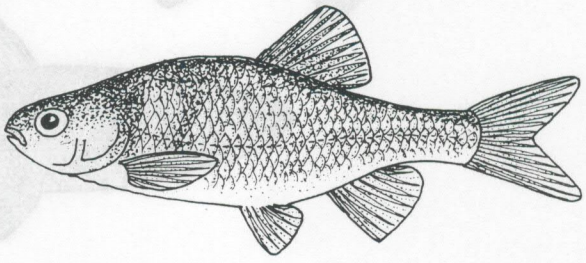
Red shiner *Cyprinella* (*Notropis*) *lutrensis*, which is common in much of Texas, lacks a ventral keel. Its gill rakers are short and narrow with round tips. Coloration is olive-green above and silvery below; spawning males become blue on their sides and develop reddened fins. Other characteristics include 32-36 lateral line scales (less than rudd and less than most roach); ii-iii, 7-8 dorsal fin rays; ii-iii, 8 (7-9) anal fin rays (with probably an additional small, unbranched ray); a peritoneum that is silvery with dark spots; and a pharyngeal tooth count of 0,4-4,0 (rarely, 0,4-4,1 or 1,4-4,1). Body depth goes into total length 3.6-4.3 times (most other shiners *Notropis/Cyprinella* found locally are much less deep bodied).

**References:**
Axelrod et al. 1989; Berg 1949a; Blanc et al. 1971; Burkhead and Williams 1991; Courtenay et al. 1984; Frank 1971; Howells 1990a, 1992; Howells et al. 1991; Lee et al. 1980; Muoneke 1990; Muus 1967; Nichols 1943; Niederholzer and Hofer 1980; Shikhshabekov 1979; Sterba 1967; Thompson and Illadou 1990; Toman and Felix 1974; Wheeler 1976; Wheeler and Maitland 1973; Williams and Jennings 1988.

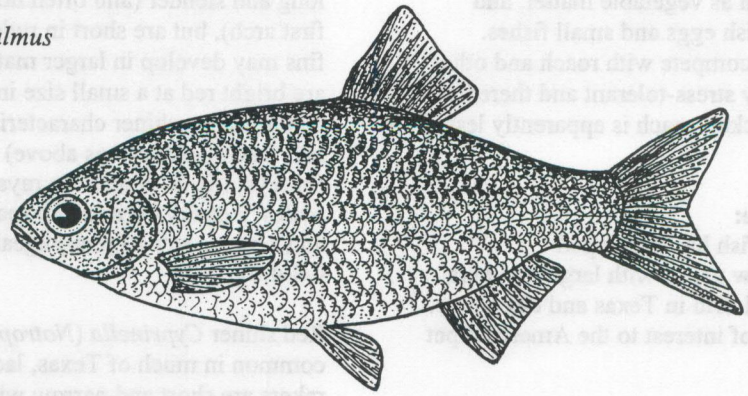
Golden shiner *Notemigonus crysoleucas*



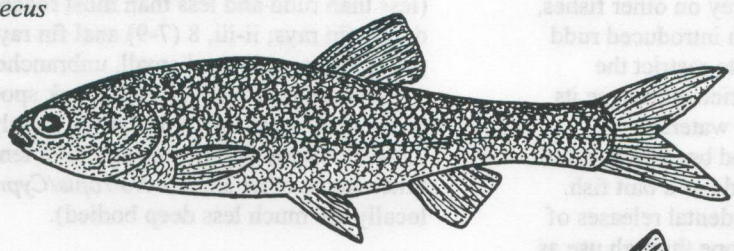
Red shiner *Cyprinella lutrensis*



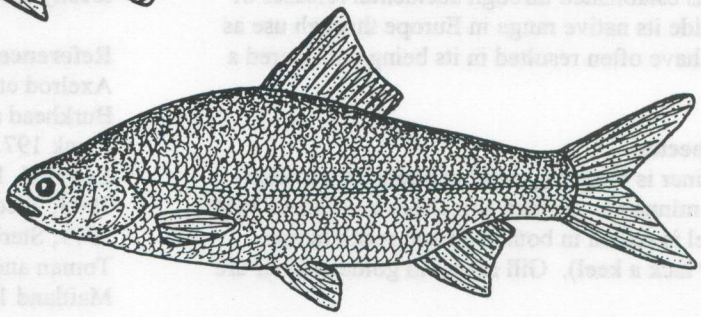
Rudd
*Scardinius erythrophthalmus*



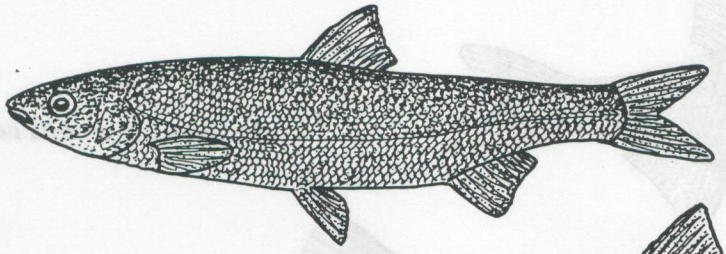
Calamithra
*Scardinius graecus*



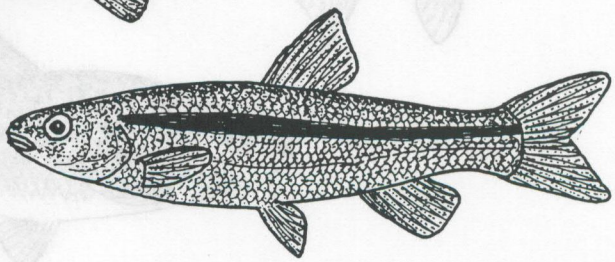
Roach
*Rutilus rutilus*



Kutum
*Rutilus frisii kutum*



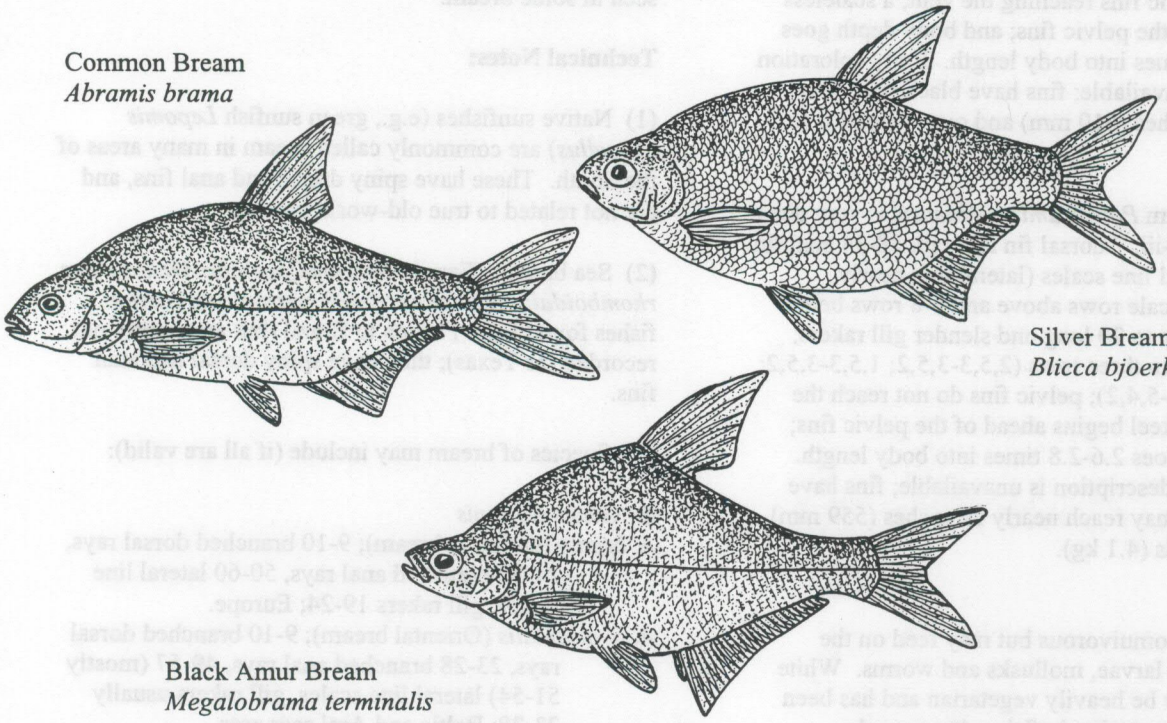
Pardilla
*Rutilus lemmingii*



# OLD WORLD BREAMS

## Family: Cyprinidae

**All Species of the Genera *Abramis, Blicca, Megalobrama*, and *Parabramis***



Common Bream
*Abramis brama*

Silver Bream
*Blicca bjoerkna*

Black Amur Bream
*Megalobrama terminalis*

**Other Names:**
*Abramis* = common bream, Danube bream, zope, Oriental bream; *Blicca* = silver or white bream; *Megalobrama* = black Amur bream, Chinese bream; *Parabramis* = white Amur bream.

**Specifics:**
*Abramis* includes four species and several subspecies; *Blicca* and *Parabramis* include one species each. *Megalobrama* may contain three or four (possibly to seven) species. Older literature may list all four under *Abramis*. Species associated with *Megalobrama* and *Parabramis* are especially problematic; *M. bramula* and *M.* (*P.*) *terminalis* may represent a single species (early descriptions are unclear).

**Range:**
*Abramis* = Europe and Eurasia; *Blicca* = Europe; *Megalobrama* and *Parabramis* = China and Formosa. Apparently they have not been imported into the U.S.; however, at least one state agency has expressed an interest in *P. pekinensis* (apparently for vegetation control).

**Description:**
All four genera are similar to American golden shiner *Notemigonus crysoleucas*; some species and subspecies are deeper bodied. None have dorsal spines.

Common bream *Abramis brama* and its relatives are laterally compressed and have iii, 8-10 dorsal rays; a long anal fin with iii, 15-44 (usually 23-28) rays; a decurved lateral line with 50-60 scales (in common bream); 19-24 gill rakers; pharyngeal teeth in a single row (5-5 or 6-5); pelvic fins which reach beyond the vent; a scaleless keel; and body depth 35-40% body length. Size reaches about 20 inches (508 mm) and over 13 pounds (5.9 kg). Coloration is a silvery-olive with grey fins that become black with age.

Silver or white bream *Blicca bjoerkna* is laterally compressed and has iii, 7-9 dorsal fin rays; iii, 17-25 anal fin rays; 40-51 lateral line scales; 9-10 scale rows above and 4-6 scale rows below the lateral line; 14-21 slightly long gill rakers; pharyngeal teeth in two rows (2,5-5,2 or 3,5-5,2); pelvic fins usually not reaching the vent or the anal fin; a scaleless keel; and body depth goes 2.2-2.7 times into body length. Coloration is silvery with grey fins; some fins may be reddish at the bases. Size may reach 12 inches (305 mm) and 2.75 pounds (1.2 kg).

Black Amur bream *Megalobrama bramula* (*M. terminalis* may be a synonym) and related Chinese breams are usually very deep bodied and have ii-iii, 6-7 dorsal fin rays (one reference indicates the presence of a spine, but others do not); iii, 26-32 anal rays; 49-63

lateral line scales (lateral line nearly straight); 12-13 scale rows above and 7-8 rows below the lateral line; up to 30 gill rakers which are "not very long"; pharyngeal teeth that are presumably similar to those in *Parabramis*; pelvic fins reaching the vent; a scaleless keel only behind the pelvic fins; and body depth goes 2.2 to over 3.0 times into body length. Body coloration description is unavailable; fins have black tips. Size may reach 24 inches (610 mm) and over 6 pounds (2.7 kg).

White Amur bream *Parabramis pekinensis* is very deep bodied and has ii-iii, 7 dorsal fin rays; iii, 28-34 anal fin rays; 54-65 lateral line scales (lateral line nearly straight); 11-13 scale rows above and 6-8 rows below the lateral line; up to 20 long and slender gill rakers; pharyngeal teeth in three rows (2,5,3-3,5,2; 1,5,3-3,5,2; 2,4,5-5,4,2; 2,4,4-5,4,2); pelvic fins do not reach the vent; a scaleless keel begins ahead of the pelvic fins; and body depth goes 2.6-2.8 times into body length. Body coloration description is unavailable; fins have black tips. Size may reach nearly 22 inches (559 mm) and over 9 pounds (4.1 kg).

**Biology:**
Most breams are omnivorous but may feed on the bottom for insect larvae, mollusks and worms. White Amur bream may be heavily vegetarian and has been used to control vegetation in fish culture ponds. Breams are often found in slow, even stagnant waters. Small individuals are used as forage by larger predatory fishes. Eggs of the European species are adhesive and adhere to vegetation, while eggs of the Chinese species may be pelagic.

**Commercial Importance:**
Some species are taken by sport and commercial fishermen in Europe and Asia; others have been used in old-world aquaculture. None are presently cultured by U.S. fish farmers or aquarists.

**Reasons For Restriction:**
Restrictions were applied to old-world breams to prevent importation and substitution for rudd *Scardinius erythrophthalmus* as a bait fish, or for grass carp *Ctenopharyngodon idella* in vegetation control, without appropriate consideration and impact analysis. Accidental releases outside native ranges in Europe, which occurred during introduction of other fishes, have often been viewed unfavorably by anglers.

**Similar Species:**
Native golden shiner is probably more similar to breams than other American minnows. Golden shiner has 7-9 branched dorsal fin rays, 8-19 branched anal fin rays, 40-57 lateral line scales, 5-16 gill rakers, a single row of pharyngeal teeth (usually given as 0,5-5,0 or 0,4-4,0), a scaleless keel, and body depth 17.1-33.3% body length. Coloration is a brassy-yellow with yellow-green to reddish fins. Even exceptionally deep-bodied individuals do not show the highly arched backs seen in some bream.

**Technical Notes:**

(1) Native sunfishes (e.g., green sunfish *Lepomis cyanellus*) are commonly called bream in many areas of the South. These have spiny dorsal and anal fins, and are not related to true old-world breams.

(2) Sea breams (Family Sparidae) include *Archosargus rhomboidalis* and are unrelated warm-water marine fishes found from Florida to Brazil (but apparently not recorded for Texas); they have spiny dorsal and anal fins.

(3) Species of bream may include (if all are valid):

- Genus *Abramis*

*A. brama* (common bream); 9-10 branched dorsal rays, 24-30 branched anal rays, 50-60 lateral line scales, gill rakers 19-24; Europe.

*A. b. orientalis* (Oriental bream); 9-10 branched dorsal rays, 23-28 branched anal rays, 49-57 (mostly 51-54) lateral line scales, gill rakers usually 23-28; Baltic and Aral seas area.

*A. sapa* (white-eye bream, Danube bream); 8 branched dorsal rays, 35-42 (usually 37-39) branched anal rays, 49-53 lateral line scales, gill rakers 18-23; Danube Basin to the Caspian Sea.

*A. melanops* (Macedonian vimba); 8-9 branched dorsal rays, 15+ branched dorsal rays, 52-60 (usually 54-56) lateral line scales, gill rakers 16-17; considered genus *Vimba* by some because it lacks a post-dorsal fin keel; northwest Aegean Sea drainage basin.

*A. ballerus* (blue bream, zope); 8-9 branched dorsal rays, 34-44 anal rays, 65-76 lateral line scales, gill rakers 30-39 (usually 34-35); Europe east of the Rhine River to the Caspian Sea.

- Genus *Blicca*

*Blicca bjoerkna* (silver or white bream); previously described.

- Genus *Megalobrama*

*M. bramula* (Chinese bream or black Amur bream); very deep bodied (depth half body length), 7 branched dorsal rays, more than 30 (about 34) branched anal rays, lateral line scales about 57; China.

*M. terminalis* (black Amur bream); body depth goes 2.2-2.5 times into body length, 7-8 branched dorsal rays, 26-32 branched anal rays, 53-57

lateral line scales; China. It is unclear whether *M. bramula* and *M. terminalis* represent different species or not; early descriptions are not sufficiently detailed to permit confident comparisons.

*M. macrops* (Chinese bream); body depth goes about 3.2-3.6 times into body length, 7-8 branched dorsal rays, 22-27 branched anal rays, 55-60 lateral line scales; China.

*M. kurematsui* (Chinese bream); body depth goes 3.7 to 4.0 times into body length, 7 branched dorsal rays, 24-24 branched anal rays, 58-63 lateral line scales; China.

*M. melrosei* (Chinese bream); body depth goes 3.1 times into body length, 7 unbranched dorsal rays, 23 unbranched anal rays, 54 lateral line scales; China.

*M. hoffmanni* (Chinese bream); body depth goes 2.6-2.7 times into body length, 6-7 branched dorsal rays, 26-28 branched anal rays, 47-53 lateral line scales; China.

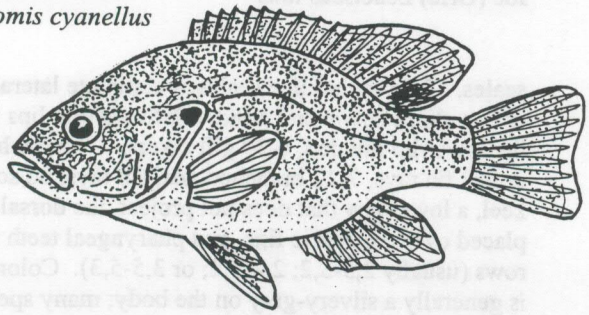
● Genus *Parabramis*

*Parabramis pekinensis* (white Amur bream, Peking bream); previously described.

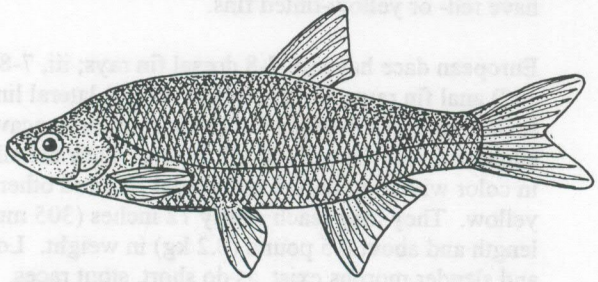
**References:**

Axelrod et al. 1989; Berg 1949a; Blanc et al. 1971; Frank 1971; Muus 1967; Nichols 1943; Sterba 1967; Toman and Felix 1974.

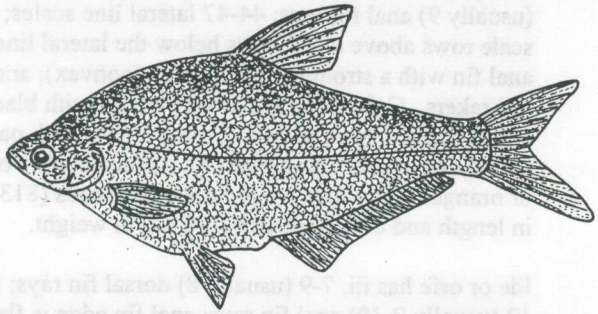
Green Sunfish
*Lepomis cyanellus*



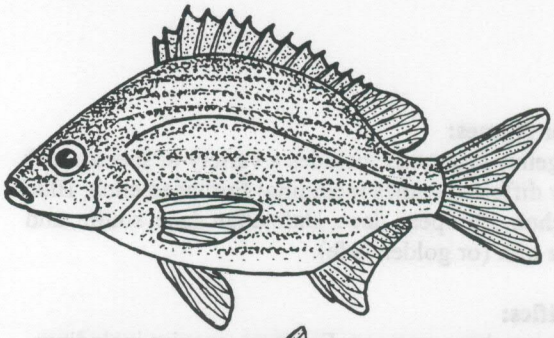
Golden Shiner
*Notemigonus crysoleucas*



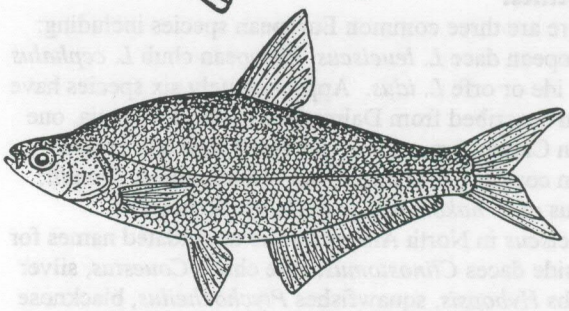
White Amur Bream
*Parabramis pekinensis*



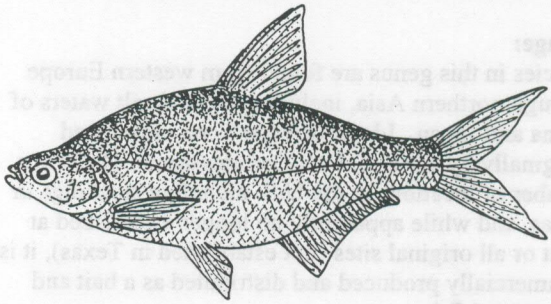
Sea Bream
*Archosargus rhomboidalis*



Chinese Bream
*Megalobrama bramula*



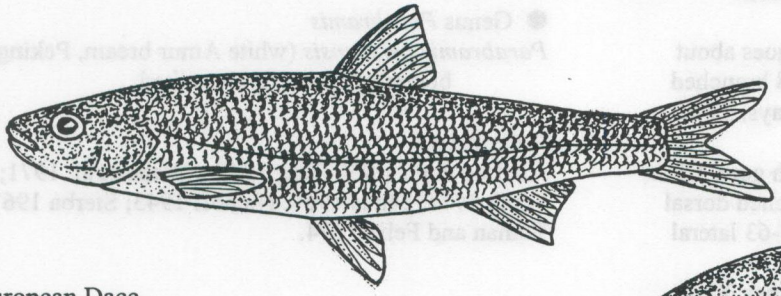
Black Amur Bream
*Megalobrama terminalis*



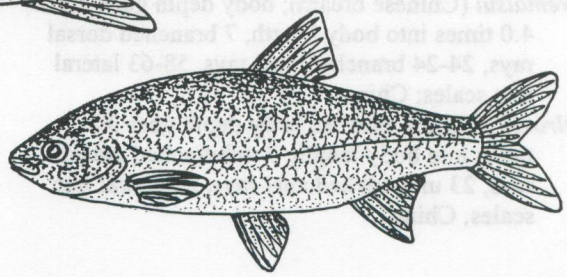
# OLD WORLD CHUBS, IDE, and DACE

## Family: Cyprinidae

### All Species of the Genus *Leuciscus*



European Dace
*Leuciscus leuciscus*



Ide (Orfe) *Leuciscus idus*

**Other Names:**
The genus *Leuciscus* includes a variety of species with many different names including: European chub, Black Sea chub, European dace, Dalmatian dace, soufie, and ide or orfe (or golden orfe).

**Specifics:**
There are three common European species including: European dace *L. leuciscus*, European chub *L. cephalus* and ide or orfe *L. idus*. Approximately six species have been described from Dalmatia, nine from Eurasia, one from China (Amur ide *L. waleckii*), and one or two from coastal China and Japan (eastern ide *L. brandti*; status of *L. hakonensis* is unclear). Reports of *Leuciscus* in North America refer to outdated names for redside daces *Clinostomus*, lake chubs *Couesius*, silver chubs *Hybopsis,* squawfishes *Ptychocheilus*, blacknose daces *Rhinichthys*, redside shiners *Richardsonius,* and creek chubs and fallfish *Semotilus*; no native North American minnows now belong to this genus.

**Range:**
Species in this genus are found from western Europe through northern Asia, including coastal salt waters of China and Japan. Ide or orfe has been introduced (originally by the U.S. Fish Commission in 1887) at a number of locations in the U.S. including stockings in Texas, and while apparently no longer established at most or all original sites (not established in Texas), it is commercially produced and distributed as a bait and ornamental fish.

**Description:**
Leuciscids are basically chub-like with small to large scales, 37-93 lateral line scales, a complete lateral line with a slight downward bend, relatively thin lips with the lower lip divided, 6-30 gill rakers, 7-9 branched dorsal fin rays, 7-12 branched anal fin rays, no scaleless keel, a lower jaw that does not project, the dorsal fin placed over the pelvic fins, and pharyngeal teeth in two rows (usually 2,5-5,2; 2,4-5,2; or 3,5-5,3). Coloration is generally a silvery-gray on the body; many species have red- or yellow-tinted fins.

European dace have iii, 7-8 dorsal fin rays; iii, 7-8 (to 11?) anal fin rays; 45-55 (usually 49-52) lateral line scales; an anal fin with a flat (truncated) or concave edge; and 7-11 (usually 8) gill rakers. They are silvery in color with grey dorsal and caudal fins and other fins yellow. They may reach nearly 12 inches (305 mm) in length and about 0.5 pound (0.2 kg) in weight. Long and slender morphs exist, as do short, stout races.

European chubs have iii, 8 dorsal fin rays; iii, 8-10 (usually 9) anal fin rays; 44-47 lateral line scales; 7-7.5 scale rows above and 3 rows below the lateral line; an anal fin with a strongly curved edge (convex); and 8-11 gill rakers. Coloration is a silvery-olive with black-edged scales which gives a distinct cross-hatch pattern; dorsal and caudal fins are dusky; other fins may be red or orange. They may reach nearly 32 inches (813 mm) in length and over 8 pounds (3.6 kg) in weight.

Ide or orfe has iii, 7-9 (usually 8) dorsal fin rays; iii, 9-12 (usually 9-10) anal fin rays; anal fin edge is flat (truncated) or concave; 55-63 lateral line scales; 8-9 scale rows above the lateral line and 4-5 rows below; and 10-14 gill rakers. Coloration is usually a silvery-

grey with reddish fins. A gold (xanthic) domestic morph is commonly sold as golden orfe. Some specimens may reach three feet (0.9 m) in length and nearly 18 pounds (8.2 kg) in weight. Although most specimens are long and slender, deep-bodied forms also exist.

**Biology:**
Most leuciscids fill ecological niches similar to American chubs and occupy flowing streams and rivers; some live in ponds or lakes, while other enter estuaries, with the eastern-most species in the Yellow Sea and Sea of Japan. Smaller species and individuals feed on aquatic invertebrates; however, larger specimens may consume fish eggs and fry as well as smaller fishes and frogs. Some species like ide are reportedly rather stress tolerant.

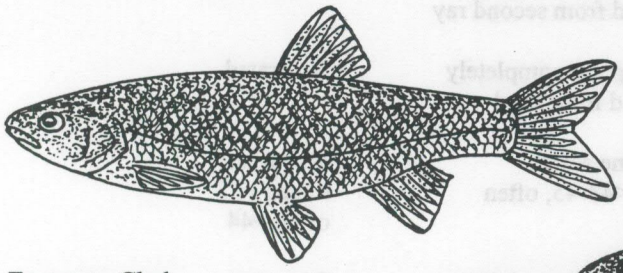
**Commercial Importance:**
Old World populations are sometimes fished commercially or for sport; many are used as bait fishes. Golden orfe (ide) is used in Europe and to a lesser extent in the U.S. as an ornamental pool fish (has been produced by sources in Florida, New Jersey and probably elsewhere), and ide has also been sold as a bait fish in Tennessee (and probably elsewhere, but not reported thus far from Texas). However, ide is not a prominent bait or ornamental species in the U.S.

**Reasons For Restriction:**
With restrictions on rudd *Scardinius erythrophthalmus*, several species (including ide which is already present in U.S. culture) could have been used as substitutes. Large size, occasionally piscivorous diets and lack of potential environmental impact information for U.S. waters suggested their introduction could be undesirable.

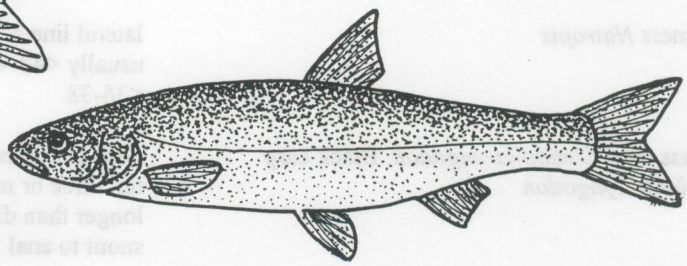
**Similar Species:**
Most *Leuciscus* could be mistaken for a number of American minnows and chubs, as well as several exotic species. Ide has been reportedly confused with goldfish.

**Technical Notes:**

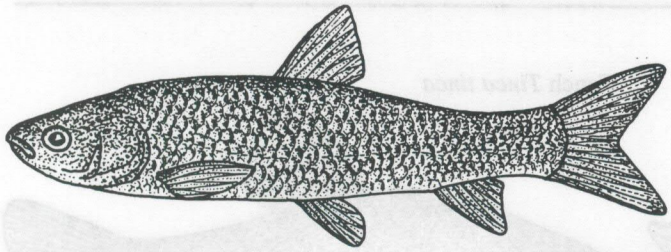
(1) Golden variants of ide (golden orfe) could be confused with gold morphs of common carp (called koi), goldfish, tench, grass carp, or hybrid grass carp. Characteristics given above apply to both wild-type and gold-colored individuals.



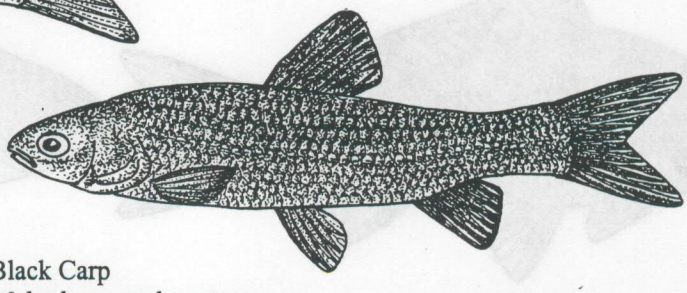
European Chub
*Leuciscus cephalus*



Eastern Ide
*Leuciscus brandti*



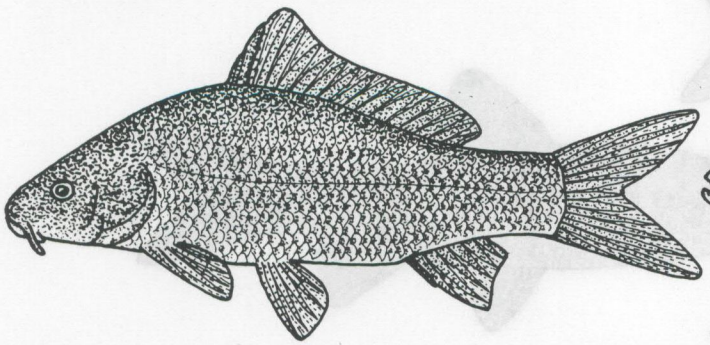
Grass Carp
*Ctenopharyngodon idella*



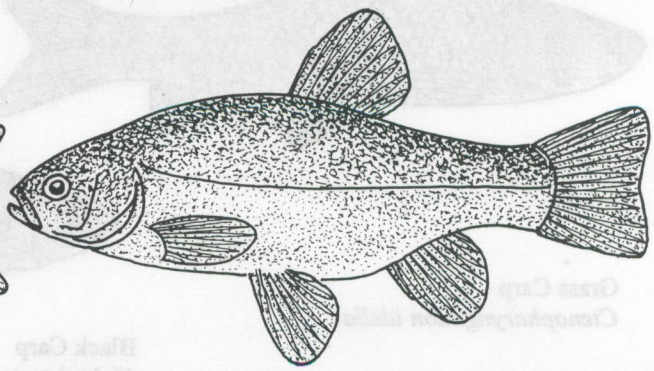
Black Carp
*Mylopharyngodon piceus*

| Similar Species | Characteristic | *Leuciscus* |
|---|---|---|
| Common carp *Cyprinus*, Goldfish *Carassius* | Dorsal spine; > 11 dorsal rays | No dorsal spine; < 10 rays |
| Golden shiner *Notemigonus* | Naked keel | No keel |
| Breams (several genera), Rudd *Scardinius*, Bighead carp *Aristichthys*, Silver carp *Hypophthalmichthys*, Roach *Rutilus* | Scaled keel | No keel |
| Common carp; Chubs *Necomis, Hybopsis, Semotilus*; Tench *Tinca* | Barbel on upper lip | No barbels |
| Tench, Bighead carp, Silver carp | ≥ 93 lateral line scales | ≤ 93 lateral line scales |
| Dace *Phoxinus*, Pugnose minnow *Notropis* | Lateral line incomplete or undeveloped | Complete lateral line otherwise |
| Stonerollers *Campostoma*, Roundnose minnows *Dionda*, Silvery minnows *Hybognathus* Suckermouth minnow *Phenacobius*, Silverjaw minnow *Ericymba* | Projecting snout or sucker-like mouth; snout slightly projects in some chubs | |
| Fathead minnows *Pimephales* | First dorsal ray well separated from second ray | Connected |
| Daces *Rhinichthys* | Upper lip not completely separated from head | Separated |
| Shiners *Notropis* | lateral line scales usually <43-45, often <36-38 | lateral line scales ≥37 often >44 |
| Grass carp *Ctenopharyngodon*, Black carp *Mylopharyngodon* | Distance from anal fin to tail three or more times longer than distance from snout to anal fin | Distance less than three times snout to anal fin |

Common Carp *Cyprinus carpio*



Tench *Tinca tinca*

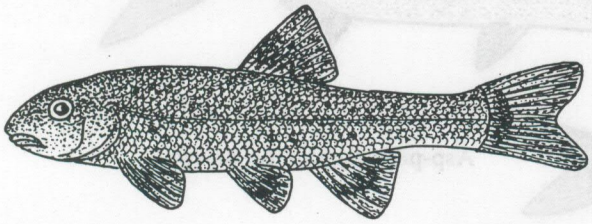


(2) Other Dalmatian daces and other species of *Leuciscus* may include (if all are valid):

*L. svallize*; 48-49 lateral line scales.
*L. illyrucus*; 49-54 lateral line scales.
*L. ukliva*; 62-64 lateral line scales.
*L. turskyi*; 70-72 lateral line scales.
*L. microlepis*; 73-75 lateral line scales.
*L. lehmanni* (Zeravshan dace); Syr-Darya drainage.
*L. latus* (Transcaspian dace); Murgab and Tedzhen rivers.
*L. danilewskii* (Danilewskii's dace) Don River.
*L. lindbergi* (Talas dace); Talas River.
*L. schmidti* (Chebak); Issyk-kul River area.
*L. bergi* (Chebak); Issyk-kul River area.
*L. borysthenicus* (Dnieper or Black Sea chub); tributaries of the Black Sea south of the Danube River.
*L. aphipsi* (no common name); Afips and Psekup rivers.
*L. agdamicus* (no common name); Shusha district but not the Kura River.
*L. squallusculus* (no common name); Leninabad and Yany-kurgan regions.
*L. waleckii* (Amur ide); Amur River, China.
*L. brandti* (Far Eastern ide, eastern redfin, eastern rudd); coastal marine in the Sea of Japan and Yellow Sea.
*L. hakonensis* (no common name); similar to *L. brandti.*

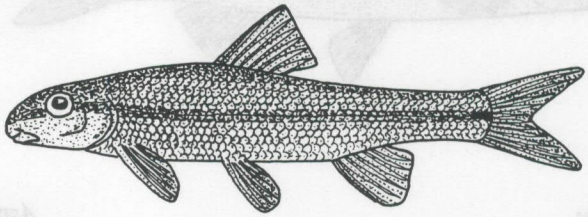
**References:**

Berg 1949a; Blanc et al. 1971; Muus 1967; Nichols 1943; Shikhshabekov 1979; Sterba 1967; Toman and Felix 1974.

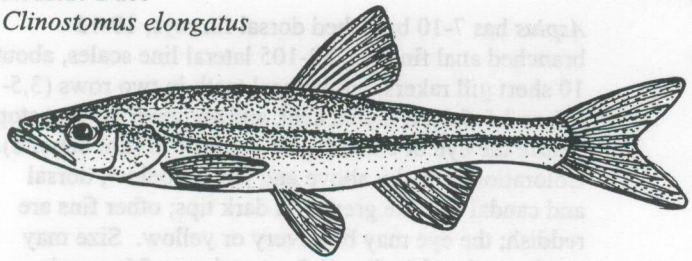


Stoneroller *Campostoma anomalum*

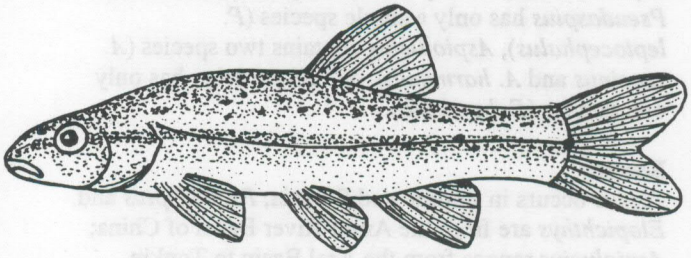
Suckermouth Minnow
*Phenacobius mirabilis*

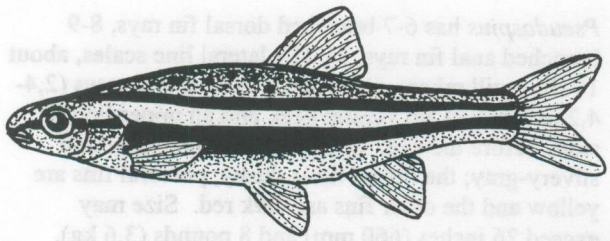


Redside Dace
*Clinostomus elongatus*

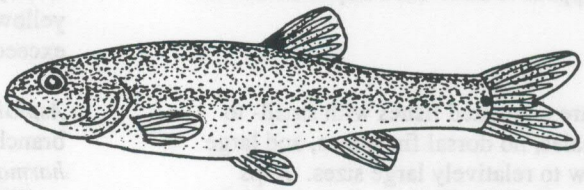


Blacknose Dace
*Rhinichthys atratulus*





Southern Redbellied Dace
*Phoxinus erythrogaster*



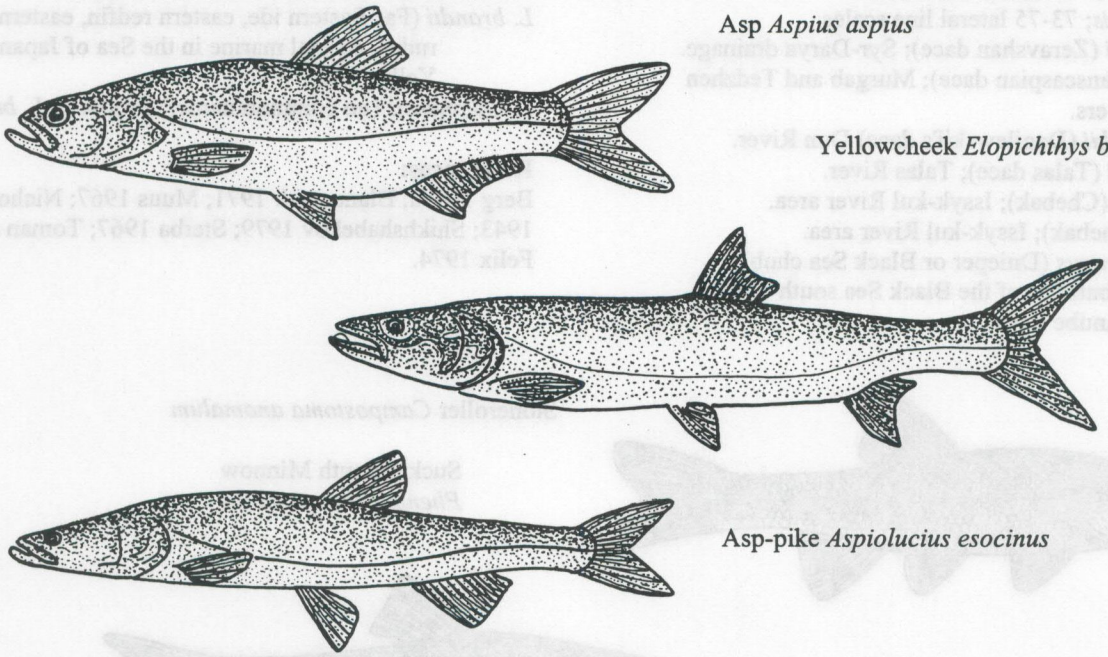
Creek Chub *Semotilus atromaculatus*

# ASPS and YELLOWCHEEK

## Family: Cyprinidae

### All Species of the Genera

### *Aspius, Pseudaspius, Aspiolucius,* and *Elopichthys*



Asp *Aspius aspius*

Yellowcheek *Elopichthys bambusa*

Asp-pike *Aspiolucius esocinus*

**Other Names:**
*Aspius* = asp, asp-pike or European asp; *Pseudaspius* = Chinese asp, redfin or krasnoper; *Aspiolucius* = asp-pike or lysach; *Elopichthys* = yellowcheek.

**Specifics:**
*Aspius* contains two species (*A. aspius* and *A. vorax*), *Pseudaspius* has only a single species (*P. leptocephalus*), *Aspiolucius* contains two species (*A. esocinus* and *A. harmandi*), and *Elopichthys* has only one species (*E. bambusa*).

**Range:**
*Aspius* occurs in Europe and Eurasia; *Pseudaspius* and *Elopichthys* are from the Amur River Basin of China; *Aspiolucius* ranges from the Aral Basin to Tonkin (Hanoi). None appear to have been imported into the U.S.

**Description:**
All four genera are elongated fishes with small- to medium-sized scales, no dorsal fin spines, and large mouths. All grow to relatively large sizes. Asps generally have three unbranched dorsal and anal fin rays.

*Aspius* has 7-10 branched dorsal fin rays, 10-15 branched anal fin rays, 62-105 lateral line scales, about 10 short gill rakers, pharyngeal teeth in two rows (3,5-5,3 or 2,5-5,3), a scaled keel, and an upper lip that stops before the eye or extends just to mid-eye (not beyond). Coloration is dusky above and silvery below; dorsal and caudal fins are grey with dark tips; other fins are reddish; the eye may be silvery or yellow. Size may reach nearly 48 inches (1.2 m) and over 26 pounds (11.8 kg), but is usually less.

*Pseudaspius* has 6-7 branched dorsal fin rays, 8-9 branched anal fin rays, 91-102 lateral line scales, about 10 short gill rakers, pharyngeal teeth in two rows (2,4-4,2 or 2,5-4,2), no ventral keel, and an upper lip that stops before the eye. Coloration is apparently dull silvery-gray; the dorsal fin is dusky, pectoral fins are yellow and the other fins are dark red. Size may exceed 26 inches (660 mm) and 8 pounds (3.6 kg).

*Aspiolucius* has 8-9 (*A. esocinus*) or 12 (*A. harmandi*) branched dorsal fin rays, 10-12 (*A. esocinus*) or 15 (*A. harmandi*) branched anal fin rays, 83-95 (*A. esocinus*) or 100 (*A. harmandi*) lateral line scales, an incomplete lateral line in young, 10-11 short gill rakers, pharyngeal

teeth in two rows (3,5-5,3), no ventral keel, a long depressed head (unlike *Aspius*), and an upper lip that extends to the middle of the eye or even beyond the eye. Coloration is generally a dull silvery-gray. Length may exceed 20 inches (508 mm).

*Elopichthys* has iii-v, 10 dorsal fin rays, iii, 10-12 (13) anal fin rays, 105-110 lateral line scales, gill rakers that are medium sized and set widely apart, pharyngeal teeth in three rows (2,4,4-5,4,2 or 1,4,4-4,4,2), no ventral keel, and a large mouth with the upper lip extending beyond the eye. Coloration is dark brown above with a blue-green dorsal fin and jaws; cheeks and other fins are ocher-yellow. Length may reach 6.5 feet (2.0 m) and nearly 90 pounds (41 kg).

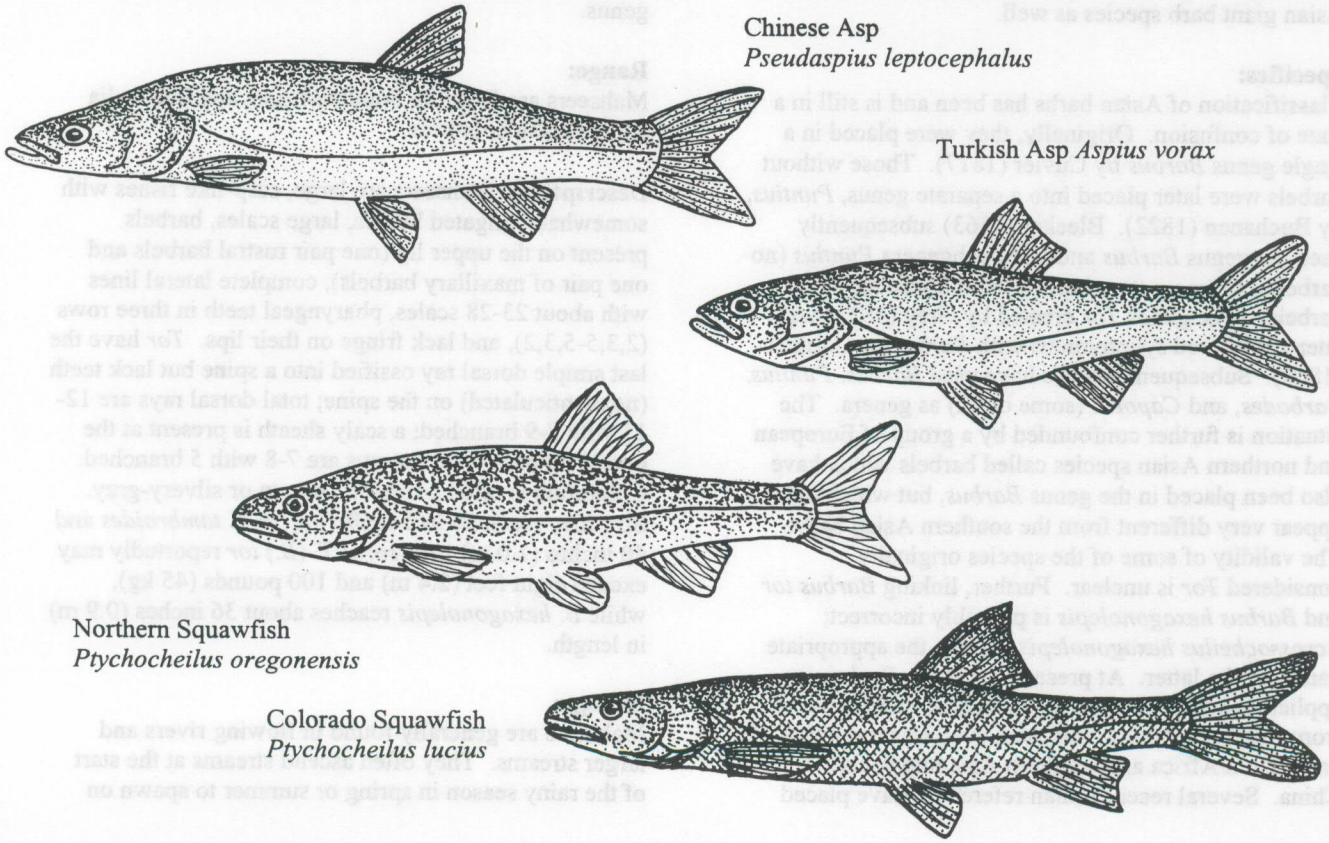
**Biology:**
All of these fishes are large predators which prey primarily on other fishes. European asp has been reported to feed on frogs and ducklings as well. These fishes probably fill ecological niches similar to that of Colorado squawfish *Ptychocheilus lucius* and other squawfishes in North America. Some are considered sport fish and are taken on rod and reel. Both asps and yellowcheek appear to prefer larger flowing rivers; some may enter brackish water to feed. Asp eggs fall to the bottom after spawning and incubate between stones while those of yellowcheek are planktonic; larvae are planktonic in both.

**Commercial Importance:**
Although taken as game or commercial food fish in their native waters, none are as yet of interest to either American aquaculturists or aquarists.

**Reasons For Restriction:**
Large size and predatory habits suggest introductions would be undesirable. Increased recent importation of other cyprinids from Europe and Asia also suggests an increased possibility of asp or yellowcheek importation (whether deliberate or accidental) as well.

**Similar Species:**
Asps and yellowcheek are more elongated and pike-like, with longer snouts than most other minnows. Squawfishes found in North America are similar but usually have fewer lateral line scales (67-95; often over 95-100 in asps and yellowcheek); squawfishes have fewer branched anal fin rays (7-9 versus 10-15) than asps and yellowcheek except for *Pseudaspius* (8-9). True pikes and pickerels *Esox* spp. have the dorsal fin set farther back on the body and fang-like teeth.

**References:**
Berg 1949a; Blanc et al. 1971; Muus 1967; Nichols 1943; Shikhshabekov 1979; Sterba 1967; Toman and Felix 1974.



Chinese Asp
*Pseudaspius leptocephalus*

Turkish Asp *Aspius vorax*

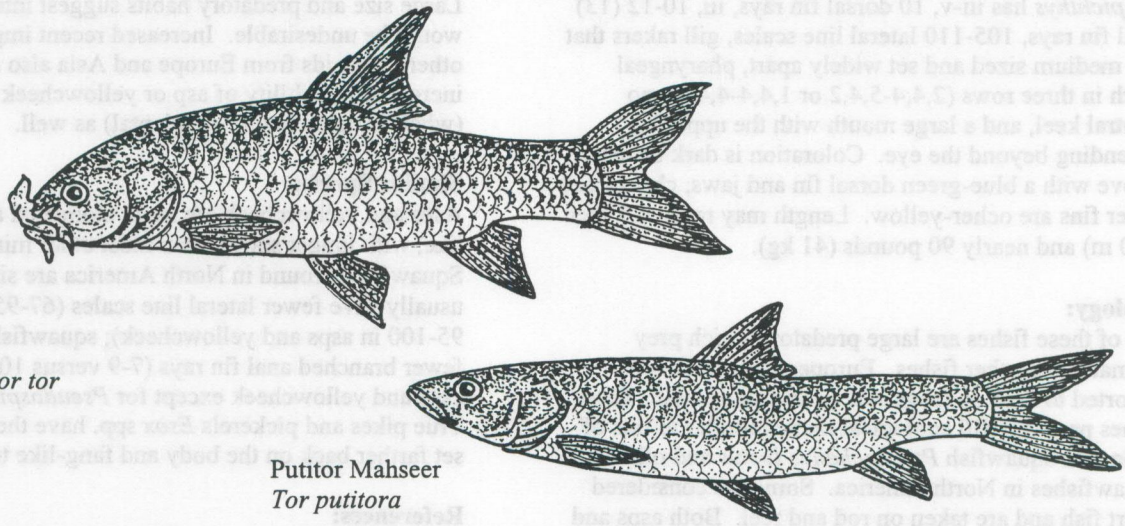
Northern Squawfish
*Ptychocheilus oregonensis*

Colorado Squawfish
*Ptychocheilus lucius*

# GIANT BARBS and MAHSEERS

## Family: Cyprinidae

**All Species of the Genus *Tor* and the Species *Barbus tor* and *Barbus hexagonolepis***



Mahseer *Tor tor*

Putitor Mahseer
*Tor putitora*

**Other Names:**
Some are called Indian giant barbs and copper mahseers. Although mahseer is often applied to the Indian species, it is used collectively here for Southeast Asian giant barb species as well.

**Specifics:**
Classification of Asian barbs has been and is still in a state of confusion. Originally, they were placed in a single genus *Barbus* by Cuvier (1817). Those without barbels were later placed into a separate genus, *Puntius*, by Buchanan (1822). Bleeker (1863) subsequently used the genus *Barbus* and three subgenera *Puntius* (no barbels), *Capoeta* (two barbels) and *Barbodes* (four barbels). The genus *Tor* erected by Grey (1833) was later considered synonymous with *Barbus* by Gunther (1868). Subsequent authors have used *Barbus, Puntius, Barbodes*, and *Capoeta* (some or all) as genera. The situation is further confounded by a group of European and northern Asian species called barbels which have also been placed in the genus *Barbus*, but which often appear very different from the southern Asian barbs. The validity of some of the species originally considered *Tor* is unclear. Further, linking *Barbus tor* and *Barbus hexagonolepis* is probably incorrect; *Acrossocheilus hexagonolepis* may be the appropriate name for the latter. At present the genus *Barbus* is applied to a large number of species of barbels found from Europe to China, and to an even larger number of barbs from Africa and southern Asia into southern China. Several recent Indian references have placed *Barbus tor* and other mahseers back under *Tor* (hence *Tor tor*, etc.) and collectively consider both Indian and Southeast Asian species to be mahseers under this genus.

**Range:**
Mahseers are found in Southeast Asia and into India and adjacent countries.

**Description:** Mahseers are large, carp-like fishes with somewhat elongated bodies, large scales, barbels present on the upper lip (one pair rostral barbels and one pair of maxillary barbels), complete lateral lines with about 23-28 scales, pharyngeal teeth in three rows (2,3,5-5,3,2), and lack fringe on their lips. *Tor* have the last simple dorsal ray ossified into a spine but lack teeth (nondenticulated) on the spine; total dorsal rays are 12-13 with 8-9 branched; a scaly sheath is present at the dorsal fin base; anal fin rays are 7-8 with 5 branched. Coloration is often a coppery-brown or silvery-gray. Size may reach 28 inches (0.7 m) in *T. tambroides* and 40 inches (1.0 m) in *T. soro; T.* (*B.*) *tor* reportedly may exceed eight feet (2.4 m) and 100 pounds (45 kg), while *B. hexagonolepis* reaches about 36 inches (0.9 m) in length.

**Biology:**
Mahseers are generally found in flowing rivers and larger streams. They often ascend streams at the start of the rainy season in spring or summer to spawn on

gravel beds; the spawning season may be protracted in some mahseers. Some species are predatory and largely piscivorous.

**Commercial Importance:**
Mahseers are considered important game fishes in some areas, and are fished commercially and reared by aquaculturists in India. Giant barbs are also taken commercially in Southeast Asia. None have any significant importance to American aquaculturists or aquarists to date.

**Reasons For Restriction:**
Giant barbs and mahseers were restricted due to increased importation of Old World cyprinid species for aquacultural purposes in recent years, large size (potentially predatory or competitive), limited understanding of their biology and potential environmental impacts if released.

**Similar Species:**
Mahseers may superficially resemble common carp *Cyprinus carpio* which has a single unbranched dorsal ray modified into a denticulated spine. The greatest problem could arise in differentiating these from the numerous other barbs sold legally in large numbers in the pet trade. Most of the other barbs commonly sold may have either much smaller maximum sizes, are deeper bodied or are boldly colored; some lack barbels. Examples include: tiger barb *Capoeta* ( *Barbus*) *tetrazona*, tinfoil barb *Barbodes* (*Barbus*) *schwanefeldi*, longfin barb *Capoeta* (*Barbus*) *arulius*, spanner barb *Barbodes* (*Barbus*) *lateristriga* and striped barb *Puntius* (*Barbus*) *fasciatus*.

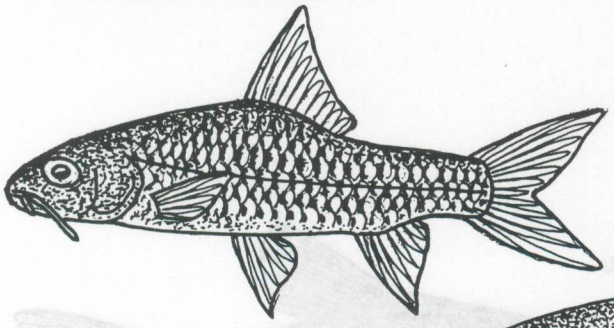
**Technical Note:**
Among the mahseers or giant barbs placed in the genus *Tor* are (if all are valid):

India and adjacent countries:
- *T. tor*
- *T. khudree*
- *T. mosal*
- *T. mussullah*
- *T. putitora*
- *T. progenius*
- *T. zholensis*

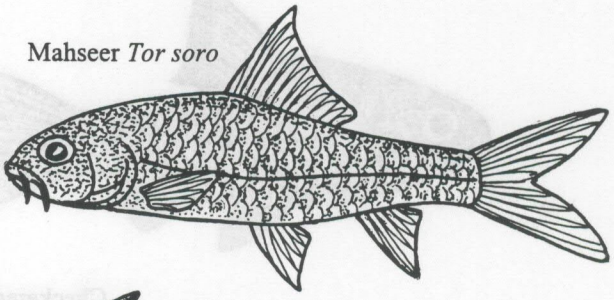
Southeast Asian species:
- *T. tambroides*
- *T. soro*
- *T. douronensis*
- *T. stracheyi*
- *T. longipinnis*

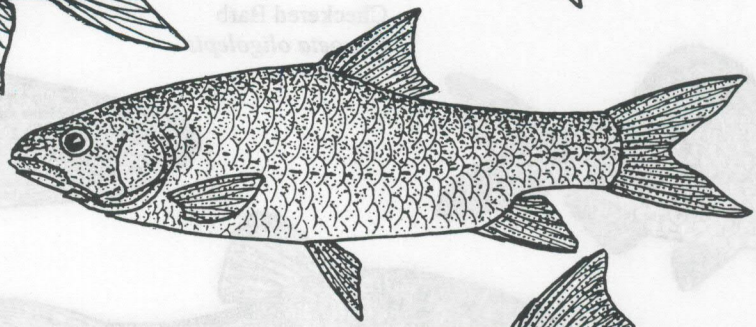
**References:**
Jayaram 1981; Munshi and Srivastava 1988; Smith 1945; Sterba 1967; Taylor 1982a; Weber and De Beaufort 1916.

Thai Mahseer *Tor tambroides*



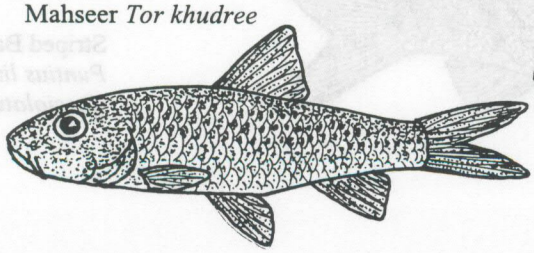
Mahseer *Tor soro*

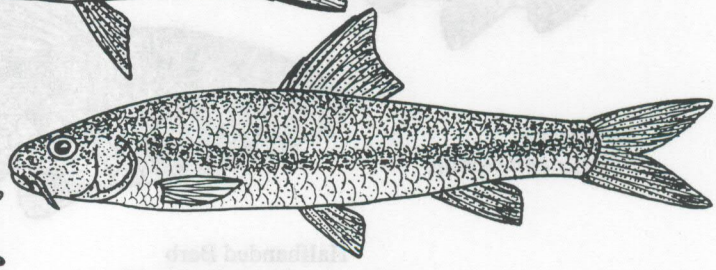




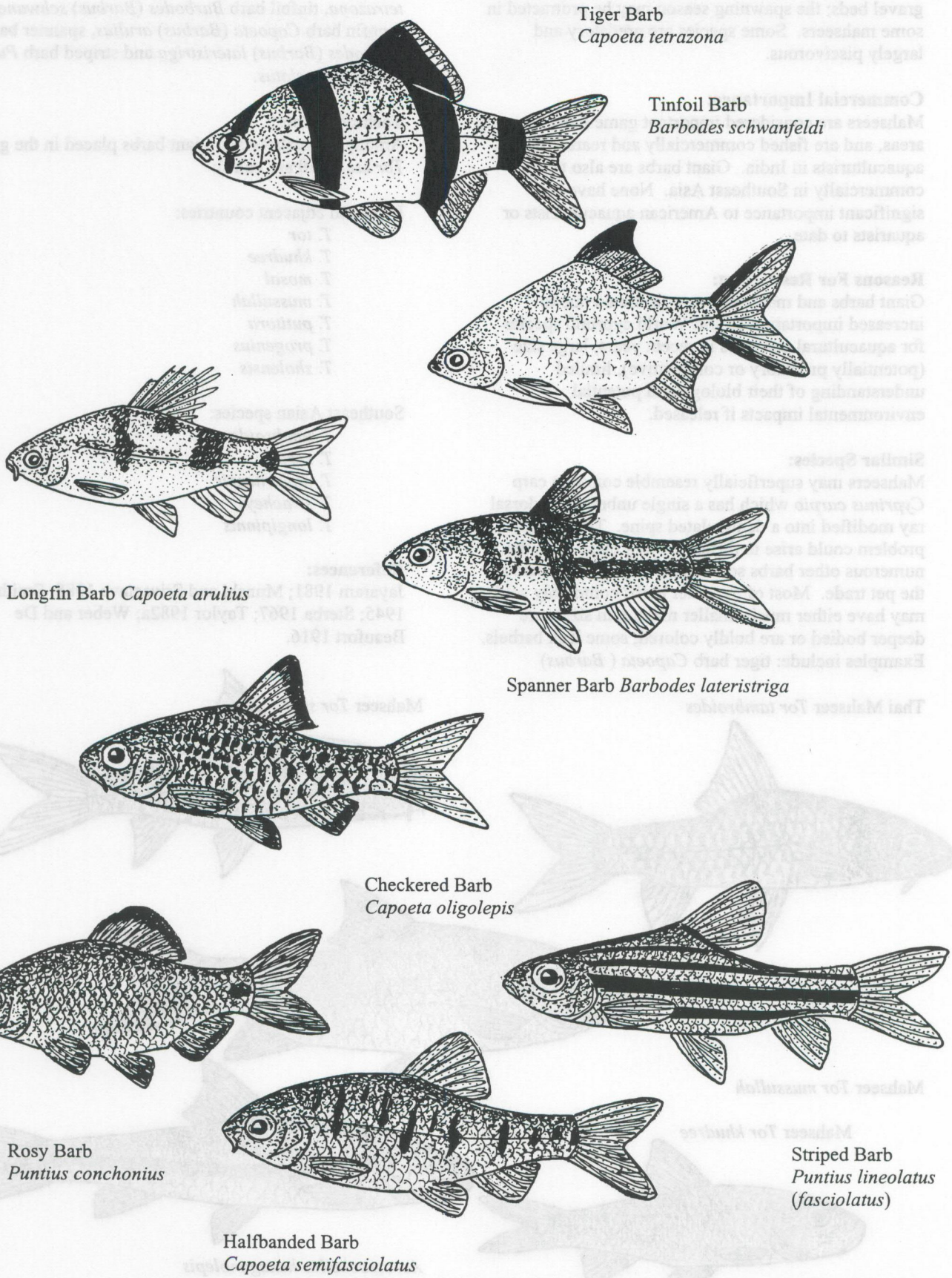
Mahseer *Tor mussullah*

Mahseer *Tor khudree*





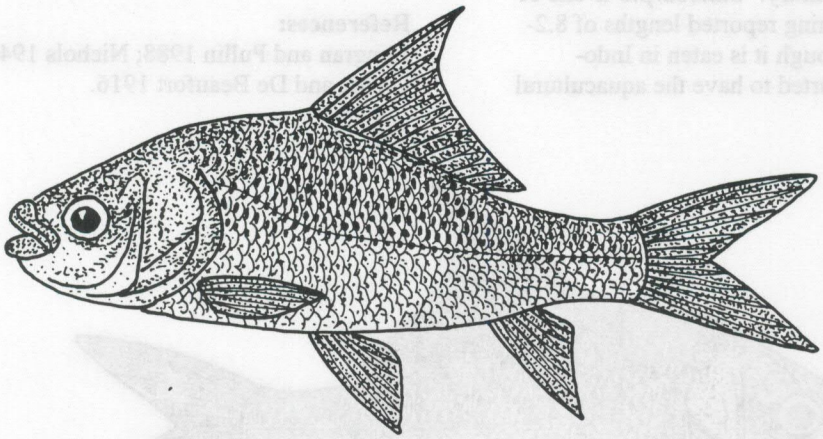
*Acrossocheilus hexagonolepis*


Tiger Barb
*Capoeta tetrazona*
Tinfoil Barb
*Barbodes schwanfeldi*
Longfin Barb *Capoeta arulius*
Spanner Barb *Barbodes lateristriga*
Checkered Barb
*Capoeta oligolepis*
Rosy Barb
*Puntius conchonius*
Striped Barb
*Puntius lineolatus*
(*fasciolatus*)
Halfbanded Barb
*Capoeta semifasciolatus*

# CATLA

## Family: Cyprinidae

### All Species of the Genus *Catla*



Catla
*Catla catla*

**Other Names:**
None.

**Specifics:**
Only one species is presently recognized in the genus; *C. buchanani* is apparently a synonym of C. catla. Another species, *Catlocarpio siamensis* from Thailand is often confused with catla.

**Range:**
Catla is found in India, Bangladesh, Burma and Pakistan, with aquacultural introductions in Sri Lanka, Israel, Africa, Japan, Malaysia, Philippines and the U.S.

**Description:**
Catla is a relatively heavy-bodied, high-backed carp-like cyprinid with a blunt snout, no upper lip, a large and broad head, body depth about one-third body length, terminal mouth, and lacks barbels. It has iii-iv, 15-16 dorsal fin rays, none of which are hardened and spine-like; iii, 5-8 anal fin rays; a fairly straight lateral line with about 40-43 lateral line scales and 8 scale rows above the lateral line and 9 rows below; long, slender, closely-set gill rakers; pharyngeal teeth in three rows (5,3,2-2,3,5). Size may reach 5-6 feet (1.5-1.8 m) in length and 50-100 pounds (23-45 kg) in weight. Coloration has been described as "uniform"; published color plates indicate dark olive dorsally, creamy white ventrally with the head and opercles silvery; gold domestic color morphs have been reported.

**Biology:**
Catla inhabit deep pools of large flowing rivers and streams. They spawn during the rainy season when rivers overflow their banks (usually in spring or summer). They apparently tolerate pond culture well but generally do not spawn in still water. They feed on filamentous algae, plankton and rotted macrophytes. Domestic hybrids with a number of species of other Indian carps have been reported.

**Commercial Importance:**
Although commercially fished and cultured in India, catla has generally received only experimental attention elsewhere. It is not sold in the pet trade.

**Reasons For Restriction:**
Because of its large size, low position on the food chain, and in view of established culture techniques and previous U.S. importation, it seemed wise to restrict catla and prevent possible substitution for other Asian carps which were, or have recently become, restricted in Texas.

**Similar Species:**
Catla superficially resembles common carp *Cyprinus carpio* and buffalos *Ictiobus* spp.; however, both have much longer dorsal fins with 18-20 branched rays in carp and 32-40 in buffalos. Barbels and fin spines seen in common carp are absent in catla.

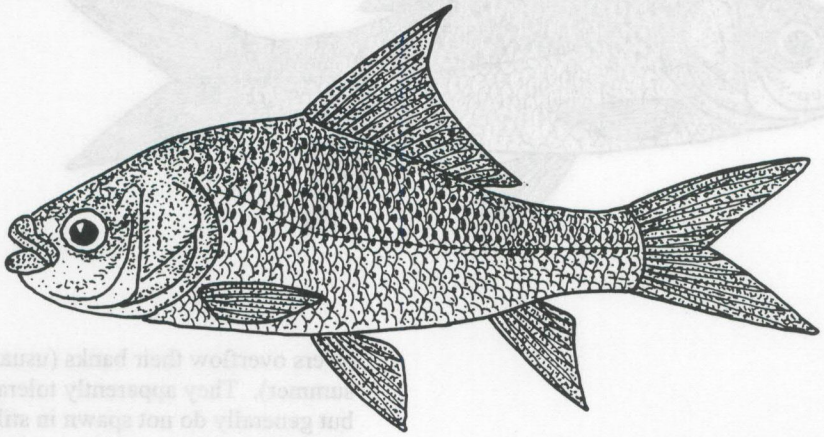
*Catlocarpio siamensis* from Indo-China (catla is from India and Burma) has been confused with catla even by prominent ichthyologists. It has only a single row of pharyngeal teeth (4-4), a mouth which extends back as far as the eye (shorter in catla), 39-40 lateral line scales, and a head which may go into standard length less than twice (shorter in catla). It has also been described as

having a longer dorsal fin with 14-16 branched rays; however, this is based on the assumption that catla has only 9 branched rays, which is inconsistent with the 15-16 branched rays in catla reported in recent Indian literature and counts reported for British museum specimens from the last century. *Catlocarpio* is one of the largest cyprinids, reaching reported lengths of 8.2-9.8 feet (2.5-3.0 m). Although it is eaten in Indo-China, it has not been reported to have the aquacultural interest seen in catla and accordingly importation into the U.S. is probably unlikely at this time. An illustration is unavailable at this writing, but *Catlocarpio* would be expected to resemble a catla-type cyprinid with a larger head.

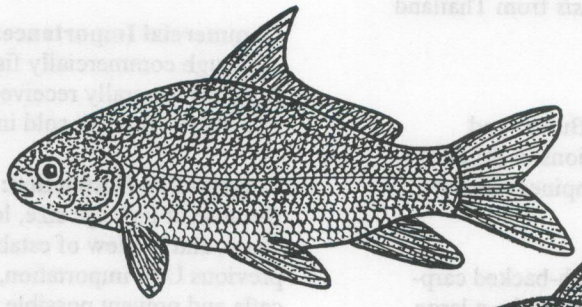
**References:**

Jhingran and Pullin 1988; Nichols 1943; Smith 1945; Weber and De Beaufort 1916.

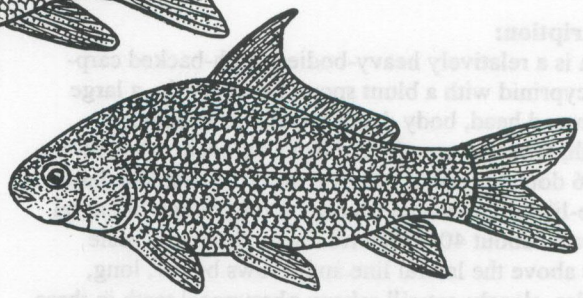
Catla *Catla catla*



Smallmouth Buffalo
*Ictiobus bubalus*



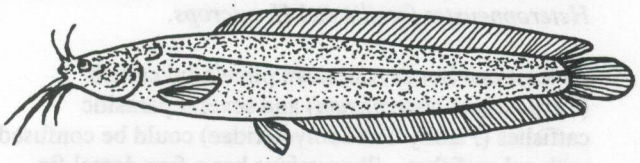
Bigmouth Buffalo
*Ictiobus cyprinellus*



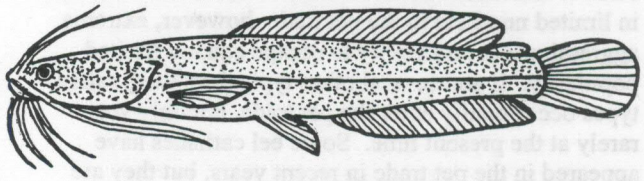
# WALKING CATFISHES

## Family: Clariidae

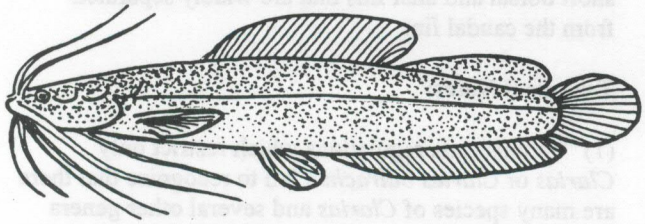
### All Species



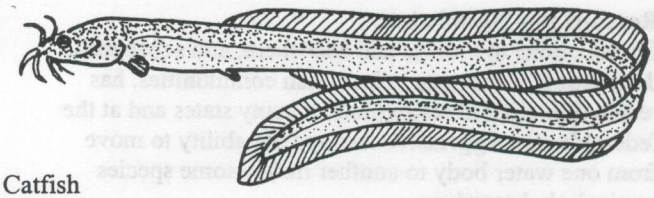
Typical Walking Catfish
*Clarias* sp.



Walking Catfish
*Dinopterus* sp.



Walking Catfish
*Heterobranchius* sp.



Eel Catfish
*Gymnallabes* sp.

**Other Names:**
Labyrinth catfish.

**Specifics:**
The family Clariidae contains about 100 species in 14 genera; the genus *Clarias* contains about 45 species.

**Range:**
This family inhabits Africa, southern Asia and Southeast Asian Islands into the Philippines. One species ranges north from Africa into Turkey. An Asian species, *C. batrachus*, was introduced into South Florida; other introductions have been made in Hawaii, Guam, Celebes, China, Hong Kong, and England.

**Description:**
Clariaid catfishes are elongated and torpedo shaped; some are very elongated and eel-like. All but a few eel-like species have an accessory breathing apparatus or labyrinth structure to enable them to breathe in oxygen-poor waters or on land. They have elongated dorsal and anal fins which are either separate from the caudal fin or only slightly connected (all three fins can be easily distinguished), except in some eel catfishes. Adipose fins are absent except in two African genera. Coloration is usually earthy browns and grays, sometimes with mottled patterns. Two blind (eyeless) species found in caves are largely colorless. The walking catfish *C. batrachus* found in Florida occurs commonly in an albino form. Clariaids can be grouped into four major types:

Typical walking catfish types: torpedo-shaped; with dorsal and anal fins either not connected to the caudal fin, or only slightly connected; adipose fin absent; small to about 3 feet (0.9 m) in length. Includes: *Clarias, Tanganikallabes*, *Xenoclarias, Prophagorus,* and *Clariallabes*.

Types bearing adipose fins: torpedo-shaped; with shorter dorsal fins than other clariaids and elongated adipose fins; some species to over 4 feet (1.2 m) in length. Includes: *Heterobranchius* and *Dinopterus*.

Eel catfishes: very elongated, eel-like body; dorsal and anal fins may be joined to the caudal fin or not; typically small in size. Includes: *Platyclarias, Platyallabes*, *Channallabes, Dolichallabes*, and *Gymnallabes.*

Blind cave species: eyeless and pigmentless species; *Uegitglanis* from African caves is similar in shape to *Clarias*; *Horaglanis* from India is somewhat more elongated than *Clarias*.

**Biology:**
Typical walking catfishes are aggressive predators and many species are capable of living in stagnant waters with low dissolved oxygen levels. Some species can leave the water and crawl across land to relocate to other water bodies. Many can burrow into mud and survive extended drought conditions. Species with adipose fins are likewise predatory. Eel catfishes are often burrowing, nocturnal species that feed on small

aquatic animals. The biology of cave-dwelling species is poorly known.

**Commercial Importance:**
Prior to introductions in Florida, *C. batrachus* was sold in limited numbers in the pet trade; however, extreme aggressiveness and ability to escape aquaria limited popularity. It and several other typical walking-catfish types occasionally enter the pet trade, but only very rarely at the present time. Some eel catfishes have appeared in the pet trade in recent years, but they are not commonly seen. There is no American aquacultural interest in these fishes; however, some species are cultured and commercially fished in Africa and Asia.

**Reasons For Restriction:**
Introductions in Florida and elsewhere, and subsequent destruction or changes in local fish communities, has resulted in clariaid restrictions in many states and at the federal level. Aggressiveness and the ability to move from one water body to another makes some species particularly hazardous.

**Similar Species:**
Walking catfishes are sufficiently different from American ictalurid catfishes (e.g., channel catfish *Ictalurus punctatus*) that confusion is unlikely. However, several other catfishes could be confused with clariaid species; these include:

Eel-tail or tandan catfishes (Family Plotosidae): have a single free dorsal fin placed foreword on the body and a second dorsal fin connected with the caudal and anal fins; many species less elongated than clariaids; inhabit fresh, brackish or salt water from Madagascar across southern Asia into Australia; most species are rarely seen in the pet trade except a marine species sold as coral catfish *Plotosus lineatus* which is boldly striped with horizontal black and white (or yellow or pale blue) stripes; small juveniles often school even in aquaria.

Air-sac catfishes (Family Heteropneustidae): very similar in shape to typical walking catfishes but possess only a single, short dorsal fin set far foreword on the body; spines are very poisonous; Texas and several other states have restricted them; rare in the pet trade; *Heteropneustes fossilis* and *H. microps*.

At least one South American pimelodid catfish (*Phreatobius cisternarum*) and several parasitic catfishes (Family Trichomycteridae) could be confused with eel catfishes. *Phreatobius* has a free dorsal fin (absent in eel catfishes) as well as connected second dorsal, caudal and anal fins. Parasitic catfishes have short dorsal and anal fins that are widely separated from the caudal fin.

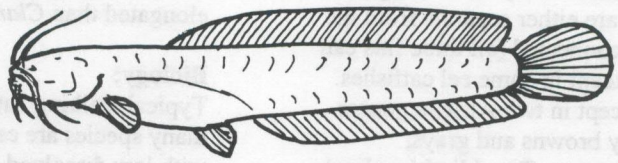
**Technical Notes:**

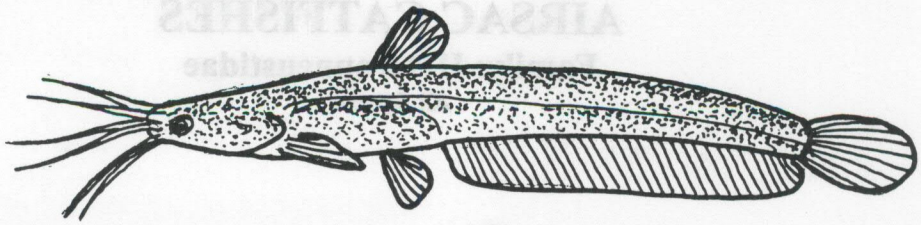
(1) Various state regulations which restrict only *Clarias* or *Clarias batrachus* fail to recognize that there are many species of *Clarias* and several other genera that are very similar to *Clarias*. Federal Lacey Act restrictions apply to all members of the family Clariidae.

(2) Introduced *C. batrachus* has had its American distribution restricted in part because of limited cold tolerance; however, the northern ranges of *C. lazera* in the eastern Mediterranean and *C. fuscus* in China suggest greater tolerance of cold temperatures (and potentially greater environmental risks if introduced in North America).

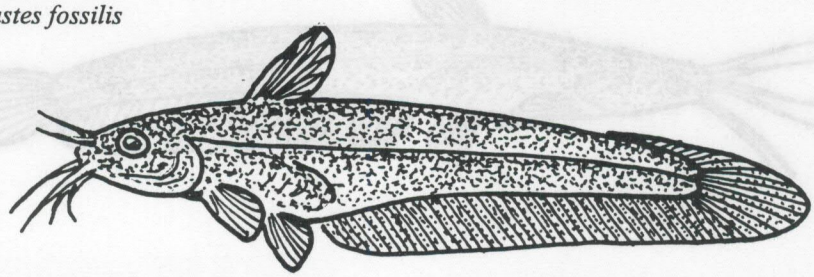
**References:**
Axelrod et al. 1976, 1989; Balon 1974; Blanc et al. 1971; Brichard 1978; Burgess 1989; Courtenay et al. 1984; Courtenay and Robins 1973; Emmens and Axelrod 1968; Frank 1971; Gilliland 1983; Howells 1985; Idyll 1969; Lachner et al. 1970; Lee et al. 1980; Nichols 1943; Smith 1945; Sterba 1967; Taylor 1982b; Weber and De Beaufort 1916.

Blind Walking Catfish *Uegitglanis* sp.

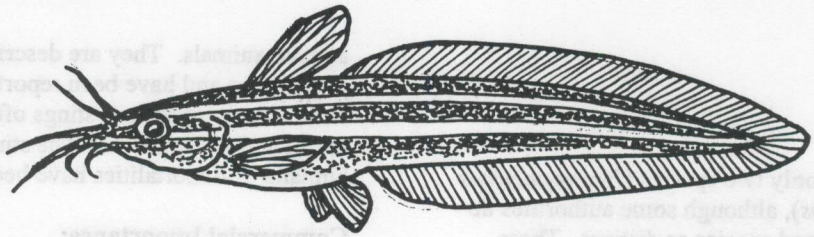




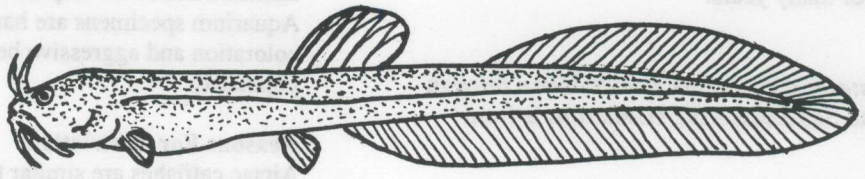
Airsac Catfish *Heteropneustes fossilis*



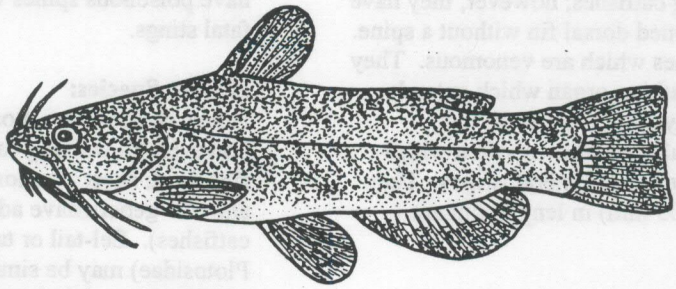
Eel-tail Catfish *Neosilurus* sp.



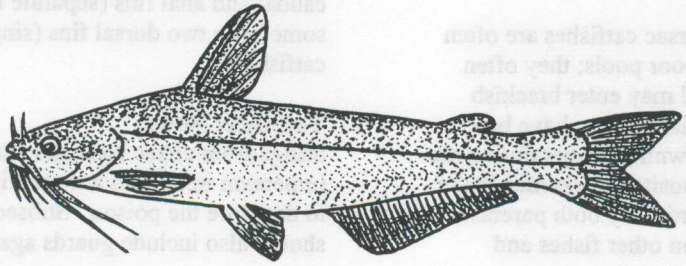
Coral Catfish *Plotosus* sp.



South American Pimelodid
*Phreatobius cisternarum*



Black Bullhead
*Ameiurus melas*

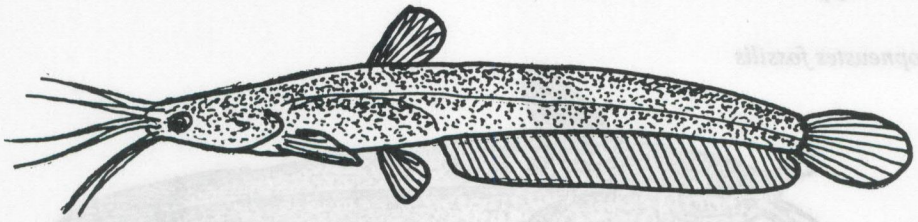


Blue Catfish
*Ictalurus furcatus*

# AIRSAC CATFISHES

## Family: Heteropneustidae

**All Species**



Airsac Catfish *Heteropneustes fossilis*

**Other Names:**
Asiatic catfish.

**Specifics:**
This family contains only two species (*Heteropneustes fossilis* and *H. microps*), although some authorities do not recognize the second species as distinct. These catfishes were included in the walking catfish family (Clariidae) for many years.

**Range:**
*Heteropneustes fossilis* occurs from Pakistan through India and into Southeast Asia; H. *microps* is from Ceylon.

**Description:**
Airsac catfishes have elongated bodies and anal fins similar to typical walking catfishes; however, they have a short, anteriorly-positioned dorsal fin without a spine. Pectoral fins contain spines which are venomous. They possess an accessory breathing organ which extends posteriorly along the body from the gill cavity. Coloration is usually a dull grey-brown, often with a suggestion of one or more lighter lateral stripes. They reach about 12 inches (305 mm) in length, but are usually smaller.

**Biology:**
Much like walking catfishes, airsac catfishes are often found in swamps and oxygen-poor pools; they often occur in flooded rice fields, and may enter brackish waters. Also, like walking catfishes, they have been reported to cross dry land. Spawning occurs during the rainy season when eggs are deposited in cavities in the substrate and subsequently guarded by both parents. Airsac catfishes are predatory on other fishes and aquatic animals. They are described as very pugnacious and have been reported to attack and sting without reason; serious stings often occur when fish are accidentally stepped on. The stings can be deadly to humans, and mortalities have been reported.

**Commercial Importance:**
Although of no interest in American aquaculture a limited number are imported and sold in the pet trade. Aquarium specimens are hardy, but unattractive coloration and aggressive behavior limit their popularity.

**Reasons For Restriction:**
Airsac catfishes are similar to walking catfishes in their ability to "walk" between water bodies and tolerate low water quality. They are aggressive and predatory, and have poisonous spines which can produce potentially fatal stings.

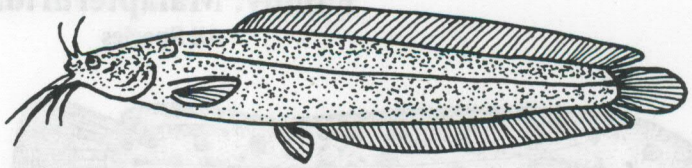
**Similar Species:**
Airsac catfishes are most similar to walking catfishes; however, all walking catfishes have an elongated dorsal fin (short, short anterior dorsal fin in airsac catfishes), and two genera have adipose fins (absent in airsac catfishes). Eel-tail or tandan catfishes (Family Plotosidae) may be similar but all have connected caudal and anal fins (separate in airsac catfishes), and some have two dorsal fins (single dorsal fin in airsac catfishes).

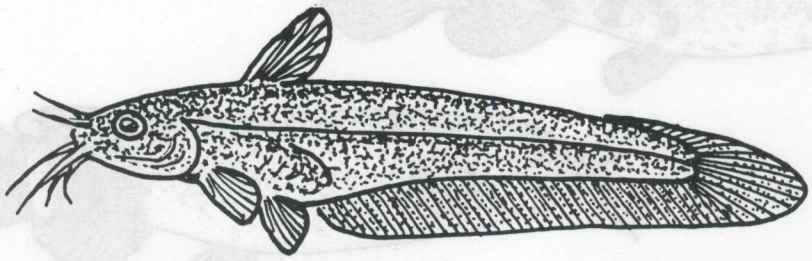
**Technical Note:**
Stings from airsac catfishes should be treated with heat (emersion in hot but not scalding water, hot packs, etc.) to denature the poison. Subsequent medical treatment should also include guards against infection.

**References:**

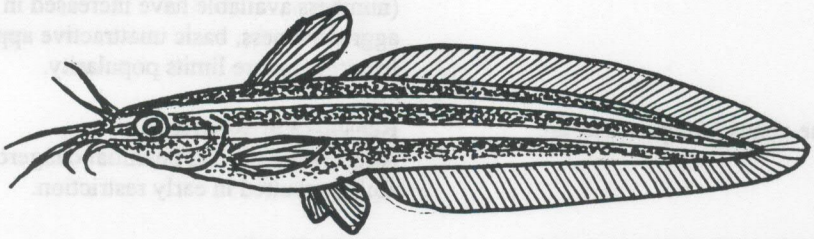
Axelrod et al. 1989; Burgess 1989; Emmens and Axelrod 1968; Frank 1971; Sterba 1967.

Walking Catfish *Clarias* sp.

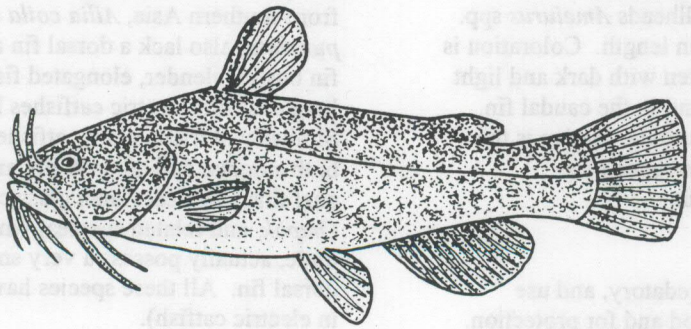




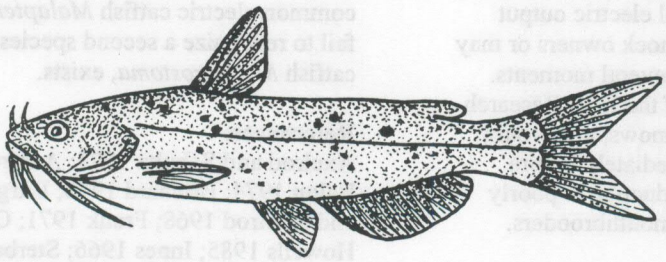
Eel-tail Catfish *Neosilurus* sp.



Coral Catfish *Plotosus* sp.



Brown Bullhead
*Amieurus nebulosus*

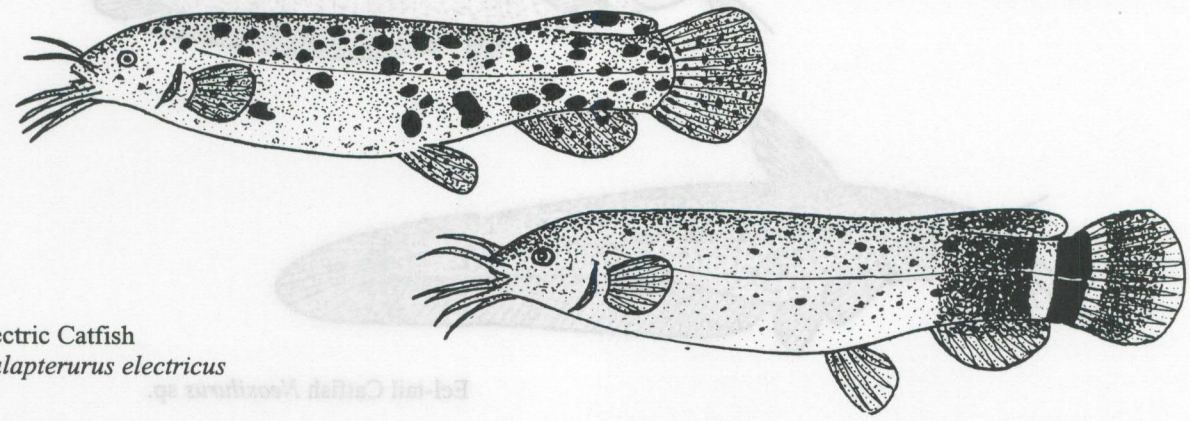


Channel Catfish *Ictalurus punctatus*

# ELECTRIC CATFISHES

## Family: Malapteruridae

**All Species**



Electric Catfish
*Malapterurus electricus*

**Other Names:**
None.

**Specifics:**
Presently two species in the genus *Malapterurus* are recognized.

**Range:**
Electric catfishes are found throughout tropical Africa.

**Description:**
Electric catfishes are stout bodied and somewhat similar in shape to American bullheads *Ameiurus* spp. Size may exceed 3 feet (0.9 m) in length. Coloration is usually a fleshy grey-yellow, often with dark and light vertical bands on the peduncle and in the caudal fin. Albinos have been reported. A unique feature is the absence of a dorsal fin but the presence of a posteriorly-positioned adipose fin.

**Biology:**
Both species are lethargic but predatory, and use electric capabilities to secure food and for protection. Some are able to generate 100-300 volts, with reports of up to 450 volts. Small individuals sometimes tolerate one another, but large specimens are decidedly solitary and aggressive. Fish control electric output such that acclimated pets may not shock owners or may only shock after being handled for several moments. Specimens held at TPWD's Heart of the Hills Research Station would accept hand-held minnows, and would only produce a stunning shock immediately before biting down on the minnow. Reproduction is poorly known, but they are believed to be mouthbrooders.

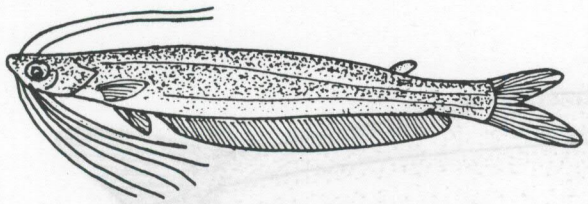
**Commercial Importance:**
Small numbers are sold in the pet trade where legal (numbers available have increased in recent years), but aggressiveness, basic unattractive appearance and lethargic nature limits popularity.

**Reasons For Restriction:**
Aggressiveness and potential dangerous electric shock ability resulted in early restriction.

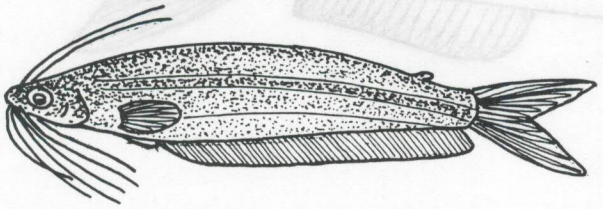
**Similar Species:**
Electric catfishes can be readily distinguished from most other catfishes by the absence of a rayed dorsal fin and presence of an adipose fin. Two schilbeid catfishes from southern Asia, *Ailia coila* and *Ailiichthys punctata*, also lack a dorsal fin and possess an adipose fin but are slender, elongated fishes and have a very long anal fin (electric catfishes have short anal fins). Similarly, African glass catfishes *Parailia* spp. lack both a dorsal and adipose fin, and have an elongated anal fins. Typical Asian glass catfishes (*Kryptopterus, Ompok,* and related species) which are seen in the pet trade, actually possess a very small, anteriorly-placed dorsal fin. All these species have forked tails (rounded in electric catfish).

**Technical Note:**
Restricted fish regulations in many states commonly list common electric catfish *Malapterurus* electricus, but fail to recognize a second species, Congo electric catfish *M. microstoma*, exists.

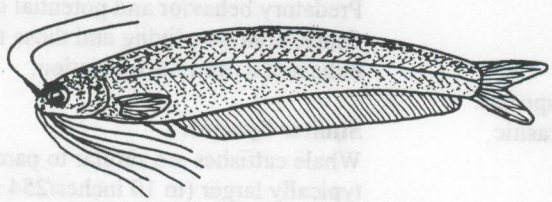
**References:**
Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Balon 1974; Brichard 1978; Burgess 1989; Emmens and Axelrod 1968; Frank 1971; Gilliland 1983; Howells 1985; Innes 1966; Sterba 1967.



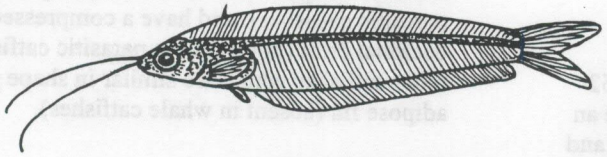
*Ailia coila*



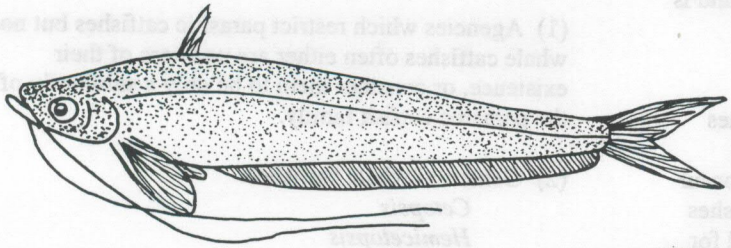
Ailiichthys punctata



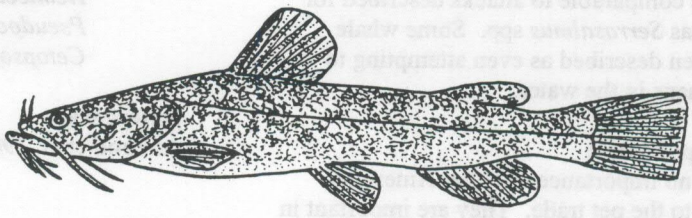
African Glass Catfish
*Parailia congica*



Asian Glass Catfish
*Kryptopterus bicirrhis*



Butter Catfish
*Ompok* sp.

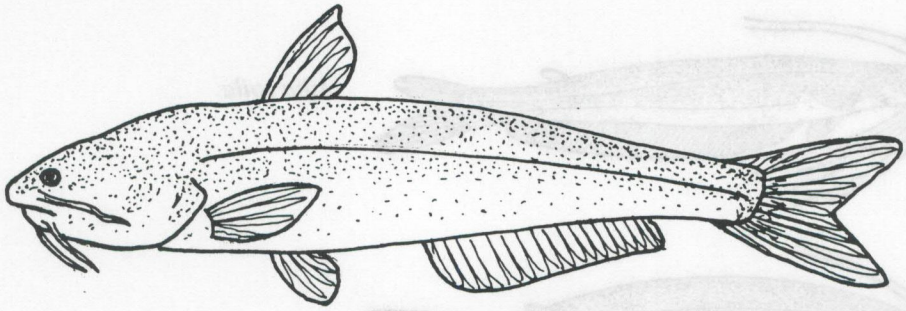


Flathead Catfish
*Pylodictus olivaris*

# WHALE CATFISHES

## Family: Cetopsidae

**All Species**



Whale Catfish
*Cetopsis coecutiens*

**Other Names:**
None.

**Specifics:**
This family contains four genera and about 12 species. It was previously considered a subfamily of parasitic catfishes (Family Trichomycteridae).

**Range:**
This family inhabits South America.

**Description:**
Whale catfishes are larger (some to 6-10 inches/152-154 mm) than most parasitic catfishes. They have an anteriorly-positioned dorsal fin with a weak spine and lack an adipose fin. The head is compressed and has an occipital crest. Coloration is usually grey or tan, and is often very pale.

**Biology:**
Whale catfishes are predatory on much larger fishes and often act in concert with parasitic catfishes to destroy hooked and gaffed fishes. When attacks occur in large numbers the resulting damage to larger fishes can reportedly be comparable to attacks described for schools of piranhas *Serrasalmus* spp. Some whale catfishes have been described as even attempting to rasp skin off humans in the water.

**Commercial Importance:**
This family is of no importance to either American aquaculturists or to the pet trade. They are important in some areas in South America where they may do considerable damage to fish taken by sport or commercial fishermen.

**Reasons For Restriction:**
Predatory behavior and potential damage to other fishes, both free-living and those taken by anglers, indicated a need for restriction.

**Similar Species:**
Whale catfishes are similar to parasitic catfishes but are typically larger (to 10 inches/254 mm) and more robust than parasitic catfishes (often < 3 inches/76 mm), have a dorsal fin spine with a buckler (not present in parasitic catfishes), and have a compressed head and occipital crest (not found in parasitic catfishes). Most other catfishes which are similar in shape possess an adipose fin (absent in whale catfishes).

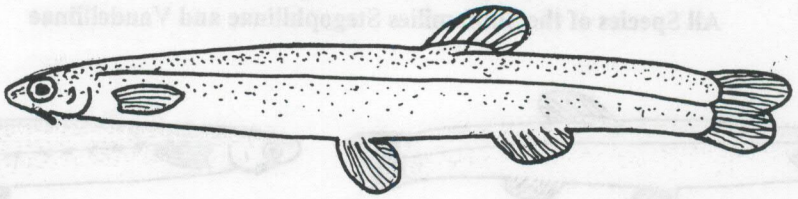
**Technical Notes:**

(1) Agencies which restrict parasitic catfishes but not whale catfishes often either are unaware of their existence, or consider them to be only a subfamily of the parasitic catfish family.

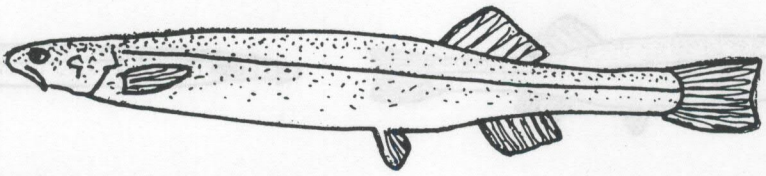
(2) Genera of whale catfishes:
*Cetopsis*
*Hemicetopsis*
*Pseudocetopsis*
*Cetopsogiton*

**References:**
Axelrod et al. 1989; Burgess 1989.

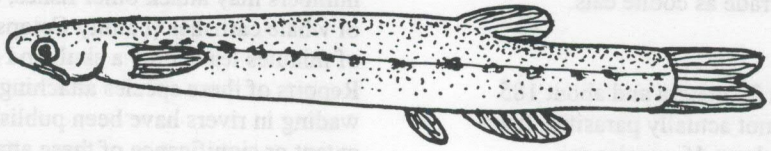
*Homodiaetus* sp.



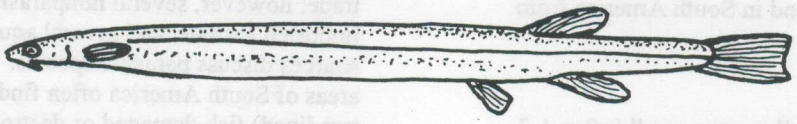
*Acanthopoma* sp.



*Stegophilus* sp.



*Vandellia* sp.

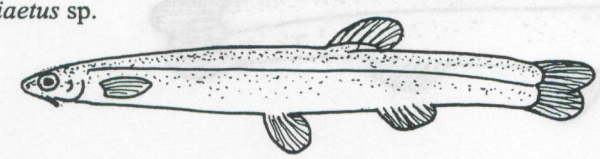


# SOUTH AMERICAN PARASITIC CATFISHES

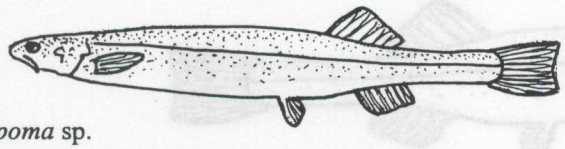
## Family: Trichomycteridae

**All Species of the Subfamilies Stegophilinae and Vandelliinae**

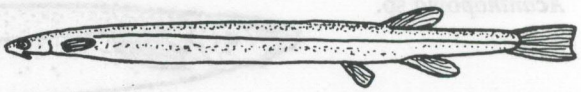
*Homodiaetus* sp.



*Stegophilus* sp.



*Acanthopoma* sp.



*Vandellia* sp.

**Other Names:**
Candiru or candiru catfishes; nonparasitic species are sometimes sold in the pet trade as coolie cats.

**Specifics:**
This family includes about 30 genera and about 185 species most of which are not actually parasitic. Two parasitic subfamilies with about 46 species are restricted in Texas.

**Range:**
Trichomycterids are found in South America from Argentina to Panama.

**Description:**
Parasitic species are small to very small (often 1-3 inches or less/25-76 mm) catfishes with elongated bodies. They possess a single centrally- or posteriorly-positioned dorsal fin, no adipose fin, paired pelvic fins, and caudal fins that range in shape from forked to rounded. Eyes are usually small and barbels are reduced in both size and number. Lips in some species form an almost sucker-like mouth. Spines are present on the gill cover of some species, but pectoral fins lack spines (typically present in many other catfishes). Coloration in parasitic species is usually rather pale, often nearly transparent.

**Biology:**
Some parasitic species feed on blood and gill tissue by entering the gill cavities of larger fishes. Similarly, they may mistakenly enter human urethras, especially in cases where the victim is urinating in the water. Once inside the urethra, they erect gill cover spines, cause extreme pain and cannot readily be removed without surgery. Reportedly some South American Indians fear these catfishes more than the infamous piranhas *Serrasalmus* spp. They have been called the only vertebrate parasite of man. Less well known are numerous species that attack large fishes, adhere with suction-like lips and bore into the host body. Vast numbers may attack other fishes, often in the company of whale catfishes (Family Cetopsidae), and in a matter of minutes leave only a skull and spinal column behind. Reports of these species attaching to legs of people wading in rivers have been published; however, the extent or significance of these attacks is unclear.

**Commercial Importance:**
True parasitic species are of no importance to the pet trade; however, several nonparasitic species have been imported for sale, and several aquarium literature sources discuss parasitic species. Fishermen in some areas of South America often find hooked (angled or trot-lined) fish damaged or destroyed by the collective work of parasitic and whale catfishes.

**Reasons For Restriction:**
The serious potential harm to humans as well as damage to other fishes in the field resulted in early concern about potential imports. Texas and a number of other states restrict these fishes. Specific parasitic subfamilies are specified in Texas thereby allowing nonparasitic species to be sold in the pet trade.

**Similar Species:**
Parasitic trichomycterids probably most closely resemble certain loaches and weatherfishes (Family Cobitidae) commonly sold in the pet trade, as well as nonparasitic trichomycterids and the parasitic whale catfishes.

Loaches include the coolie or kuhle loaches *Acanthophthalmus* spp. and weatherfishes (*Cobitis*, *Misgurnus*) and are quite common in the pet trade. Coolie loaches and their relatives are typically small (1-3 inches/25-76 mm) with short whiskers much like parasitic catfishes; however, they typically have bold

black or brown vertical bars on a pale yellow or pink background. Weatherfishes are larger (sometimes to 12 inches, usually less/305 mm) and dirty brown or grey in color, with some species having lateral stripes. Nearly all loaches have a small but definite spine in front of or below the eye (not present in parasitic catfishes); however, the spine may be covered by skin in some species.

Most other nonparasitic trichomycterid catfishes are often much less elongated and much more heavily pigmented than parasitic species, and in general, appear much like many loaches. They are typically larger (to nearly 12 inches/305 mm in some species). Adipose fins are present in a few species.

Three species of an obscure trichomycterid subfamily (Glanapteryginae including *Pygidianops*, *Typhlobelus,* and *Glanapteryx,* each with a single species) resemble some parasitic species. All three are small (less than about 1.5 inches/38 mm), lack dorsal or adipose fins (dorsal fins present in parasitic forms), and are either blind or have small vestigial eyes (even when eyes in parasitic forms are small, they are well developed). These are apparently burrowing species; their biology is poorly understood but reduced teeth, absence of sucker-like mouths or gill cover spines suggests they are probably not parasitic.

Whale catfishes (Family Cetopsidae) were previously considered a subfamily of Trichomycteridae. There are four genera and about 12 species found coexisting with parasitic catfishes and feeding on the same prey. They clearly differ from trichomycterids but only through a variety of technical points. In general, whale catfishes are often heavier bodied (especially anteriorly), have a more anteriorly-positioned dorsal fin and are larger than true parasitic catfishes (up to 6-10 inches/152-254 mm in some species).

**Technical Notes:**

(1) Unrestricted nonparasitic trichomycterid subfamilies and genera (follows Burgess 1989):

- Subfamily: Nematogenyinae
  - *Nematogenys*
- Subfamily: Trichomycterinae
  - *Scleronema*
  - *Trichomycterus*
  - *Eremophilus*
  - *Bullockia*
  - *Trichogenes*
- Subfamily: Tridentinae
  - *Tridens*
  - *Tridentopsis*
  - *Tridensimilis*
  - *Miuroglanis*
- Subfamily: Glanapteryginae
  - *Glanapteryx*
  - *Pygidianops*
  - *Typhlobelus*
- Subfamily: Sarcoglanidinae
  - *Sarcoglanis*
  - *Malacoglanis*

(2) Restricted parasitic trichomycterid subfamilies and genera (follows Burgess 1989):

- Subfamily: Stegophilinae
  - *Pareiodon*
  - *Stegophilus*
  - *Pseudostegophilus*
  - *Parastegophilus* ?
  - *Schultzichthys*
  - *Homodiaetus*
  - *Pleurophysus*
  - *Haemomaster*
  - *Apomatoceros*
  - *Acanthopoma*
  - *Ochmacanthus*
- Subfamily: Vandelliinae
  - *Vandellia*
  - *Plectrochilus*
  - *Paravandellia*
  - *Paracanthopoma*
  - *Branchioica*

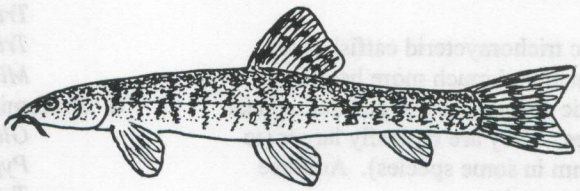
Note: Identification of parasitic catfishes can be very difficult, even for experts.

**References:**

Axelrod and Burgess 1982; Axelrod et al 1976, 1989; Burgess 1989; Emmens and Axelrod 1968; Schmidt 1987.

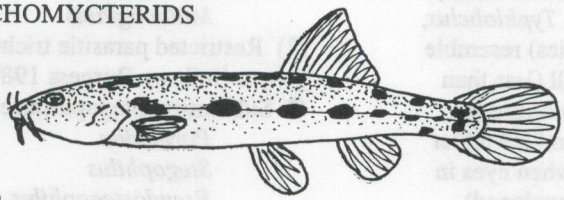
Coolie (Kuhle) Loach
*Acanthophthalmus* sp.

Barred Loach
*Nemacheilus* sp.

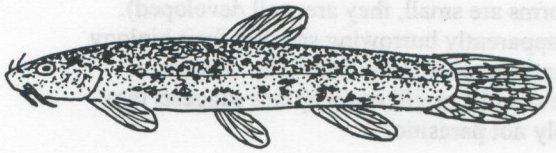


NON-PARASITIC TRICHOMYCTERIDS

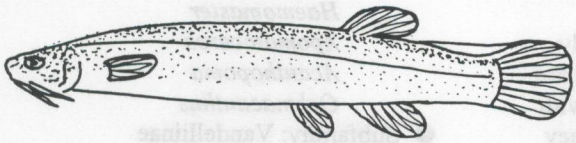
*Scleronema* sp.



*Nematogenys* sp.



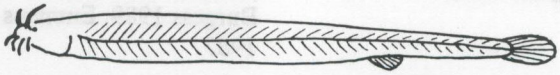
*Trichomycterus* sp.



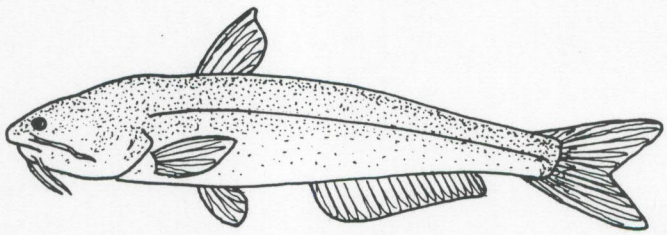
BLIND/BURROWING TRICHOMYCTERIDS

*Pygidianops eigenmanni*

*Typhlobelus ternetzi*



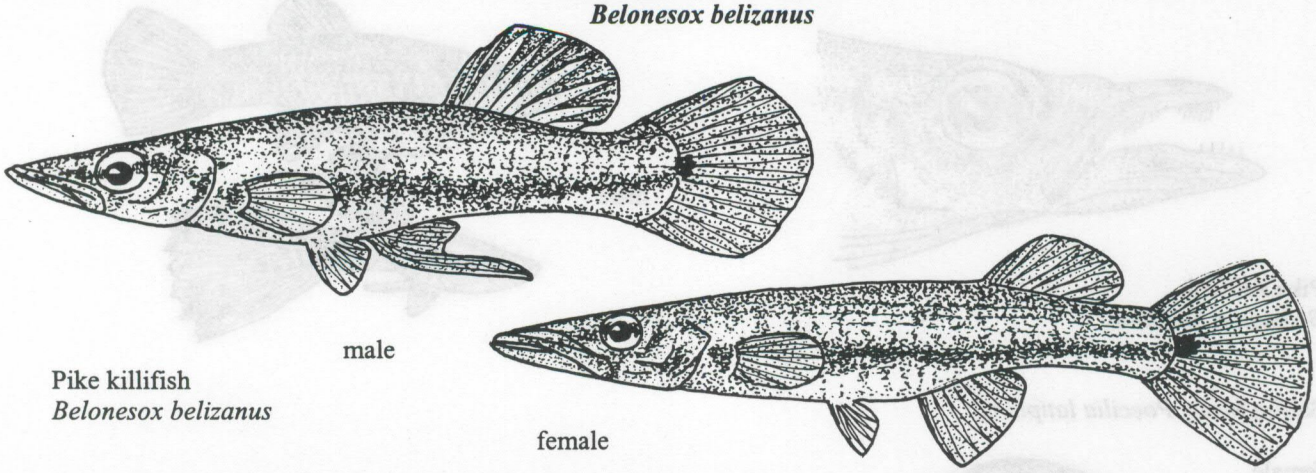
Whale Catfish
*Cetopsis* sp.



# PIKE KILLIFISH

## Family: Poeciliidae

***Belonesox belizanus***



male

Pike killifish
*Belonesox belizanus*

female

**Other Names:**
Pike topminnow, gar-pike (rarely).

**Specifics:**
Only a single species is recognized.

**Range:**
Pike killifish is native to Central America from Southern Mexico through Honduras and Guatemala. An introduced population is established in south Florida, and another population found once in Southcentral Texas has apparently died out.

**Description:**
Pike killifish is related to the guppy *Poecilia reticulata* and mosquitofishes *Gambusia* spp., and is among the largest species in the family. Males reach 4-5 inches (102-127 mm) and females grow to about 8 inches in length. They are somewhat more elongated in body shape than many other poeciliids, and have protruding jaws and snouts. Jaws possess very fine, close-set teeth. Coloration is generally a pale brownish-olive with a silvery tint and 4-5 very irregular rows of black spots (usually small); some individuals have a suggestion of a darker lateral band. Fins which are clear reportedly become black at night. Males have a modified anal fin (gonopodium) which is tubular in shape and used for copulation.

**Biology:**
This species is predatory, feeding heavily on small fishes, and fills much the same ecological niche as American pickerel *Esox* spp.. They often lie motionless in dense vegetation and rapidly strike out at passing prey. Pike killifish may bear 20-80 live young every 30-50 days. Parents are cannibalistic. They are shy and often difficult to maintain in aquaria.

**Commercial Importance:**
Although occasionally available in the pet trade where legal, their relatively large size, unattractive coloration, need for live food and fragile nature in captivity has restricted demand.

**Reasons For Restriction:**
Predatory nature in conjunction with introductions in Florida and Texas resulted in early restriction.

**Similar Species:**
Other poeciliids are probably most similar to pike killifish; however, other species are usually much smaller, never have elongated snouts and many species commonly sold in the pet trade are much more colorful. Both African and South American pike characoids (several families and species) are superficially similar as well; all possess an adipose fin (absent in pike killifish) and none possess gonopodia.

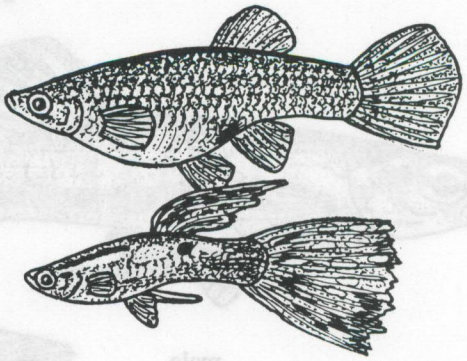
**Technical Note:**
Small juveniles (0.5-1.0 inch/13-25 mm at birth) might be confused with other poeciliids (especially some wild-type females).

**References:**
Axelrod and Schutz 1971; Axelrod et al. 1976, 1989; Courtenay et al. 1984; Courtenay and Robins 1973; Frank 1971; Howells 1985, 1992; Hubbs 1982; Hubbs et al. 1978; Jacobs 1973; Lee et al. 1980; Sterba 1967.

Pike Killifish
*Belonesox belizanus*

Guppy
*Poecilia reticulata*

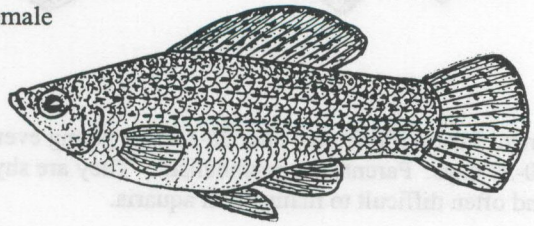
female



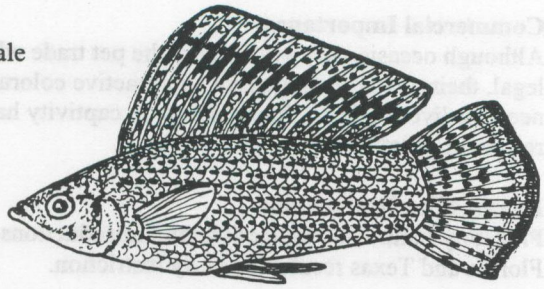
male

Sailfin Molly *Poecilia latipinna*

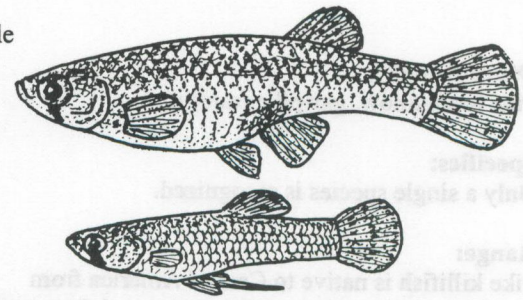
female



male



female



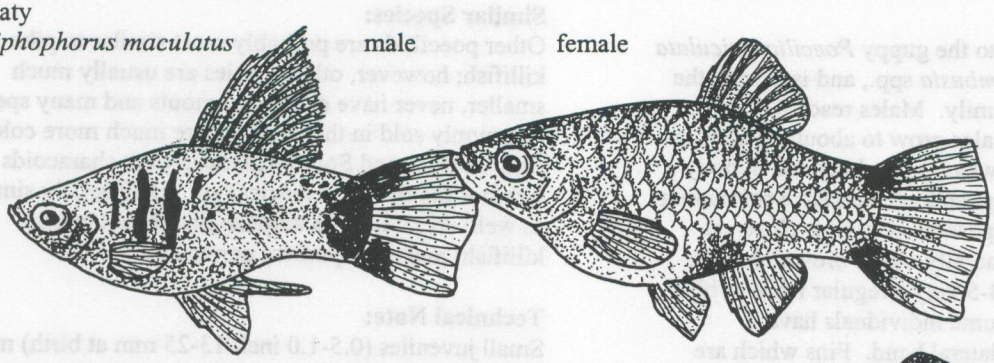
male

Mosquitofish *Gambusia affinis*

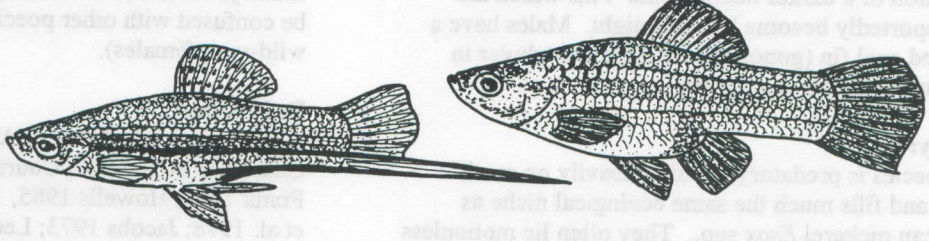
Platy
*Xiphophorus maculatus*

male

female



male



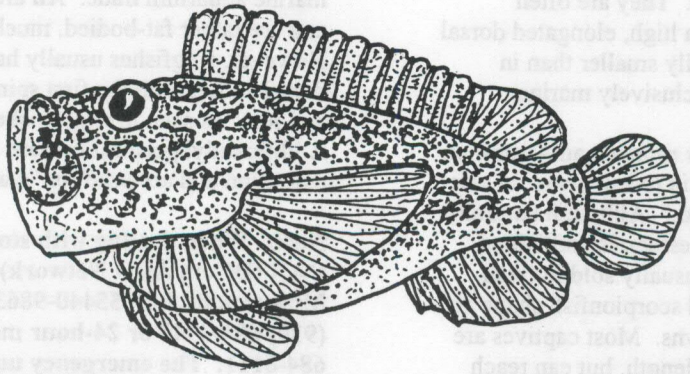
Green Swordtail *Xiphophorus helleri*

female

# MARINE STONEFISHES

## Family: Synanceiidae

### All Species



Stonefish
*Synanceia* sp.

**Other Names:**
None.

**Specifics:**
This family contains nine genera and about 20 species. The name is sometimes spelled Synancejidae. This restriction does not include scorpionfishes (Family Scorpaenidae) some of which are native to North American coastal waters, or tropical marine *Pterois* spp. sold in the pet trade as lionfish or turkeyfish.

**Range:**
Stonefishes are native to the Indo-Pacific, from the Red Sea and South Africa, east to Japan and Australia.

**Description:**
Stonefishes have scaleless, stout bodies and large heads. Mouths are large and nearly vertical in some species. Numerous skin glands provide a warty appearance. Spines are present in dorsal, pelvic, and anal fins. Poison glands located at the base of hypodermic-like dorsal spines produces extremely toxic venom. Coloration is typically earthy browns, yellows and blacks, which provides unusually good camouflage and makes them extremely difficult to see. Most species grow to about 12 inches (305 mm) or less in length.

**Biology:**
Stonefishes prey on small fish, crustaceans and other marine life; they use camouflaged coloration and skin texture to blend in with natural surroundings and wait motionless until an unsuspecting meal approaches. They are often found partially buried in sand. Stings usually occur during handling or when fish are stepped on; venom is not used in obtaining food and fish rarely if ever aggressively attack. Stings are extremely painful and may lead to death, sometimes within a very short period of time. Associated symptoms include swelling, tissue discoloration, necrosis, respiratory distress, muscle weakness, shock and coma. Systemic effects are apparently due to myotoxins which act directly on all types of muscles. Antivenin specific to stonefishes has been produced in Australia but is unavailable in the U.S. They are primarily marine (rarely in brackish or fresh water).

**Commercial Importance:**
Small numbers of stonefishes have been imported by the pet trade in recent years for use in saltwater aquaria; however, while lionfishes are readily available in many pet stores, stonefish availability and demand has been relatively limited.

**Reasons For Restriction:**
Because marine aquarium culture and availability of tropical marine fishes has improved in recent years, increased importation and availability of stonefishes could be expected. This coupled with their potentially lethal venom and lack of ready access to antivenin in North America suggested a need for restrictions. Further, concerns about the possibility of stonefishes surviving and establishing if released have also been voiced.

**Similar Species:**
Stonefishes are relatively unique and not readily confused with most other fishes.

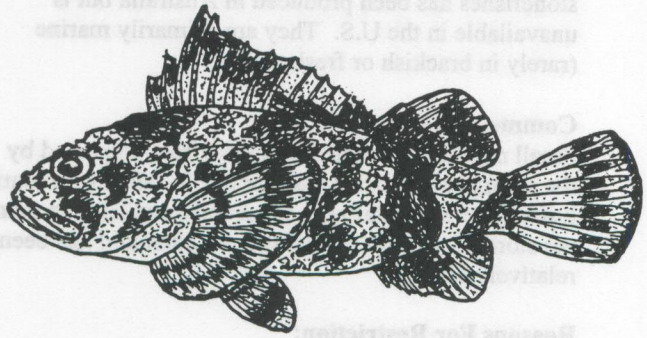
Among the scorpionfishes commonly sold in the pet trade, lionfishes (also called turkeyfishes or zebra-fishes) of the genus *Pterois* (several species) are boldly colored in stripes of white, black, and reddish brown and possess long dorsal and pectoral spines. Although lionfishes are also poisonous, their venom is produced in cells located within spine grooves and the poison-delivery system is far less efficient than in stonefishes. Lionfish stings are also very painful, but fatalities are

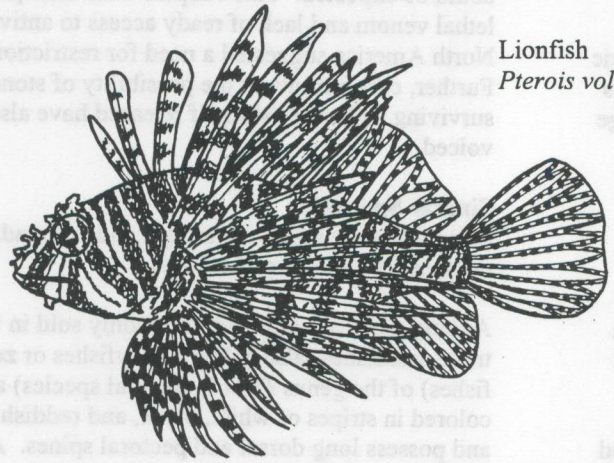
largely unknown. Lionfishes are exclusively marine.

Sailfin or sailback scorpionfishes (Family Scorpaenidae, Subfamily Tetraroginae) are less frequently seen in the pet trade. They are often protectively colored, but have a high, elongated dorsal fin; pectoral fins are substantially smaller than in lionfishes. These fishes are exclusively marine.

The bullrout or kroki *Notesthes robusta,* an Australian scorpaenid, has been imported in recent years for sale in the pet trade as "butterfly cod." Although naturally occurring in both high salinity estuaries and inland lakes, pet store specimens are usually sold in fresh water. Bullrouts have a typical scorpionfish shape and are marbled in blacks and browns. Most captives are only 1-2 inches (25-51 mm)in length, but can reach about 14 inches (356 mm).

Bullrout *Notesthes robusta*





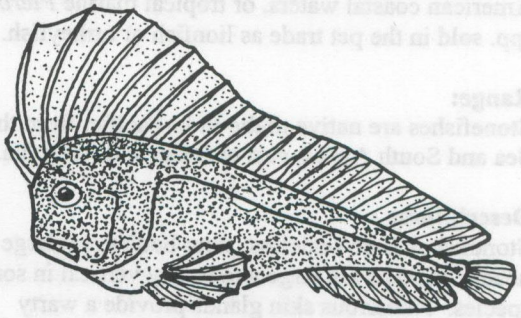
Lionfish
*Pterois volitans*

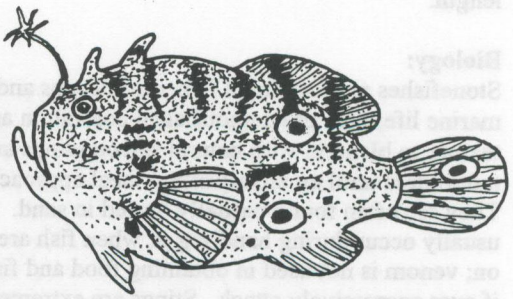
**Technical Note:**
Occasionally frogfishes (Family Antennariidae) are mistaken for stonefishes. Several species occur along the Texas coast and a number of species are sold in the marine aquarium trade. All are protectively colored and are rather fat-bodied, much like stonefishes. However, frogfishes usually have only about three dorsal spines with the first spine modified into a "rod and lure" as seen in anglerfishes (Family Lophiidae). Additionally, pectoral fins are set on an arm-like extension and are used for "walking."

**Note: When dealing with stonefish stings, contact DAN (Divers Alert Network), P.O. Box 907, Minneapolis, MN 55440-9863; general information (919) 684-2948 or 24-hour medical emergency (919) 684-8111. The emergency number is manned by physicians who generally deal with dive medicine, but are also prime sources for medical information on venomous fish stings.**

**References:**
Burgess et al. 1988; Caras 1974; Mackley 1983.

Sailfin Scorpionfish *Pataecus fronto*

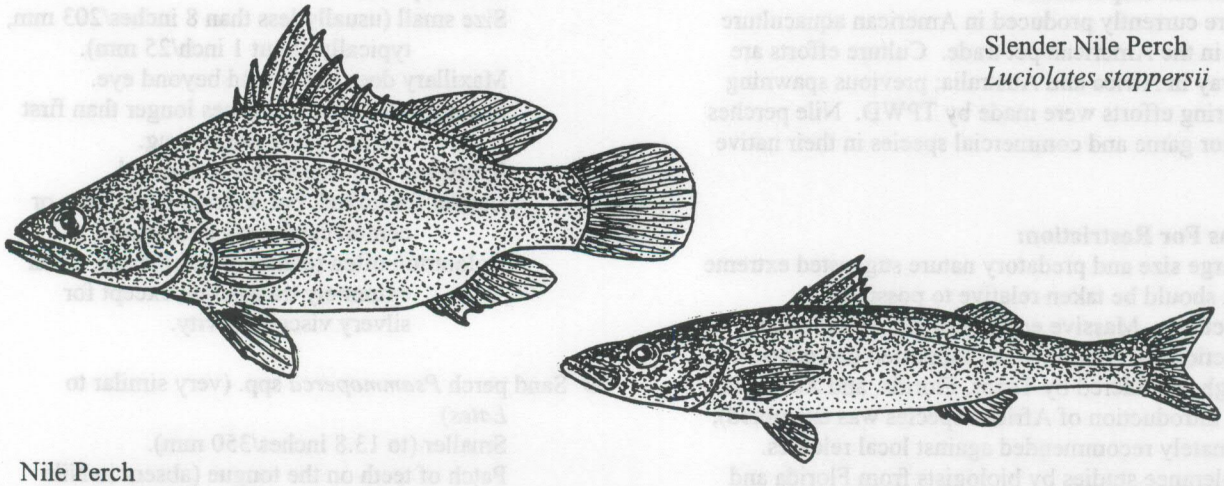




Ocellated Frogfish *Antennarius ocellatus*

# Nile Perches

**Family: Centropomidae**
**All Species of the Genera *Lates* and *Luciolates***



Slender Nile Perch
*Luciolates stappersii*

Nile Perch
*Lates niloticus*

**Other Names:**
Giant perches, barramundi (in Australia). Barramundi is also applied to some osteoglossids (see comments under arapaima) and the Australian lungfish *Neoceratodus forsteri.*

**Specifics:**
The family includes two major subfamilies: Centropominae which includes the snooks *Centropomus* spp. with 12 recognized species and Latinae which includes *Lates* spp. with 5-7 species and *Luciolates* spp. with two species, as well as *Psammoperca* spp. Note that *Luciolates* is apparently considered *Lates* by some authorities. Some sources consider the glass fishes (*Chanda* spp. and related genera) in this family; however, most place them in their own family Chandidae (genus *Ambassis* and family Ambassidae in older literature). The genus *Niphon* once listed there as well was subsequently moved to the sea basses (Family Serranidae), and more recently to temperate basses (Family Percichthyidae).

**Range:**
Both genera are found in Africa, with one *Lates* found in southern Asia and into Australia. Most are associated with freshwater rivers and lakes, but *Lates niloticus* enters African coastal waters and *Lates calcarifer* is found in both fresh waters and high salinity environments in Australia. Note that biologists in Florida and Texas imported African Nile perches for study. In Texas, fish were stocked into Victor Braunig Reservoir (a total of 128 in 1978, 1979 and 1984), Coleto Creek Reservoir (68,119 in 1981), Fairfield Reservoir (1,310 in 1983), and Smithers Reservoir (14 in 1985). Some were taken by anglers shortly after stocking, but it was believed that there was no long-term survival until a single 45.5-inch (1.2-m), 60-lb (27-kg) *L. niloticus* was found dead at Smithers Reservoir in January 1990 following extremely cold weather. Introductions have also occurred in Africa into lakes Victoria and Kyoga.

**Description:**
Nile perches are heavy-bodied fishes with pointed heads, concave foreheads and large mouths. *Lates* are deep-bodied (body depth > 25% body length); *Luciolates* are more slender (body depth ≤ 25% body length). Spiny and soft dorsal fins are widely separated in *Luciolates*, but slightly connected in *Lates*. Lateral lines are complete. Eyes are large and may reflect light much like those of American walleye *Stizostedion vitreum*. Coloration is typically dark browns and blacks on a lighter background; belly is white in some species and life stages. Maximum size varies with species, with African *Lates niloticus* exceeding 240 pounds (109 kg)and a record of *Lates calcarifer* from the Bay of Bengal at 580 pounds (253 kg); most are far smaller.

**Biology:**
Most African species are open-water predators in large lakes. *Lates niloticus* also inhabits large river systems as well, and may enter coastal waters. Australasian *Lates calcarifer* enters freshwater rivers and lakes, but migrates to higher salinity coastal waters to spawn (catadromous). Nile perches are extremely effective predators on other fishes. Introductions into Lake Victoria have resulted in major changes to the local fish

community and collapse of the commercial fishery there. Spawning occurs near shore, and eggs and larvae are pelagic.

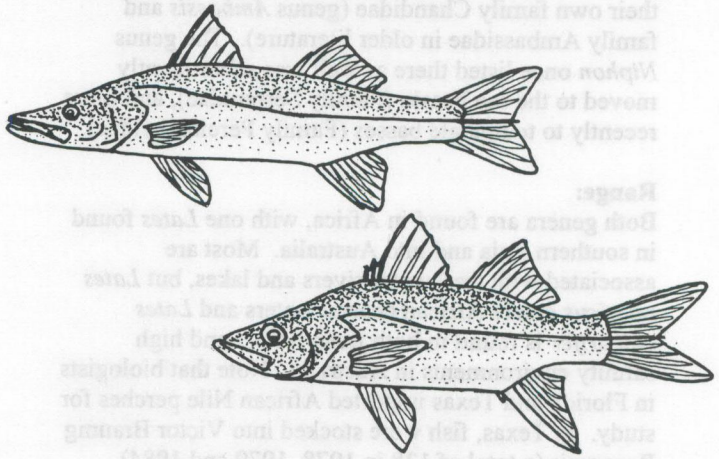
**Commercial Importance:**
None are currently produced in American aquaculture or sold in the American pet trade. Culture efforts are underway in Africa and Australia; previous spawning and rearing efforts were made by TPWD. Nile perches are major game and commercial species in their native waters.

**Reasons For Restriction:**
Very large size and predatory nature suggested extreme caution should be taken relative to possible introductions. Massive ecological alterations caused by introductions in African lakes supported this concern. Although considered by Texas, Florida, and Australia (where introduction of African species was examined), all ultimately recommended against local releases. Cold tolerance studies by biologists from Florida and Texas indicated potential for successful survival in certain power plant reservoirs.

**Similar Species:**
Nile perches would most likely be confused with sand perches, snooks and related species.

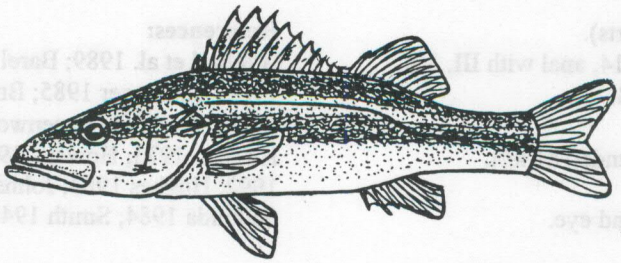
- Nile perches (*Lates* and *Luciolates*):
  - Deep-bodied or elongated.
  - Preopercle with a single edge, serrated below.
  - Scales ctenoid.
  - Size medium to very large.
  - Maxillary may or may not extend beyond eye.
  - Anal spines three; second and third longer than first, but not exceedingly long.
  - Spiny and soft dorsal fins connected or separated.
  - Caudal fin rounded or flat (truncated); lateral line not extending into caudal fin.
- Snooks (*Centropomus*):
  - Deep-bodied or elongated.
  - Preopercle with a double edge and serrated with one to five heavy teeth.
  - Scales ctenoid.
  - Size medium to large (20 inches/508 mm to nearly 5 feet/1.5 m and over 50 pounds/23 kg).
  - Maxillary does not extend beyond the eye.
  - Second and third anal spines very long (see figure).
  - Spiny and soft dorsal fins separated.
  - Caudal fin forked; lateral line extends through caudal fin and onto an extension at the center of the fork.
- Glassfishes (*Chanda* and related species)
  - All relatively deep bodied.
  - Preopercle with a double edge and fine serration.
  - Scales cycloid.
  - Size small (usually less than 8 inches/203 mm, typically about 1 inch/25 mm).
  - Maxillary does not extend beyond eye.
  - Second and third anal spines longer than first but not exceedingly long.
  - Spiny and soft dorsal fins connected.
  - Caudal fin forked, but without lateral line or central caudal ray extensions.
  - Coloration often relatively transparent, often extremely transparent except for silvery visceral cavity.
- Sand perch *Psammoperca* spp. (very similar to *Lates*)
  - Smaller (to 13.8 inches/350 mm).
  - Patch of teeth on the tongue (absent in Nile perches).
  - Dorsal fins VII+I, 12-15, with scaly sheath.
  - Anal fin III, 9-13, with scaly sheath.
  - Lateral line scales 45-50.
  - Gill rakers 11-13.
  - Jaw extends to below the center of the eye.
  - Eye is 25-33% HL (and equal to snout length).
  - Coloration brownish-grey above and yellowish below.
  - Found from India to China and Australia.
  - Species include *P. vaigiensis* and *P. macroptera*.
- Sawedged perch *Niphon spinosus*
  - More elongated than *Lates*.
  - Definite long, pointed preopercular spines (not present in Nile perches).

Snook *Centropomus undecimalis*

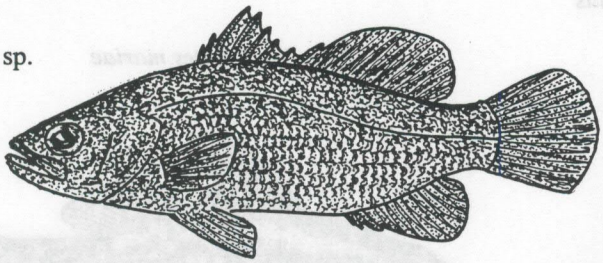


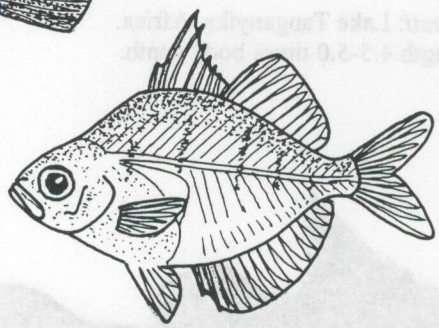
Large-scale Fat Snook *Centropomus mexicanus*

Sawedged Perch
*Niphon spinosus*



Sand Perch
*Psammoperca* sp.





Glassfish
*Chanda* sp.

**Technical Note:**
Species of *Lates* and *Luciolates*:

- ***Lates*:** deep-bodied; spiny and soft dorsal fins joined.

*Lates calcarifer*: Australia to southern and eastern Asia.
Very large (to 580 pounds).
Caudal fin rounded.
Maxillary extends past eye.
Dorsal VII-VIII+I, 10-12.
Lateral line scales (50) 52-61.
Gill rakers 16-17 (lower arch).
*L. japonicus* from Japanese waters is sometimes considered a distinct species based on different relative lengths of dorsal and anal spines, pectoral ray counts and gill raker counts (2+1+6-7).

*Lates microlepis*: Lake Tanganyika, Africa.
Smaller (to about 20 pounds).
Caudal fin crescent or concave edged.
Maxillary extends to mid-eye.
Gill rakers 12-15.
Interorbital width 5.5-7.5 times in head length (HL).
Eye small, 3.6-6.4 times in HL.

*Lates mariae*: Lake Tanganyika, Africa.
Small (to about 1 pound).
Caudal fin rounded.
Maxillary extends to mid-eye.
Dorsal fins VII+I+I, 11-13.
Lateral line scales 95-120.
Gill rakers 9-10.
Interorbital width 7-10 times in HL.
Eye very large, 3.1-4.8 times in HL.

*Lates angustifrons*: Lake Tanganyika, Africa.
Small (to about 10 pounds).
Caudal fin rounded.
Maxillary extends to mid-eye.
Dorsal fins VII+I, 12-13.
Lateral line scales 88-99.
Gill rakers 5-8.
Interorbital width 7-10 times in HL.
Eye medium sized, 2.2-6.8 times in HL.

*Lates niloticus*: Widely distributed in Africa including Nile, Senegal, Niger, and Congo rivers and lakes Albert and Rudolf (introduced in lakes Victoria and Kyoga); the *albertianus/ macrophthalamus* forms from Lake Albert and the *rudolfianus/longispinis* forms from Lake Rudolf may represent subspecies of *L. niloticus* (or unique species

according to some experts).
Dorsal VII-VIII+II, 10-14, anal with III, 8-9.
Lateral line scales 63-73.
Gill rakers 16-17.
Large (to about 400 pounds/181 kg).
Caudal fin rounded.
Maxillary extends beyond eye.
Eye size variable.

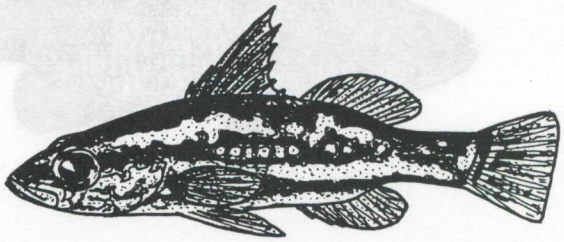
● ***Luciolates***: elongated; spiny and soft dorsal fins widely separated.

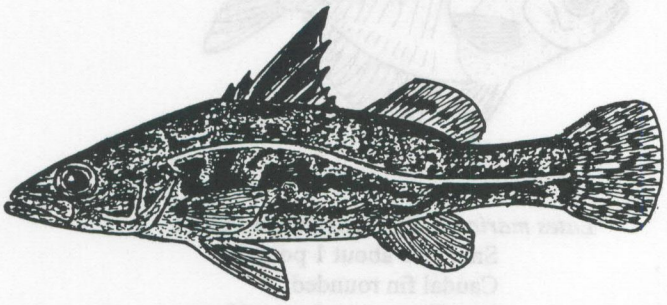
*Luciolates brevior*: Lake Tanganyika, Africa.
Body length 4.0 times body depth.

*Luciolates stappersii*: Lake Tanganyika, Africa.
Body length 4.5-5.0 times body depth.

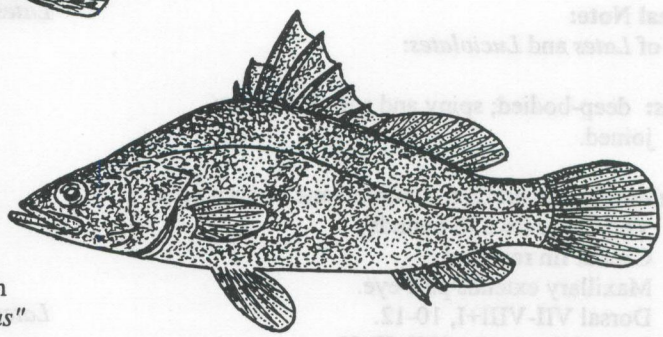
**References:**
Axelrod et al. 1989; Barel et al. 1985; Barlow and Lisle 1987; Boulenger 1985; Brichard 1978; Courtenay et al. 1984; Gee 1966; Greenwood 1966; Hashem and Hussein 1973; Howells 1992; Howells and Garrett 1992; Hughes 1983; Johnson 1983; Merrick and Schmida 1984; Smith 1945; Thompson et al. 1977.

Bigeye Nile Perch *Lates mariae*
juvenile

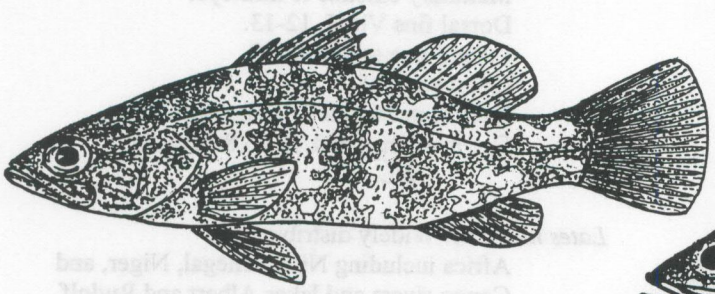


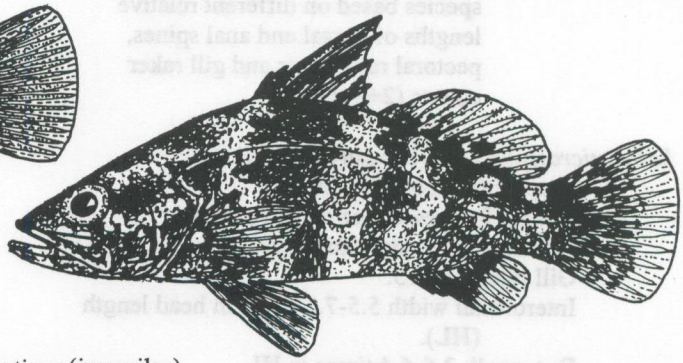


Tanganyikan Nile Perch
*Lates angustifrons*



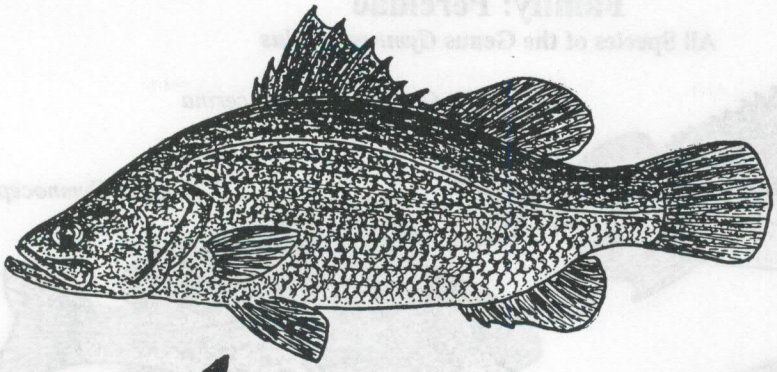
Lake Albert Nile Perch
*Lates "macrophthalmus"*

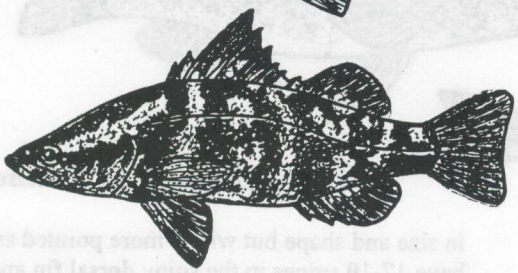




Nile Perch *Lates niloticus* (juveniles)

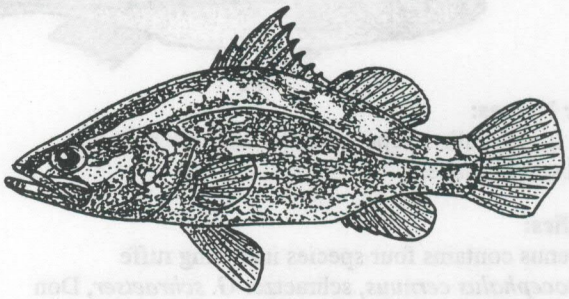
Japanese Barramundi
*Lates japonica*

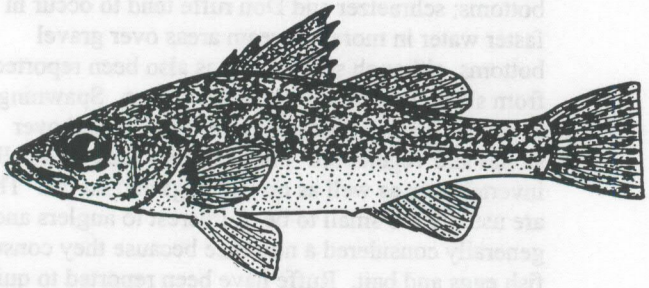




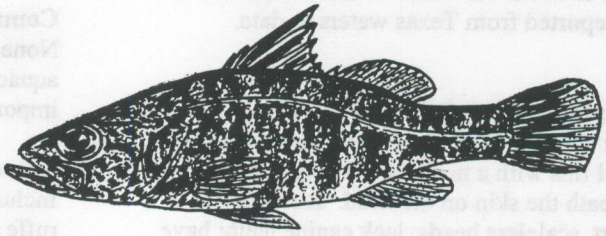
juvenile

Barramundi
*Lates calcifer*





Forktail Nile Perch
*Lates microlepis*

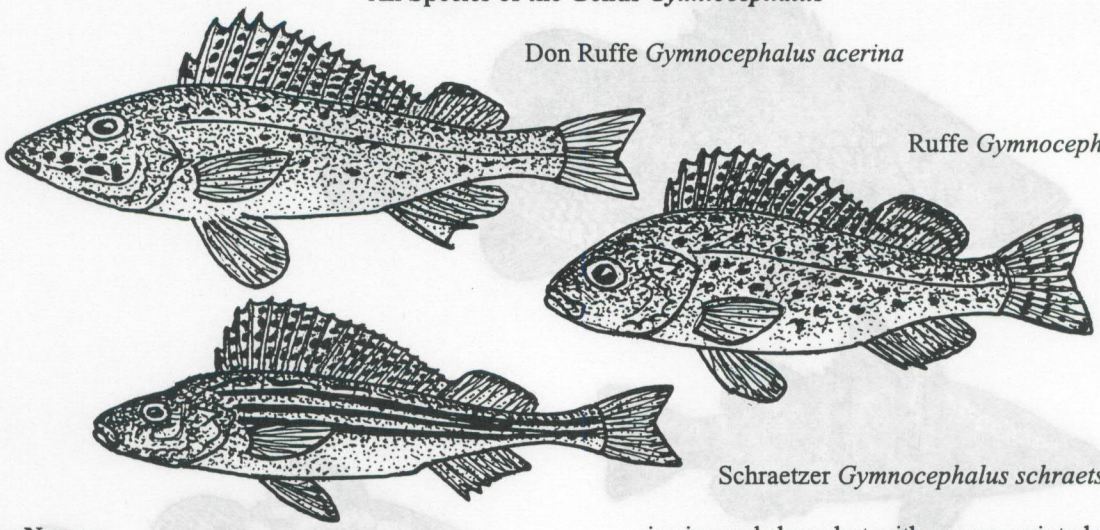


Tanganyikan Nile Perch
*Lates angustifrons*

# RUFFES and SCHRAETZERS

## Family: Percidae

**All Species of the Genus *Gymnocephalus***



Don Ruffe *Gymnocephalus acerina*

Ruffe *Gymnocephalus cernuus*

Schraetzer *Gymnocephalus schraetser*

**Other Names:**
Ruffe is also called pope and ruff. Schraetzer is also called stirped ruffe.

**Specifics:**
The genus contains four species including ruffe *Gymnocephalus cernuus*, schraetzer *G. schraetser*, Don ruffe *G. acerina*, and Danube ruffe *G. baloni*. Some sources list only three species.

**Range:**
Ruffe is the most widely distributed species in the genus, ranging throughout most of Europe and east across Siberia into Asia. Schraetzer occurs in the Danube and Kamchia basins of eastern Europe; Don ruffe is found in the northern tributaries of the Black Sea; Danube ruffe occurs in the Danube Basin. Ruffe was found in Lake Superior in 1987; it apparently entered the Great Lakes through ballast-water discharges from ocean-going ships. There are concerns that ruffe may increase in abundance and distribution within the Great Lakes, but thus far it has remained within a range of about 200 miles in Lake Superior. It has not been reported from Texas waters to date.

**Description:**
Gymnocephalids are generally similar to yellow perches *Perca* spp. but have clearly connected spiny and soft dorsal fins with a notch in between, and have large pits beneath the skin on the head. Ruffe have relatively short, scaleless heads; lack canine teeth; have 11-16 spines in the spiny dorsal fin, and two spines and 11-15 rays in the soft dorsal fin; coloration is mottled greenish-brown above and white below; size reaches nearly 12 inches (35 mm) but is usually 6-7 inches (152-178 mm) in length. Schraetzer is similar to ruffe in size and shape but with a more pointed snout; they have 17-19 spines in the spiny dorsal fin and 12-14 rays in the soft dorsal fin; coloration is brownish above and white below but with several interrupted horizontal dark stripes. The remaining species are similar.

**Biology:**
Ruffe and and Danube ruffe occur in slow-moving waters in the lower reaches of rivers, often over sandy bottoms; schraetzer and Don ruffe tend to occur in faster water in more upstream areas over gravel bottoms, although schraetzer has also been reported from slow-flowing, deeper delta waters. Spawning occurs in spring when adhesive eggs are laid over stones and vegetation. These species feed on small invertebrates as well as on fish eggs and larvae. They are usually too small to be of interest to anglers and are generally considered a nuisance because they consume fish eggs and bait. Ruffe have been reported to quickly dominate yellow perch *P. fluviatilis* populations in Europe and reduce whitefish *Coregonus* spp. populations in Russia.

**Commercial Importance:**
None of the gymnocephalids are of interest to either aquaculturists or the pet trade. None are of commercial importance at present even within their native ranges.

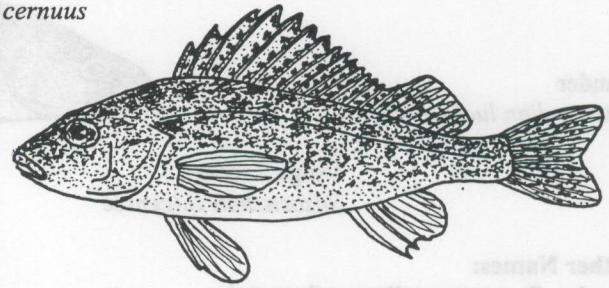
**Reasons For Restriction:**
Inclusion of these species reflected the establishment of ruffe in the Great Lakes and potential competition with native species, as well as predation on eggs and larvae. Negative impacts on other fish populations have already been reported from introductions in Europe and Russia.

**Similar Species:**
Gynmocephalids most closely resemble yellow perch *P. flavescens*, but have strongly connected spiny and soft dorsal fins and pits on the head. Other perches including yellow perch, pike-perches *Stizostedion* spp., European zingel *Zingel* (*Aspro*) *zingel* and streber *Z. streber*, and American darters and logperches (several genera) typically have separate or nearly separate dorsal fins; most are far more elongated in body shape. Yellow perches have vertical bars on a yellow background rather than the mottling or horizontal stripes seen in gymnocephalids. American sunfishes *Lepomis* spp. are usually substantially deeper bodied.

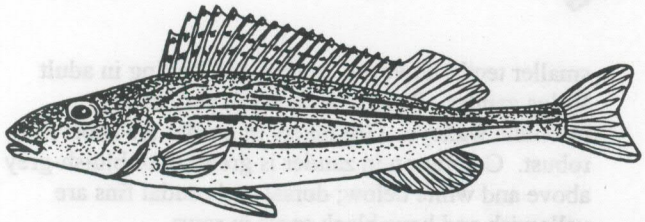
**Technical Note:**
Personnel with the U.S. Fish and Wildlife Service suspect that ruffe in Lake Superior may be kept in the vicinity of a warm-water river near the site of introduction by the extremely cold waters of Lake Superior; however, it is also suspected that additional introductions to other waters via ship ballast or bait bucket may be only a matter of time.

**References:**
Berg 1949b; Blanc et al. 1971; Frank 1971; Muus 1967; Sterba 1967.

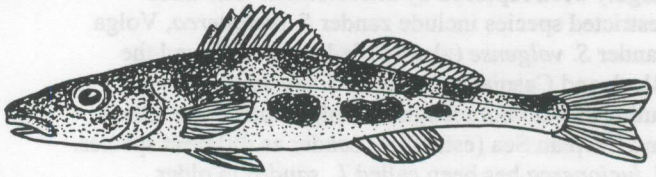
Ruffe *Gymnocephalus cernuus*



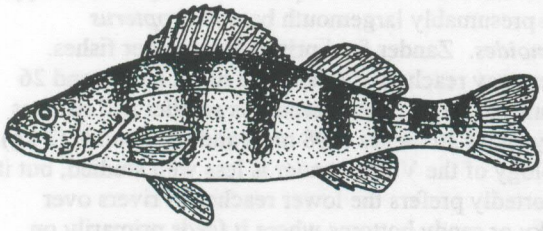
Schraetzer *Gymnocephalus schraetser*

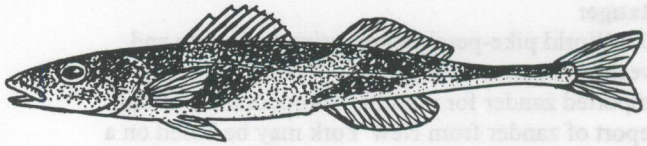


Zingle *Zingle zingle*

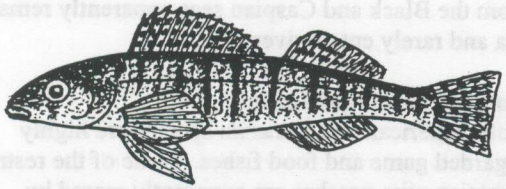


Yellow Perch *Perca flavescens*





Streber *Zingle streber*

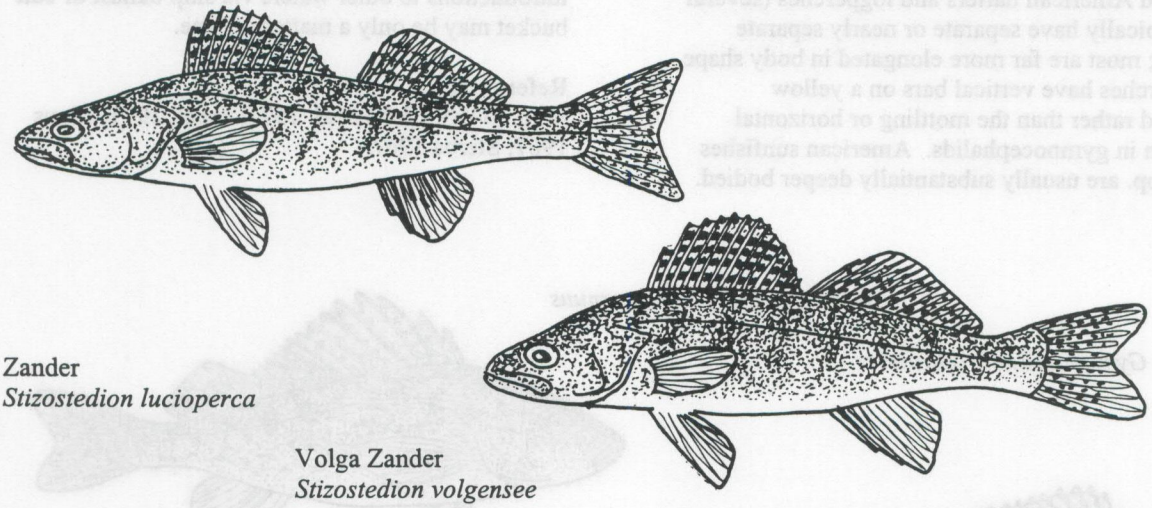


Logperch *Percina* sp.

# OLD WORLD PIKE-PERCHES

## Family: Percidae

**All Species of the Genus *Stizostedion* (*Lucioperca*) except *S. vitreum* and *S. canadense***



Zander
*Stizostedion lucioperca*

Volga Zander
*Stizostedion volgensee*

**Other Names:**
Zander, European walleye, pike-perch.

**Specifics:**
This family includes the American (two species) and European (three species) pike-perches in the subfamily Luciopercinae, as well as American and European yellow perches *Perca* spp. and American darters (e.g., *Etheostoma* spp.) in the subfamily Percinae. The genus *Lucioperca* applied to zander in older literature has largely been replaced by *Stizostedion*. The three restricted species include zander *S. lucioperca*, Volga zander *S. volgense* (also spelled *volgensis*), and the Black and Caspian sea zander *S. marinum*. Some authorities do not recognize Volga zander and Black and Caspian Sea (estuarine) zander as different species. *S. lucioperca* has been called *L. sandra* in older literature. Old listings of *L. grisea* are probably invalid references to walleye *S. vitreum*.

**Range:**
Old World pike-perches are native to Europe and western Eurasia. Biologists in North Dakota have imported zander for possible introduction. An old report of zander from New York may be based on a questionable identification. Only *S. lucioperca* has been imported to date; the remaining two species would not be expected in U.S. waters at this time.

**Description:**
Zanders have slender bodies, both spiny and soft dorsal fins, anteriorly-positioned pelvic fins, forked caudal fins and mouths with several large fangs and many smaller teeth; however, canines are lacking in adult Volga zander. Zander, in general, very closely resemble walleye. Gill rakers in zander are short and robust. Coloration in zander is greenish to bluish-grey above and white below; dorsal and caudal fins are yellowish and have black spots in rows.

**Biology:**
Zander prefers warmer, more turbid waters than do walleye or sauger *S. canadense*, and spawns at warmer temperatures. Zander nest and guard their eggs (males) unlike American *Stizostedion* spp. which scatter eggs and do not guard them. They generally avoid vegetated areas and hence limit competition with pike *Esox* spp., and presumably largemouth bass *Micropterus salmoides*. Zander feed primarily on other fishes. They may reach over 4 feet (1.2 m) in length and 26 pounds (12 kg). Volga zander is smaller and reaches only about 20 inches (508 mm) and 4.5 pounds (2 kg). Biology of the Volga zander is less well studied, but it reportedly prefers the lower reaches of rivers over rocky or sandy bottoms where it feeds primarily on small fish, crustaceans and insect larvae. The species from the Black and Caspian seas apparently remains at sea and rarely enters rivers.

**Commercial Importance:**
Both American and Eurasian species are highly regarded game and food fishes. None of the restricted Eurasian pike-perches are apparently reared by American aquaculturists at the present time, and only state biologists in North Dakota currently have zander under study.

**Reasons For Restriction:**
Although fishery scientists in North Dakota do not believe zander would seriously compete or hybridize with walleye and sauger, and other literature suggests limited competition with pikes (and probably largemouth bass), other American biologists have reacted negatively to its importation for study. Zander is at the very least a large, piscivorous and predatory species which could compete with some native game and commercial fishes.

**Similar Species:**
Zanders are most likely to be confused with walleye and sauger.

- Head: more streamlined in zander, less so in walleye (apparently less streamlined in Volga zander).
- Peduncle: deeper and more robust in zander than in walleye.
- Gill rakers: short and robust on both edges of the gill arch in zander; slender and elongated on the outer edge of the gill arch in walleye.
- Body coloration: greenish or bluish-grey with a white or bluish white belly in zander and Volga zander; olive-brown to yellowish background color with a milky- or yellowish-white belly in walleye; both may show an indistinct dark vertical bar pattern (sauger has larger dark blotches on the body). Black Sea zander reportedly has 10-12 dark bars; however, one published illustration shows no bars.
- Spiny dorsal fin pigmentation: horizontal rows of definite black spots and no dark webbing between the last three dorsal spines in zander and Volga zander; walleye spiny dorsal largely without spots except for dark webbing between the last three spines, if spots are present then obscure and ill-defined (sauger spiny dorsal similar to zander). The spiny dorsal in Black Sea zander is reportedly blackish.
- Sexual dimorphism: male zander darker than female; no significant distinction in walleye or sauger.
- Caudal fin coloration: lower lobe of walleye tail with white; not white in zander, Volga zander or sauger (or probably in Black Sea zander).
- Lateral line scales are 75-150 in zander, 83-104 in walleye, 79-87 in sauger, 70-83 in Volga zander, and 78-84 in Black Sea zander.
- Anal spine and ray counts in Volga zander (II, 9-10) differ from zander (II-III, 11-13), walleye (II, 11-14), sauger (II, 6-8), and Black Sea zander (II, 11-12).

**Technical Notes:**

(1) Blue pike or blue walleye *S. v. glaucum* from Lake Erie which was more slender and more bluish-grey in color than walleye has been recognized as extinct, and should not present an identification problem.

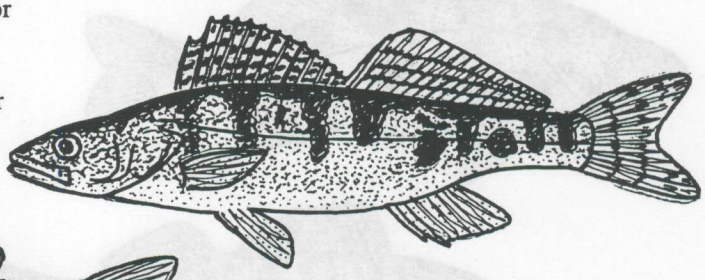
(2) Another European percid, the ruffe *Gymnocephalus cernuus*, has recently become established in the Great Lakes (presumably through ship-ballast introduction). Its small size (less than 10 inches), lack of fang-like teeth, and well connected spiny and soft dorsal fins readily distinguish it from pike-perches.

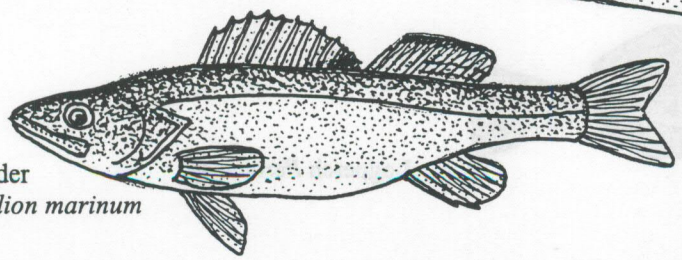
(3) In Texas, sauger is rare and would only be expected in the Red River, including the tailrace below Lake Texoma, where it occurs naturally, and in Belton Reservoir, Bell County, where it was stocked in 1985.

(4) In the 1990s, TPWD began experimental stocking of saugeye (walley x sauger hybrids) in selected reservoirs around the state (Gordon, Kirby, Langsford Creek, Live Oak City, and Sulphur Springs reservoirs). It should only be encountered locally at these specific sites and is morphologically intermediate between walleye and sauger.

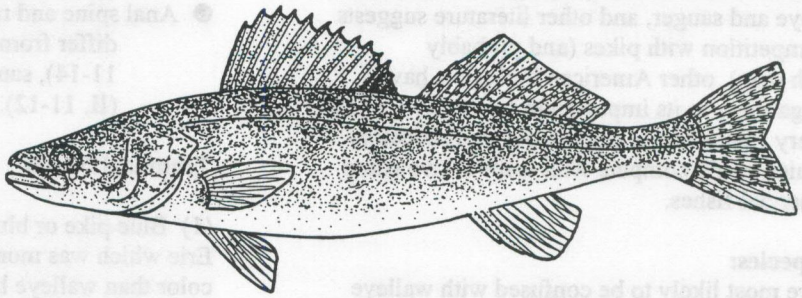
**References:**
Berg 1949b; Blanc et al. 1971; Boulenger 1895; Collette and Banarescu 1977; Eddy 1969; Frank 1971; Marshall 1977; Muus 1967; North Dakota Game and Fish Department (undated); Ragan and Steinwand (undated); Scott and Crossman 1973.

Volga Zander *Stizostedion volgense*

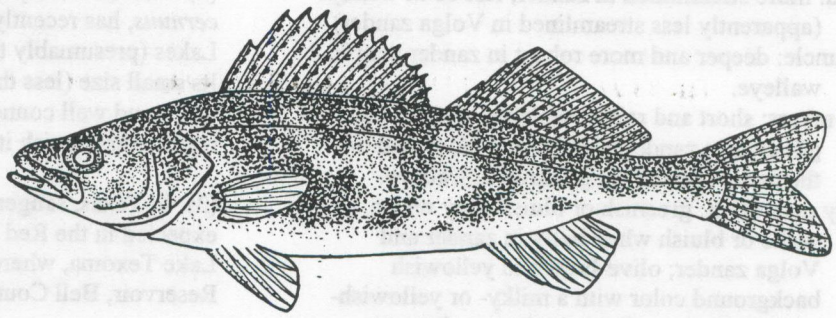




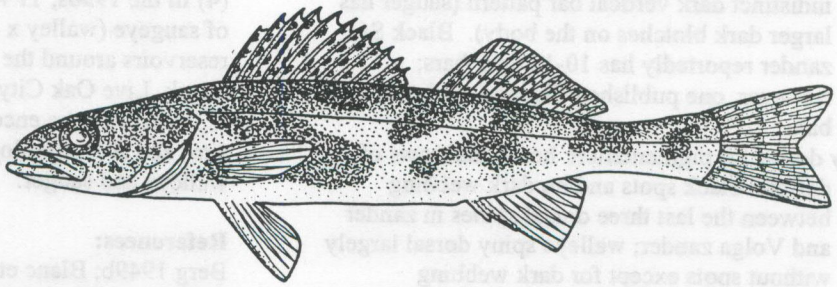
Sea Zander
*Stizostedion marinum*



Walleye *Stizostedion vitreum*

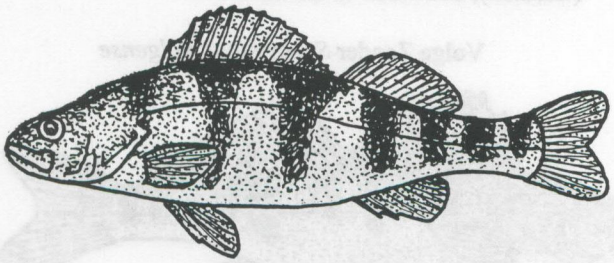


Saugeye
(walleye x sauger hybrid)

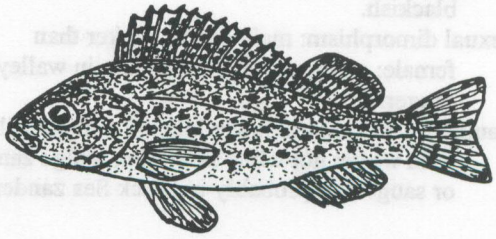


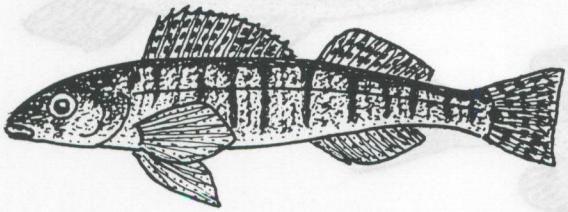
Sauger *Stizostedion canadense*

Yellow Perch *Perca flavescens*



Ruffe *Gymnocephalus cernuus*



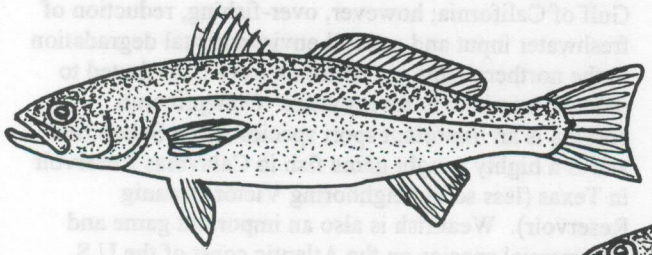


Logperch *Percina* sp.

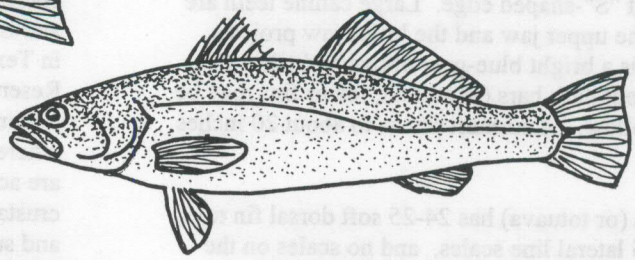
# SEATROUTS AND CORVINAS

## Family: Sciaenidae

**All Species of the Genus *Cynoscion*, except *C. nebulosus*, *C. nothus*, and *C. arenarius***



Weakfish
*Cynoscion regalis*



Shortfin Corvina
*Cynoscion parvipinnis*

**Other Names:**
Fishes in the genus *Cynoscion* are collectively known as seatrouts. Weakfish *C. regalis* is also known as seatrout, trout, squeteague, and grey squeteague. Orangemouth corvina *C. xanthulus* and shortfin corvina *C. parvipinnis* are sometimes called simply corvinas. Spotted seatrout *C. nebulosus* is also called speckled seatrout or simply speck. Sand seatrout *C. arenarius* is also know as sand trout or white trout, and silver seatrout *C. nothus* has been called bastard trout and silver squeteague.

**Specifics:**
The genus contains numerous species in U.S. and Mexican waters, and others along coastal Central and South America (in both the Atlantic and Pacific). Three species are native to Texas waters. Some authorities have indicated that sand seatrout may only be a subspecies of weakfish; others disagree. The American Fisheries Society moved *C. nobilis* to the genus *Atractoscion* in 1980; however, because taxonomic differences between these genera are minor, it is discussed here with other seatrouts.

**Range:**
Spotted seatrout and silver seatrout occur in coastal Atlantic waters both along the East Coast and Gulf of Mexico. Weakfish is found from Nova Scotia to Florida, and into the Gulf of Mexico, but has not been reported in Texas waters. Prohibited species include those from the Atlantic and Pacific coasts of Central and South America. Orangemouth corvina ranges from Acapulco to the northern Gulf of California. It has been introduced and established in the Salton Sea in California, with additional introductions in Victor Braunig and Calaveras reservoirs, Bexar County, Texas. A hybrid corvina (orangemouth corvina x spotted seatrout) was produced in the laboratory and stocked into Calaveras Reservoir as well. Shortfin corvina is found in the Pacific Ocean from Mazatlan, Mexico, to Santa Barbara, including the Gulf of California; it was introduced into the Salton Sea in the 1950's but did not become established. Totoava *C. macdonaldi* occurs in the Gulf of California.

**Description:**
Seatrouts have elongated bodies that are not compressed much from side to side, and do not have high backs as seen in some other sciaenids (except somewhat in *C. praedatorius*). They have relatively large mouths and sharp teeth, including canine teeth in the upper jaw. They have elongated second dorsal fins typical of the family. Most seatrouts are silvery-brown, blue or olive above and silvery to white below. Soft dorsal and anal fins may or may not be scaled. The shape of the posterior margin of the caudal fin varies and is often useful in identification; however, shape may vary with age.

Four species occuring in or in close proximity to U.S. waters include:

- Orangemouth corvina has 8-9 spines in the first dorsal fin, 1 spine and 19-21 rays in the second dorsal fin; 1-2 spines and 7-9 rays in the anal fin; about 86 lateral line scales; total gill rakers of 3-4+9-10; and a caudal fin where the center-most rays are longest. Canine teeth are present in the upper jaw (roof of the

mouth) and the lower jaw projects. Coloration is tan above and silvery below with yellow inside the mouth and on throat in larger adults; fins are dusky and the caudal fin may show a yellow tint. Maximum size is about 3 feet (0.9 kg) and 32 pounds (15 kg).

- Shortfin corvina has 9-11 spines in the first dorsal fin, 1 spine and 20-24 rays in the second dorsal fin; 2 spines and 9-11 rays in the anal fin; slightly fewer lateral line scales than orangemouth corvina; total gill rakers of 2-4+7-8; unscaled soft dorsal and anal fins; and the caudal fin may be slightly indented or often with a slight "S"-shaped edge. Large canine teeth are present in the upper jaw and the lower jaw projects. Coloration is a bright blue-grey above and silvery below without dark bars (in adults); lower fins may be tinged in yellow. Maximum size is to about 20 inches (508 mm).

- Totoaba (or totuava) has 24-25 soft dorsal fin rays, less than 85 lateral line scales, and no scales on the second dorsal or anal fins. The caudal fin shape is rhomboid (i.e., diamond-shaped with the central rays longest). Coloration is silvery with a coppery tinge, and yellow inside the mouth. Maximum size may reach 6 feet (1.8 m) and 225 pounds (102 kg). This species is included on the Federal Endangered Species List.

- Weakfish has dorsal fin counts of 9-ll spines, and 2 spines and 24-29 rays; anal fin counts of 1-2 spines and 7-9 rays; a lateral line scale count of 76-86; a total gill raker count of 4-5+10-12; and the second dorsal fin and anal fin scaled. The caudal fin is slightly forked or crescent-shaped (concave) in adults. Coloration is dark olive- or blue-grey on the back and silvery-grey below with small, dark spots in forward angling rows on the upper part of the body; fins may be tinged with yellow. Maximum size about 3 feet (0.9 m) and over 17 pounds (7.7 kg).

Other Central and South American species (if all are valid) which often closely resemble native U.S. seatrouts include:

- *C. analis*-Pacific South America.
- *C. altipinnis*-Pacific South America.
- *C. othonopterus*-Gulf of California.
- *C. squamipinnis*-Pacific Central America.
- *C. virescens*-Atlantic South America.
- *C. leiarchus*-Atlantic South America.
- *C. phoxocephalus*-Pacific South America.
- *C. reticulatus*-Pacific Central America.
- *C. jamaicensis*-West Indies.
- *C. striatus*-Atlantic South America.
- *C. stolzmanni*-Pacific South America.
- *C. albus*-Pacific South America.
- *C. acoupa*-Atlantic South America.
- *C. praedatorius*-Pacific Central America.
- *C. microlepidotus*-Atlantic South America.
- *C. bairdi*-Atlantic South America.
- *C. steindachneri*-Atlantic South America.

**Biology:**
Orangemouth and shortfin corvinas and totoava have been important game and commercial food fish in the Gulf of California; however, over-fishing, reduction of freshwater input and general environmental degradation in the northern Gulf of California have contributed to reduced numbers in recent years. Orangemouth corvina is an important sport species in the Salton Sea and is a highly sought game fish in Calaveras Reservoir in Texas (less so in neighboring Victor Braunig Reservoir). Weakfish is also an important game and commercial species on the Atlantic coast of the U.S. where is coexists with spotted and silver seatrouts. All are active predators that prey on small fishes and crustaceans. Many seatrouts move inshore in spring and summer to spawn there. Orangemouth corvina in the Salton Sea complete their entire life cycle within the sea; introduced populations in the two freshwater reservoirs in Texas have apparently not spawned. Detailed studies of the biology of many of the Central and South American species are largely lacking.

**Orangemouth corvina culture studies and introductions in Texas:** Orangemouth corvina were originally obtained by TPWD research biologists from the Salton Sea in 1981 and several times thereafter to be studied as a potential predator on rough fishes, including introduced blue tilapia *Tilapia aurea*, in certain Texas reservoirs. Prior to the development of captive spawning techniques for orangemouth corvina, a hybrid between female spotted seatrout and male orangemouth corvina was developed; later, techniques for spawning corvina were refined and the reciprocal hybrid was produced. It was also determined that orangemouth corvina and both hybrids were more freshwater tolerant but less cold tolerant than spotted seatrout. Both hybrids and orangemouth corvina were stocked in Calaveras Reservoir, and orangemouth corvina was stocked in Victor Braunig Reservoir. Both reservoirs have little or no water outfall, and are fenced, guarded and have limited public access; uncontrolled escape was highly unlikely. Although culture techniques were ultimately developed, the cost of production was high and in conjunction with results of temperature and salinity tolerance studies, it was decided to terminate the program.

**Commercial Importance:**
Seatrouts are often considered game and commercial food fishes of some importance. None are of interest to the pet trade. None of the prohibited species are presently reared by aquaculturists in Texas.

**Reasons For Restriction:**
Although the reservoir introductions of orangemouth corvina and hybrid corvina in Texas were generally well received by anglers, stocked fish were generated from experimental culture research on the species. Because TPWD research determined that viable young could result from an orangemouth corvina x spotted seatrout cross, and further that both orangemouth corvina and the hybrid were less cold tolerant than was the native spotted seatrout, it seemed possible that if orangemouth corvina escaped into the Gulf of Mexico, they may compete with native seatrouts or may even produce hybrids less able to survive cold winters. Further, with culture methods being developed for spotted seatrout (in Texas), orangemouth corvina (in Texas and California) and weakfish (on the East Coast), the possibility of aquaculturists obtaining these fishes seemed increasingly likely. Restriction to protect native sciaenids before fish farmers invested time and money into culture of these non-native fishes seemed wise. Shortfin corvina and other Central and South American seatrouts have been little studied, but were included because of similarity to orangemouth corvina. Listing of totoava supports already existent federal endangered species regulations. Reasons for prohibiting weakfish which already coexists with spotted and silver seatrouts on the East Coast and which is known from the Gulf of Mexico are unknown.

**Similar Species:**
Spotted, silver and sand seatrouts most closely resemble restricted seatrouts and corvinas. True trouts, even those that run to sea, have only a single soft dorsal fin, no spines and have an adipose fin which differentiates them from seatrouts. Tail shapes often differ between seatrout species (see figures).

Native unrestricted seatrouts and restricted weakfish collectively have 24 to 29 (possibly to 31) soft dorsal fin rays while many restricted species have less than 24 soft dorsal fin rays including:

- *C. xanthulus* (19-21),
- *C. phoxocephalus* (20-22),
- *C. analis* (23),
- *C. stolzmanni* (19-21),
- *C. altipinnis* (22-23),
- *C. albus* (19-22),
- *C. squamipinnis* (21-22),
- *C. praedatorius* (18-22),
- *C. leiarchus* (20-22),
- *C. acoupa* (18-22),
- *C. parvipinnis* (20-24), and
- *C. steindachneri* (18-22).

** *C. parvipinnis* also has unscaled fins (scaled in weakfish and in silver and sand seatrout) and lacks spots on fins and body (spots present in spotted seatrout).

Several other restricted species have soft dorsal fin ray counts within the 24 to 29 (31) range including:

- *C. virescens* (29-31),
- *C. reticulatus* (25-28),
- *C. jamaicensis* (23-25),
- *C. macdonaldi* (25-27),
- *C. bairdi* (23-30),
- *C. microlepidotus* (23-30), and
- *C. regalis* (24-29)

Lateral line scale counts in *C. virescens* of 120-130 serve to differentiate it from unrestricted species in which the maximum lateral line count of 102 is seen in spotted seatrout. The soft dorsal fin in *C. reticulatus* is scaled only at the base (otherwise unscaled) while soft dorsal fins are scaled in unrestricted species except spotted seatrout (which has black spots rather than a reticulated pattern of streaks). *C. jamaicensis* is generally similar to weakfish but is brownish with dusky spots (rather than olive-grey to blue-grey). Totoava has a coppery-colored tint (not seen in unrestricted seatrouts), a diamond-shaped caudal fin (otherwise in unrestricted species, except in juveniles), and grows far larger than any unrestricted seatrout). Weakfish has more lateral line scales (76-86) than silver or sand seatrouts (68-69 and about 60, respecitvely) and fewer than spotted seatrout (90-102). In addition, *C. praedatorius* has an apparently highly arched back atypical of others in the genus. Both *C. bairdi* and *C. steindachneri* have diamond-shaped tails. A description of *C. striatus* is unavailable at this writing.

**Unrestricted Seatrout Descriptions:**

- Spotted seatrout:
  Dorsal fin counts 9-11 spines, and 1 spine and 24-28 rays.
  Anal fin counts 2 spines and 9-12 rays.
  Soft dorsal and anal fins unscaled.
  Lateral line scales 90-102.
  Soft dorsal and anal fins scaleless (scaled in weakfish, scaleless in corvina).
  Gill rakers 6-9 on the lower limb.
  Body and fins with definite black spots.
  Size exceeds 4 feet (1.2 m) and about 16 pounds (7.2 kg).

- Silver seatrout:
  Dorsal fin counts 10 spines, and 1 spine and 27-29 (31) rays.
  Anal fin counts 2 spines and 8-10 rays.
  Soft dorsal and anal fins scaled.
  Lateral line scales given as 55-58 and 68-69.
  Scales firmly set, not deciduous.
  Gill rakers 3-4+8-10.
  Soft dorsal and anal fins scaled.

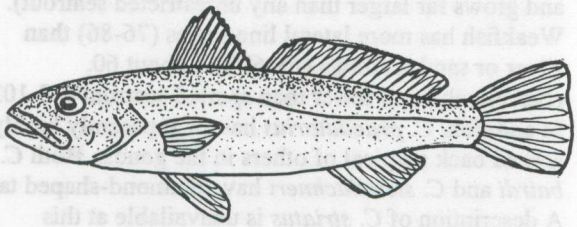
Body uniformly silver.
Reaches about 1 foot (305 mm) in length.

- Sand seatrout:
  Dorsal fin counts 10 spines, and 1 spine and 25-27 rays.
  Anal fin counts 2 spines and 11 rays.
  Soft dorsal and anal fins scaled.
  Lateral line scale count about 60.
  Scales are deciduous and easily dislodged.
  Gill rakers 13-14 total.
  Body color yellowish above and silvery below, sometimes with indistinct spots; snout, and lower jaw dark.
  Reaches about 16 inches (406 mm) in length.

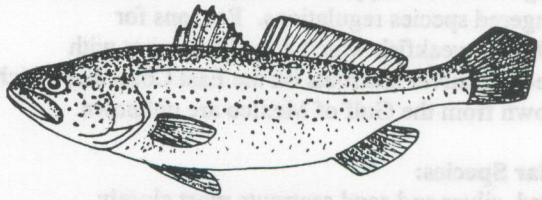
**Note:** The shape of the rear caudal margin in sand seatrout has been shown somewhat differently (truncated, sigmoid, concave, etc.) in almost every published illustration of the species; 6- to 7-inch TL specimens collected by the TPWD staff have a spade- or diamond-shaped caudal fin with the center rays being the longest; the caudal fin apparently becomes less pointed in larger specimens.

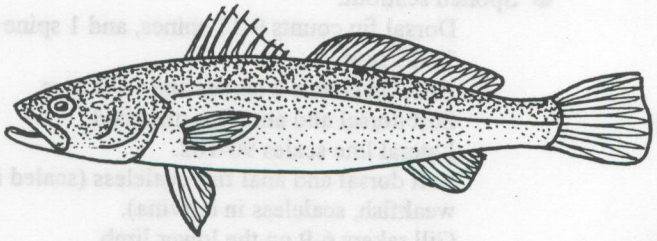
**Note:** A new record sand seatrout taken March 1992 was electrophoretically identified by TPWD. It was 26.18 inches 665 mm) TL and 8.01 lbs (3.6 kg) with D. VII+III, 20; A. I, 10; 51 pored lateral line scales; 8 scale rows above and 12 scale rows below the lateral line; lacked dorsal and anal fin scales (lost during handling?); and was unmarked silver in color. Its caudal fin was off-set spade-shaped with the longest rays 5, 6, and 7th from the dorsal edge just above the center (see figure below).

Sand Seatrout *Cynoscion arenarius*

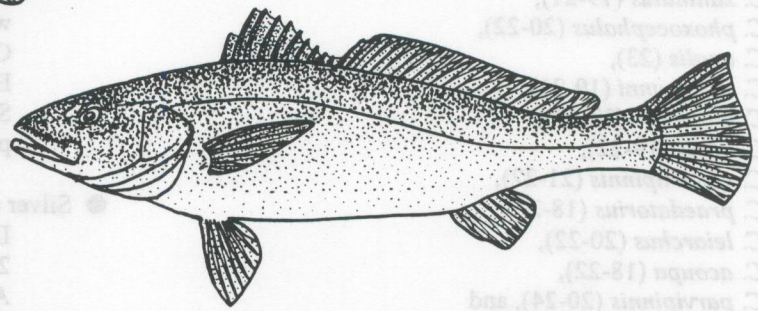


Sand Seatrout *Cynoscion arenarius*
(Record 8.01 lbs specimen)





Silver Seatrout
*Cynoscion nothus*

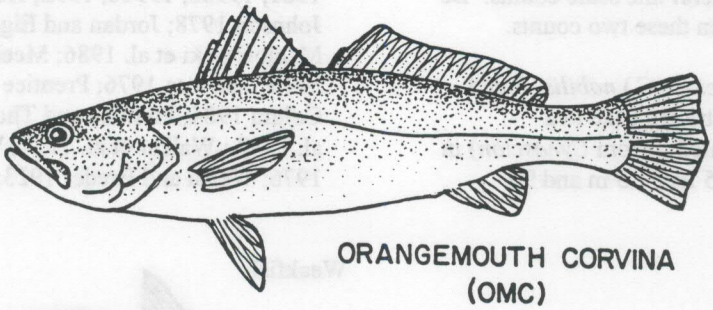


Totoaba
*Cynoscion macdonaldi*

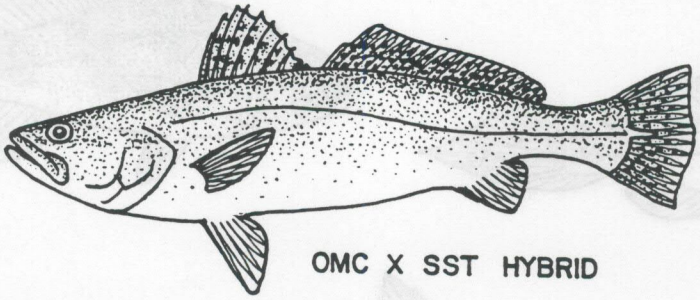
- **Hybrid corvina (Calaveras Reservoir, Texas, only):**

Hybrid corvina (i.e., orangemouth corvina x spotted seatrout) is now restricted; however, most hybrids originally stocked by TPWD have already been harvested by anglers and at the present time nearly all corvinas being taken are orangemouth corvina (few hybrids remain).

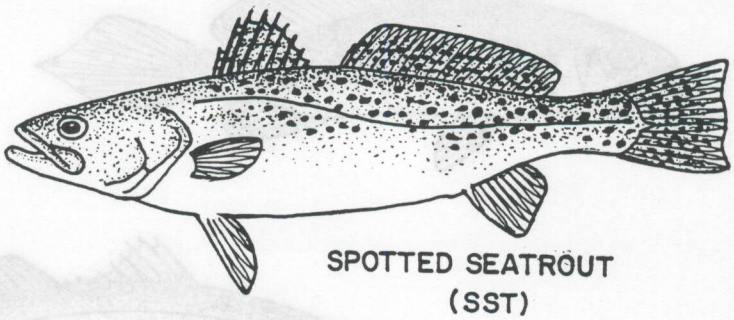
- Dorsal and caudal fin color:
  - Orangemouth corvina - unspotted.
  - Hybrid corvina - spotted (sometimes faint).
  - Spotted seatrout - spotted.
- Body spots:
  - Orangemouth corvina - unspotted.
  - Hybrid corvina - unspotted.
  - Spotted seatrout - spotted (variable).
- Dorsal fin rays:
  - Orangemouth corvina - 19-21.
  - Hybrid corvina - 21-23.
  - Spotted seatrout - 24-28.
- Anal fin rays:
  - Orangemouth corvina - 7-9.
  - Hybrid corvina - 9-11.
  - Spotted seatrout - 9-12.



ORANGEMOUTH CORVINA
(OMC)



OMC X SST HYBRID



SPOTTED SEATROUT
(SST)

**Technical Notes:**

(1) Most juvenile sciaenids have diamond-shaped caudal fins where the center rays are often longest. However, this form may be retained in adults of some species, but lost in adults in other species. Be cautious using tail shape to distinguish species in smaller specimens.

(2) Most larval and juvenile sciaenids have patterns of blotches or bars. Some larger juveniles may retain suggestions of these patterns longer than others.

(3) Lateral line scales can sometimes be difficult to count in seatrouts due to combinations of large and small scales, some of which may be offset. Further, the number of lateral line pores is sometimes given in place of or in addition to actual lateral line scale counts. Be careful to distinguish between these two counts.

(4) White sea bass *Atractoscion* (*C.*) *nobilis*, found from Alaska to Baja is unrestricted (due to a reclassification which separated it from *Cynoscion*) in Texas despite its large size (5 feet/1.5 m and 90 pounds/41 kg), and can be legally possessed, transported, cultured or sold. Characteristics include: dorsal fin count 9-10 spines, and 1 spine and 19-23 rays; anal fin count 1-2 spines and 8-10 rays; color blue-grey above and silvery below; lateral line scales 85-150 (more than in other sciaenids); soft dorsal and anal fins not scaled; canine teeth are small or absent in adults (usually present in other sciaenids); and gill rakers 5+11-13.

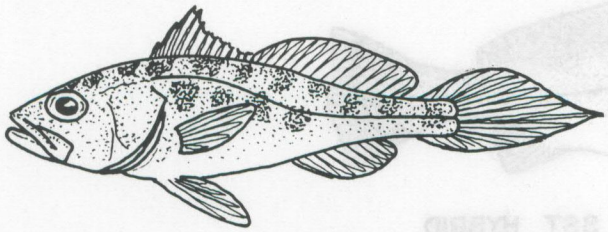
**Note:** The present validity of some species is unclear, and except for orangemouth corvina, no other seatrouts appear to have been imported alive into Texas.

**References:**

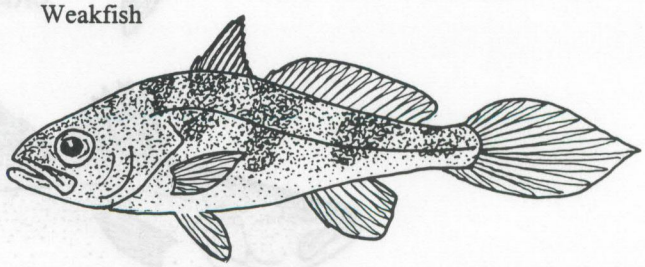
Flanagan and Hendrickson 1976; Hardy 1978b; Hildebrand 1946; Hildebrand and Cable 1934; Howells 1981, 1990b, 1991b, 1992; Howells and Garrett 1992; Johnson 1978; Jordan and Eigenmann 1886; Maciorowski et al. 1986; Meek and Hildebrand 1925; Miller and Lea 1976; Prentice 1985; Prentice and Colura 1984; Prentice and Thomas 1987; Procarione et al. 1988.; Walker et al. 1961; Weinstein and Yeager 1976; Welsh and Breder 1923; Whitney 1961.

SEATROUT JUVENILES

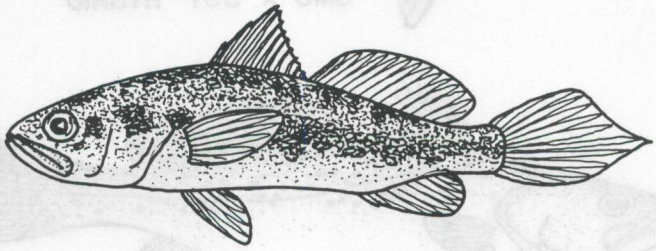
Silver Seatrout

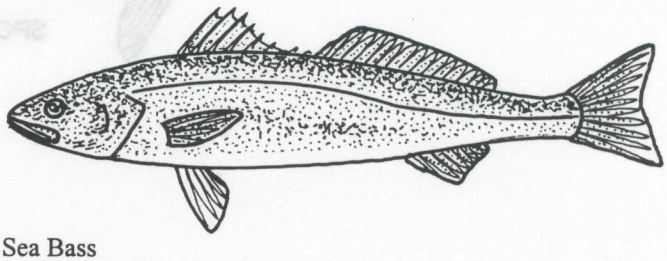


Weakfish



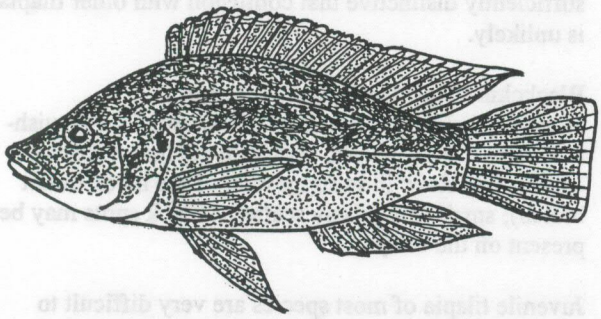
Spotted Seatrout



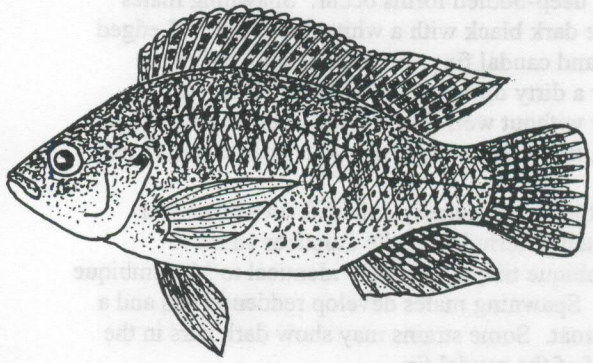


White Sea Bass
*Atractoscion* (*C.*) *nobilis*

# Tilapia
## Family: Cichlidae
**All Species of *Tilapia* = *Sarotherodon* = *Oreochromis***



Mozambique Tilapia *Tilapia* (*O.*) *mossambica*



Blue Tilapia *Tilapia* (*O.*) *aurea*

**Other Names:**
Tilapia-perch, Nile perch.

**Specifics:**
There are about 70 species of Tilapine cichlids known as tilapias. Although TPWD and the American Fisheries Society consider all species under the single genus *Tilapia*, other experts (including aquaculturists, aquarists and many foreign fishery scientists) follow a revision in classification which has broken the group into four genera: *Tilapia, Sarotherodon, Oreochromis,* and *Danakilia.*

**Note:** The generic names used for various tilapias can cause problems where different genera are used by different individuals to refer to the same species. Spawning method is reflected in the multiple genus approach where:

- *Tilapia* = substrate spawners (redbellied tilapia *T. zilli*, hornet tilapia *T. buttikoferi*, and spotted tilapia *T. mariae*),
- *Sarotherodon* = biparental mouthbrooders (blackchin tilapia *T. melanotheron* and Galilee tilapia *T. galilaea*),
- *Oreochromis* = maternal mouthbrooders (Mozambique tilapia *T. mossambica*, Wami tilapia *T. urolepis hornorum,* blue tilapia *T. aurea*, and Nile tilapia *T. nilotica*), and
- *Danakilia* = a single, poorly known species from Ethiopia (Lake Afrera tilapia *T. franchetti*).

**Note:** When *Tilapia aurea* is replaced by *Oreochromis aureus* the spelling of the species changes.

**Range:**
Tilapia were originally distributed throughout Africa and into Syria and Israel; however, because of aquacultural, bait-bucket and pet-trade introductions, several species have become almost cosmopolitan in warm-water areas. Introductions in Texas came in 1956 when Mozambique tilapia escaped into the San Antonio River, in the 1960's when blue tilapia *T. aurea* appeared in Texas reservoirs and again in 1978 when redbelly tilapia was found in San Antonio River tributaries of the San Antonio Zoo. Presently, Mozambique and redbelly tilapia are restricted to waters within the San Antonio Zoo (or possibly downstream in summer), blue tilapia is widely distributed throughout the state, and populations of blue x Mozambique tilapia hybrids are present in the San Marcos River and Canyon and Gibbons Creek reservoirs.

**Description:**
Tilapia are generally similar to American sunfishes *Lepomis* spp. They usually have 12-18 dorsal fin spines and typically 3 (very rarely 4-6) anal fin spines. Gill rakers number 9-18, often with 9-12 among the substrate spawning species (with exceptions) and 14 or more among the maternal mouthbrooding species. Mature males of some species, like Mozambique tilapia and Wami tilapia, develop extremely enlarged jaws; others like blue and redbelly tilapia do not. Most juveniles have a series of dark vertical bars and a dark spot or ocellus in the soft dorsal fin. Wild-type coloration is generally a silvery- or olive-grey in many species. A variety of domestic color variations have been developed including; white, yellow, red, bronze,

gold and mottled; these were probably developed in Mozambique tilapia (possibly in blue tilapia as well) but have been bred into hybrids with blue tilapia, Nile tilapia, and Wami tilapia. Examples of species most frequently seen in the U.S. include:

Mozambique tilapia is often more elongated than other tilapia; deep-bodied forms occur. Spawning males become dark black with a white throat and red-edged dorsal and caudal fins. Females and juveniles are usually a dirty olive-tan with darker blotches, but usually without well-defined bars seen in other tilapia. Rarely, this species may have four or five anal spines.

Wami tilapia, commonly called *T. hornorum* and previously referred to as the Zanzibar strain of Mozambique tilapia, is nearly identical to Mozambique tilapia. Spawning males develop reddened lips and a grey throat. Some strains may show dark bars in the top half of the caudal fin.

Blue tilapia is generally a silvery-grey and deep bodied.The dorsal and caudal fins are edged with red, and spawning males become blue-tinted but without red throats. Dark mottlings in some fins may suggest bars, but the caudal fin does not develop a series a fine but bold vertical bars like those in Nile tilapia. Juveniles have vertical bars on the body.

Nile tilapia is very similar to blue tilapia, and both species have been confused. Their dorsal fin is usually edged in black and the caudal fin has a series of thin, vertical black bars. Spawning males become more violet than blue, develop red throats and may show a red tint in the fins. A blue tilapia x Mozambique tilapia strain which has been imported from Israel into the Houston area has a black-barred tail similar to Nile tilapia, but has fewer and wider bars (electrophoretic analysis is needed for positive identification).

Redbellied tilapia often shows a series or dark bars over a yellow tint on the body. The throat and belly are red (boldest in spawning males), and some strains including the San Antonio population may also show black overlaying the red on the throat, belly and into the pelvic fins. Dorsal, caudal and anal fins may show spots or bars of bright blue-green and yellow. An ocellus (dark spot with a light edge) is usually present in the dorsal fin. Very small juveniles often show pearly edges on their scales (not usually seen in most other tilapia). Gill rakers are usually 8-10 (14 or more in other feral tilapia in Texas). Redbreast tilapia *T. rendalli*, Thallon's tilapia *T. thalloni*, and Guinea tilapia *T. guineensis* are nearly identical.

Hornet tilapia is boldly marked with black and yellowish-white vertical bars on the body and fins; these bars are retained into adulthood (unlike other tilapia that are strongly barred only as juveniles). They are generally deep bodied. Color pattern is so distinct that confusion with other tilapia is unlikely.

Spotted tilapia has a yellow-tinted body with seven or eight black lateral blotches; fins often have white spots and may have white edges. Color pattern is usually sufficiently distinctive that confusion with other tilapia is unlikely.

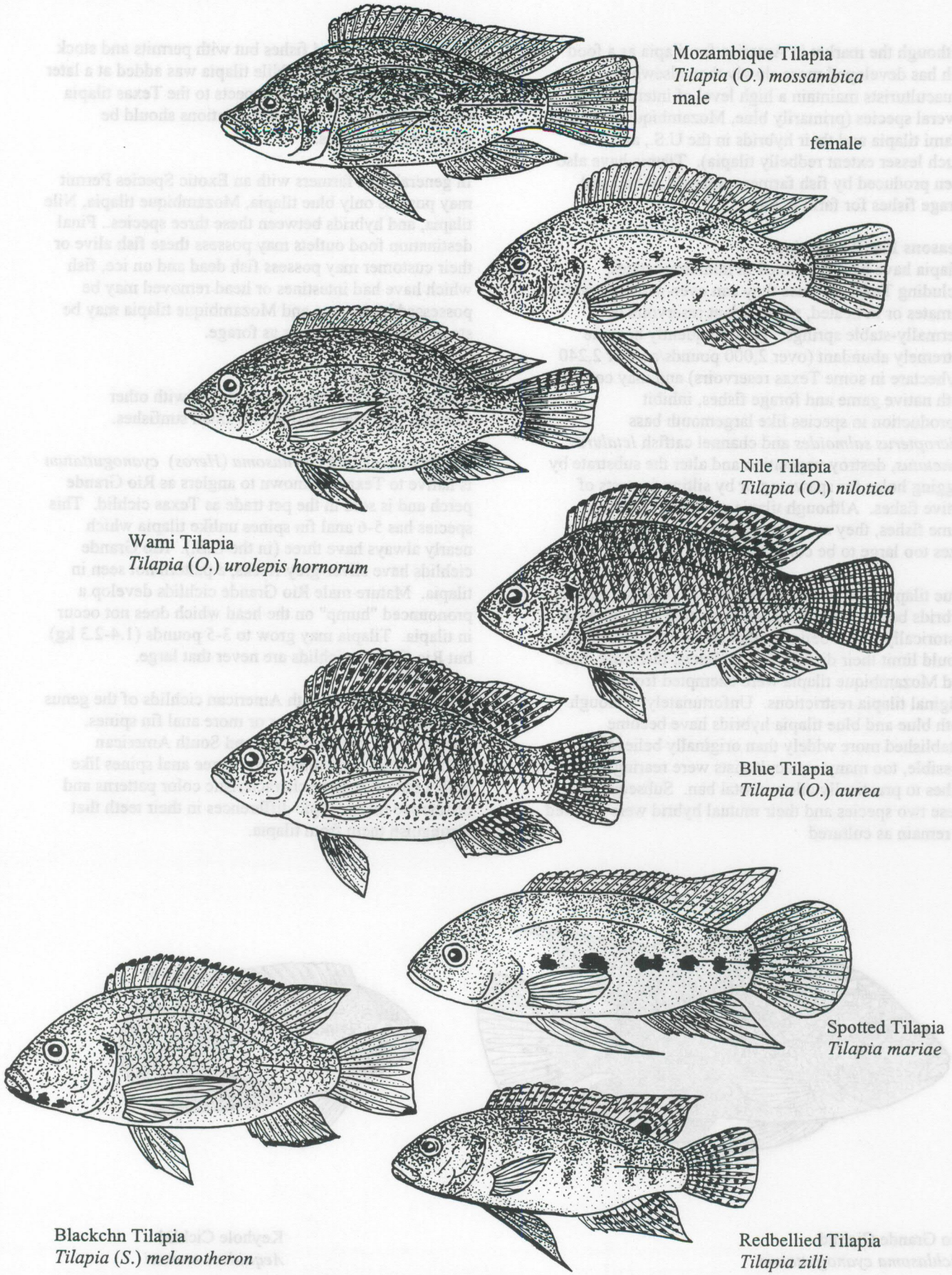
Blackchin tilapia (previously listed as *T. macrocephalus* and *T. heudelotii*) is usually a greyish-tan in color with a black blotch on the throat (some strains may show little suggestion of the black throat blotch); small, irregularly scattered black spots may be present on the body.

Juvenile tilapia of most species are very difficult to distinguish. Most species have 7-10 dark bars on a silvery-grey background, but can change color depending on mood, health, etc. The bar pattern is often lost by the time fish reach 1.2-3.1 inches (53-79 mm) long.

Unfortunately many tilapia species have become badly hybridized, especially among aquacultural specimens, including some native stocks in Africa. Identification of most species is difficult or impossible without resorting to electrophoretic analysis to confirm genetic identity.

**Biology:**
Tilapia are largely omnivorous; some species may consume large amounts of algae and other vegetation; many can be carnivorous and will consume small fishes. Many species are tolerant of low water quality, some tolerate cool waters down to or below 10°C and other species can live in brackish or sea waters. Tilapia may be either substrate spawners or mouthbrooders, and tend to reproduce rapidly. They often over-populate and create stunted populations.

**Commercial Importance:**
Although several species of tilapia were sold in the pet trade in the 1940's and 1950's, importation since the 1960's of smaller and more colorful African rift lake cichlids has largely displaced all but a few tilapia. Aquarists maintain interest in hornet and more rarely Tanganikan tilapia *T. tanganicae* and some of the domestic color morphs of Mozambique tilapia, but otherwise tilapia appear in the pet trade only when accidentally shipped. However, aquacultural production is of world-wide interest; tilapia compete with common carp *Cyprinus carpio* as the most commonly cultured food fish worldwide.


Mozambique Tilapia
*Tilapia* (*O.*) *mossambica*
male
female
Nile Tilapia
*Tilapia* (*O.*) *nilotica*
Wami Tilapia
*Tilapia* (*O.*) *urolepis hornorum*
Blue Tilapia
*Tilapia* (*O.*) *aurea*
Spotted Tilapia
*Tilapia mariae*
Blackchn Tilapia
*Tilapia* (*S.*) *melanotheron*
Redbellied Tilapia
*Tilapia zilli*

Although the market in America for tilapia as a food fish has developed more slowly than elsewhere, aquaculturists maintain a high level of interest in several species (primarily blue, Mozambique, Nile and Wami tilapia and their hybrids in the U.S., and to a much lesser extent redbelly tilapia). Tilapia have also been produced by fish farmers and sold as bait and forage fishes for farm ponds.

**Reasons For Restriction:**
Tilapia have been restricted in numerous states, including Texas because they can over-winter in warm climates or in heated, power-plant reservoirs or thermally-stable springs. They frequently become extremely abundant (over 2,000 pounds/acre or 2,240 kg/hectare in some Texas reservoirs) and may compete with native game and forage fishes, inhibit reproduction in species like largemouth bass *Micropterus salmoides* and channel catfish *Ictalurus punctatus*, destroy vegetation and alter the substrate by digging holes for spawning or by silting-in nests of native fishes. Although tilapia are eaten by native game fishes, they are very spiny and grow quickly to sizes too large to be consumed.

Blue tilapia, Mozambique tilapia, Nile tilapia, and the hybrids between the three are permitted only because historically it was believed that limited cold tolerance would limit their distribution in Texas; therefore, blue and Mozambique tilapia were exempted from the original tilapia restrictions. Unfortunately, although both blue and blue tilapia hybrids have become established more widely than originally believed possible, too many aquaculturists were rearing these fishes to practically allow a total ban. Subsequently, these two species and their mutual hybrid were allowed to remain as cultured

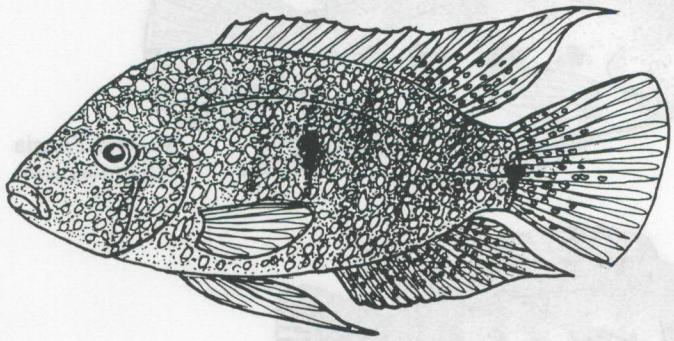
to remain as cultured fishes but with permits and stock identifications required. Nile tilapia was added at a later date. There are numerous aspects to the Texas tilapia restrictions and the current regulations should be consulted for details.

In general, fish farmers with an Exotic Species Permit may possess only blue tilapia, Mozambique tilapia, Nile tilapia, and hybrids between these three species.. Final destination food outlets may possess these fish alive or their customer may possess fish dead and on ice, fish which have had intestines or head removed may be possessed by anyone and Mozambique tilapia may be stocked in private waters as forage.

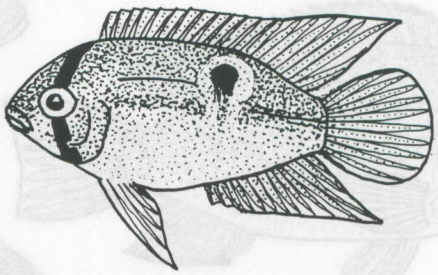
**Similar Species:**
Tilapia are most frequently confused with other cichlids, and occasionally with small sunfishes.

Rio Grande cichlid *Cichlasoma* (*Heros*) *cyanoguttatum* is native to Texas, is known to anglers as Rio Grande perch and is sold in the pet trade as Texas cichlid. This species has 5-6 anal fin spines unlike tilapia which nearly always have three (in the U.S.). Rio Grande cichlids have silver-grey flecks, a pattern not seen in tilapia. Mature male Rio Grande cichlids develop a pronounced "hump" on the head which does not occur in tilapia. Tilapia may grow to 3-5 pounds (1.4-2.3 kg) but Rio Grande cichlids are never that large.

Other Central and South American cichlids of the genus *Cichlasoma* also have four or more anal fin spines. Members of another Central and South American cichlid genus, *Aequidens*, have three anal spines like tilapia but often have characteristic color patterns and distinctive microscopic differences in their teeth that distinguish them from tilapia.



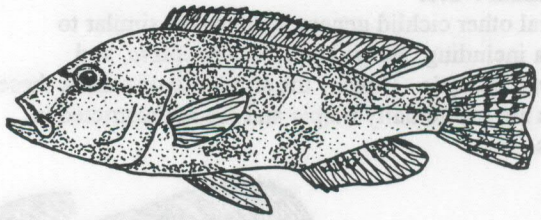
Rio Grande Cichlid
*Cichlasoma cyanoguttatum*

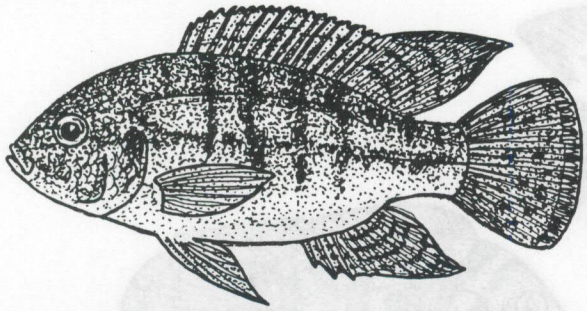


Keyhole Cichlid
*Aequidens maroni*

Very small tilapia and small sunfishes have caused identification problems in some field samples. Sunfishes usually have 9-11 dorsal fin spines while tilapia usually have 12 or more. Sunfishes often have lateral line scale counts over 40, with those in tilapia being about 27-35; lateral lines are complete in sunfishes and broken in tilapia. Further, the dusky spot seen in some (but not all) small sunfishes like bluegill *L. macrochirus* and green sunfish *L. cyanellus* is located posteriorly on the last few dorsal rays, but in tilapia is positioned anteriorly in the soft dorsal fin within the first 2-3 rays.

*Haplochromis livingstoni*

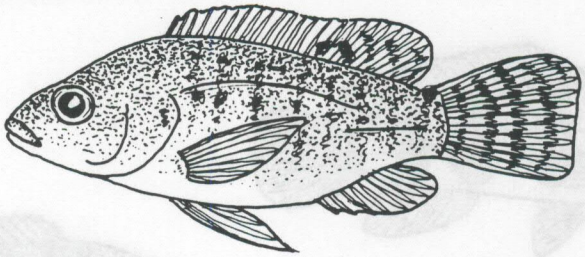


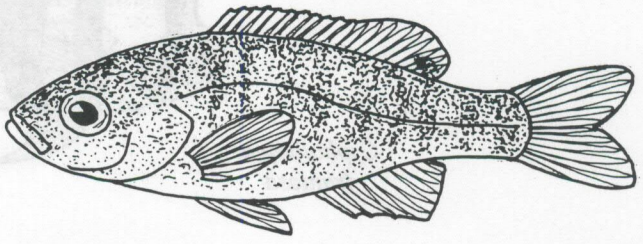


Banded Tilapia *Tilapia sparrmanii*

The African cichlids genus *Haplochromis*, which includes many species imported for the pet trade, unfortunately contains a number of species that could be confused with tilapia. Haplochromids usually have three anal fin spines like tilapia. However, most species of *Haplochromis* in the pet trade have more elongated bodies and larger mouths than are typical in tilapia; most also have distinctive color patterns that differ from those of tilapia. Their scales are usually ctenoid (ctenoid or cycloid in tilapia), their outer rows of teeth are usually bicuspid or conical (usually not conical in tilapia) and details of their skull and jaw bone structures differ from tilapia. Confusion between tilapia and haplochromids has not thus far been reported as a problem.

Juvenile Tilapia *Tilapia* sp.





Juvenile Sunfish *Lepomis* sp.

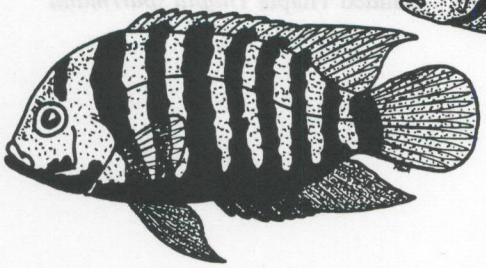
Hornet tilapia, often sold in the pet trade as "buttikoferi", have a black and white bar pattern that could be confused with several other unrestricted cichlid species (*Cichlasoma*, *Lamprologus,* and *Cyphotilapia*); however, the pattern of bars on the body and fins as illustrated below is generally characteristic among these species.

**Technical Note:**
Several other cichlid genera have names similar to tilapia including: *Herotilapia*, *Heterotilapia,* and *Chromidotilapia*. Despite the similarity of names, these fishes are not actually tilapia and are not restricted in Texas.

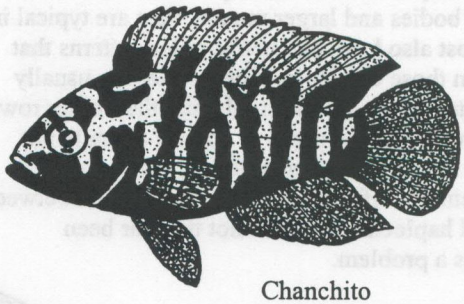
**References:**
Axelrod and Burgess 1978; Axelrod and Schultz 1971; Axelrod et al. 1976, 1989; Balon 1974; Behrends et al. 1982; Brown 1961; Courtenay et al. 1984; Courtenay and Robins 1973; Dupree and Huner 1984; Garcia Pinto 1982; Germany and Noble 1977; Gilliland 1983; Goldstein 1973; Hauser et al. 1976; Hendricks and Noble 1979; Howells 1985, 1991a, 1992; Hubbs 1977; Konings 1989; Lee 1979; Lee et al. 1980; Meek 1904; Muoneke 1989; Noakes and Balon 1984; Noble et al. 1978; Pullin 1984; Pullin and Lowe-McConnell 1984; Shafland and Pestrak 1981, 1982, 1983; Skinner 1987; Stauffer et al. 1988; Trewavas 1965, 1982, 1983, 1984.

Hornet Tilapia
*Tilapia buttkoferi*

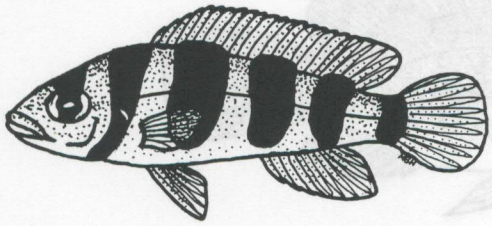
Convict Cichlid
*Cichlasoma nigrofasciatum*



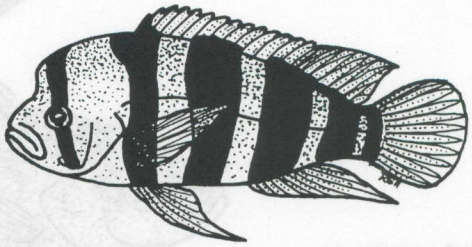
Blue-eyed Cichlid
*Cichlasoma spilurum*



Chanchito
*Cichlasoma facetum*



*Lamprologus tretocephalus*

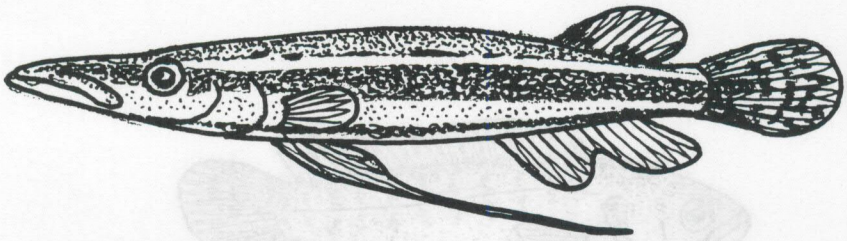


*Cyphotilapia frontosa*

# ASIAN PIKEHEAD

## Family: Luciocephalus

**All Species**



Asian Pikehead *Luciocephalus pulcher*

**Other Names:**
None.

**Specifics:**
The family contains a single species, *Luciocephalus pulcher.*

**Range:**
The pikehead is native to Malaysia, Sumatra and Borneo.

**Description:**
Pikehead has an elongated, slender body and a head with a large, protractile mouth. The dorsal fin is set far back on the body, the anal fin has a deep notch, the caudal fin is rounded, and pelvic fins have long, thread-like extensions. Maximum size is 7-8 inches (178-203 mm) in length. Coloration is yellowish-or reddish-brown with horizontal dark and light stripes; prominent rows of spots are sometime present above these stripes.

**Biology:**
The natural history of pikehead is poorly known; however, it generally seems to occupy and ecological niche similar to American pickerel *Esox* spp. It is predatory on other fishes and small aquatic invertebrates including insects. It is reportedly found in quite, vegetated waters or in flowing streams where it drifts awaiting the approach of prey. Reproductive biology is largely unknown. It is extremely difficult to maintain for extended periods in captivity and would likely be in greater demand in the pet trade if more readily available and longer lived.

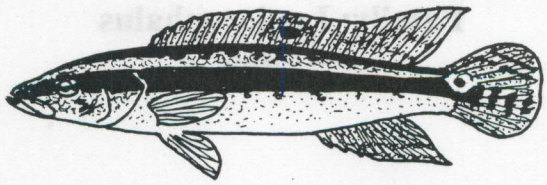
**Commercial Importance:**
Pikeheads are occasionally available in the pet trade, but are never common.

**Reasons For Restriction:**
Its predatory habits, which are similar to pike killifish *Belonesox belizanus* and some of the pike characoids (e.g., *Acestrorhynchus*, *Ctenolucius*, *Phago*, etc.), and limited understanding of its biology led to concern about unrestricted importation and possible introductions.

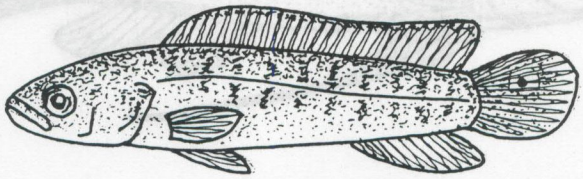
**Similar Species:**
Pikehead is probably sufficiently unique in appearance that confusion with other species seems unlikely. See descriptions under pike characoids, pike killifish, pike cichlids *Crenichichla* and *Batrachops*, and snakeheads (Channidae) for comparison to other elongated pike-like predators.

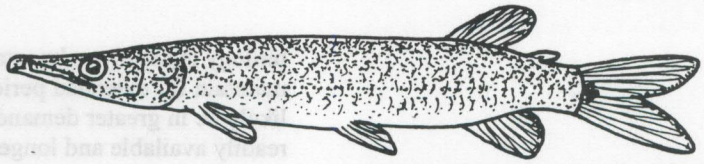
**References:**
Axelrod et al. 1976, 1989; Frank 1971; Smith 1945; Sterba 1967.

Pike Cichlid
*Crenicichla dorsocellata*



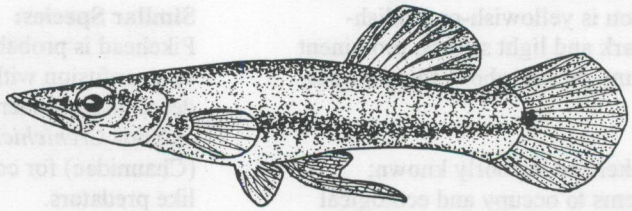
Pike Cichlid
*Batrachops semifasciatus*



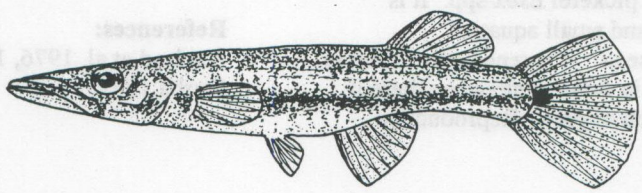


Gar Characin
*Ctenolucius hujeta*

Snakehead
*Ophiocephalus pleurophthalmus*



Pike Killifish
*Belonesox belizanus*

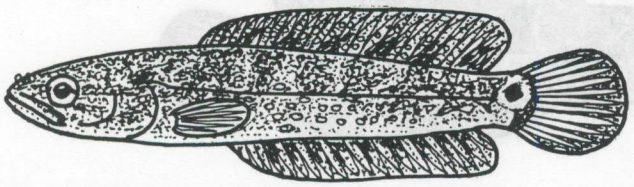


# SNAKEHEADS

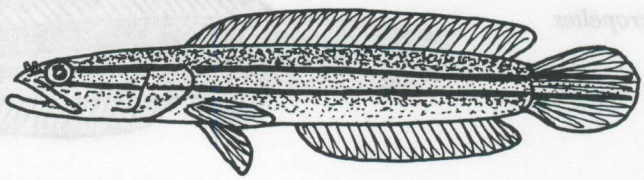
## Family: Channidae

### All Species

Snakehead
*Channa asiatica*



Snakehead
*Ophiocephalus micropeltes*



**Other Names:**
None.

**Specifics:**
Family (sometimes listed as Family Ophiocephalidae) contains two genera including *Channa* with one species and *Ophiocephalus* with about 10 species.

**Range:**
Snakeheads are native to Africa and southern Asia.

**Description:**
Snakeheads have elongated bodies with long dorsal and anal fins (both lacking fin spines). Pelvic fins are lacking in *Channa*, but present in *Ophiocephalus*. They possess an accessory breathing organ. Scales may be either ctenoid or cycloid. Nostrils are typically tube-shaped. Size may range from 6-7 inches (152-178 mm) in small species to nearly 4 feet (1.2 m) in larger forms. Coloration varies between species and between juveniles and adults. Some species have longitudinal stripes, others vertical bars or blotches; some possess eye-spots on dorsal or caudal fins.

**Biology:**
Snakeheads can survive long periods out of water and can burrow into mud and sediments to endure drought. Some less tropical species likely have resistance to cold temperatures as well. Ability to cross dry land to other water bodies has been reported for some species. All are very aggressive predators, and may destroy other fishes in waters they inhabit.

**Commercial Importance:**
Although not produced in American aquaculture, they are reared in other parts of the world. Snakeheads have occasionally been stocked in numbers in ponds containing other cultured fishes to prevent excess reproduction and stunting. A number of species have been available in the pet trade, with red snakehead *Ophiocephalus micropeltes* juveniles being sold relatively frequently in recent years.

**Reasons For Restriction:**
Their aggressive and predatory nature, coupled with an extreme tenacity to life, resulted in early restriction.

**Similar Species:**
Snakeheads are probably most commonly confused with bowfin *Amia calva* or pike cichlids *Crenicichla* and *Batrachops*.

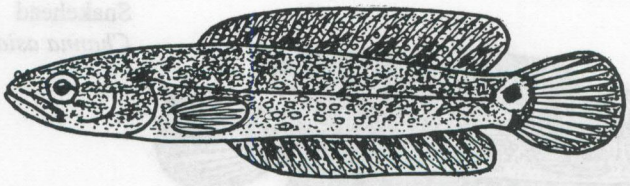
- Bowfin: has a shorter anal fin and bony gular plate on the throat (not found in snakeheads).
- Pike cichlids: have spines in both dorsal and anal fins (not found in snakeheads).

**Technical Note:**
The genera *Channa* and *Ophiocephalus* are used interchangeably on occasion.

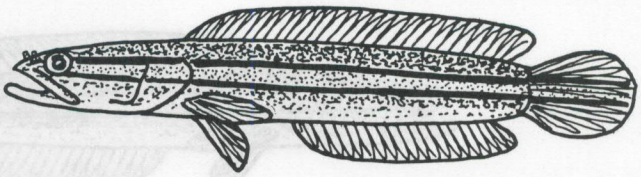
**Referenes:**
Axelrod et al. 1976, 1989; Frank 1971; Nichols 1943; Smith 1945; Sterba 1967.

SNAKEHEADS

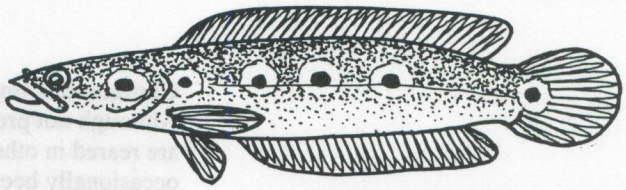
*Channa asiatica*



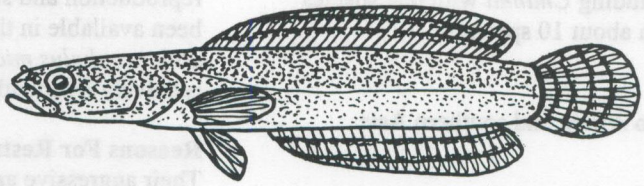
*Ophiocephalus micropeltes*



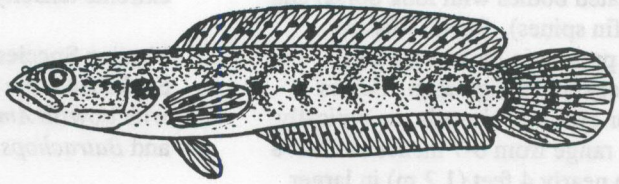
*Ophiocephalus pleurophthalmus*



*Ophiocephalus polylepis*



*Ophiocephalus africanus*



Bowfin
*Amia calva*