SPECIES ACCOUNTS: PROHIBITED SHELLFISHES

Definitions for Crustaceans

Areola - the central posterior portion of the carapace (cephalothorax).

Abdomen - the segmented "tail" consisting of the abdominal segments (called somites) and the telson.

Antennal flagellum - small, segmented, whip-like structure adjacent to the antenna (attached to the same base segment).

Antennal peduncle - the base segment of the antenna and flagellum.

Antennule - each of a pair of segmented, whip-like structures located closer to the body midline than the antennae and usually much shorter than the antennae.

Armed - with spines or tooth-like structures.

Branchia - gills or gill-like structures of the body or appendages.

Carapace - the cephalothorax or body (head and thorax in a single unit).

Carapace length - the straight-line distance from the posterior margin of the eye socket to the posterior edge of the carapace (does not include the rostrum) in lobsters, but is usually measured from the anterior tip of the rostrum to the posterior edge of the carapace in shrimps and crayfishes.

Carapace width - the widest straight-line distance across the carapace, including from point to point in crabs with laterally pointed shells.

Carina - a ridge.

Carpus - the fifth segment of an appendage (counting from the body outward).

Cephalothorax - the carapace.

Cervical sinus - depression or notch between the head- and thorax-portions of a cephalothorax.

Chela - the pincer formed by the two distal (outer most) segments of the major legs attached to the body.

Cornea - the faceted portion of the eye.

Coxa - the first segment of a typically seven-segmented appendage (counting from the body outward).

Dactyl - the movable finger-like segment of the chela or claw.

Denticles - small spines or tooth-like projections.

Endopod - the branch of a forked appendage segment nearest the body midline, often at the base of a swimmerette.

Exopod - the branch of a forked appendage segment positioned outward and not toward the body midline (see Endopod).

Mandible - jaws, positioned in front of or below other mouth parts.

Maxillipeds - three pairs of appendages posterior to the mouth parts.

Merus - the fourth segment of a typically seven-segmented appendage.

Pereopods (also spelled periopods or pereiopods) - the five pairs of segmented appendages attached to the cephalothorax (carapace).

Petasma - the male genital structure on the first pair of swimmerettes (pleopods) arising from the enlarged and joined endopods; presence and absence or positioning may assist in sex or species differentiation in shrimps.

Pleopods - swimmerettes; paired, segmented appendages associated with abdominal segments in shrimps, crayfishes and lobsters.

Pleura - lateral flaps on the first five abdominal segments.

Podobranchia - respiratory structures on the base segments of the first five abdominal segments.

Propodus - the major segment of the chela or claw.

Rostrum - the central, beak-like projection of the carapace between the eyes (usually only the portion projecting anterior to the carapace).

Somite - a body segment.

Sternite - the ventral part of a thoracic or abdominal

segment.

Sulcus - a groove.

Suture - line where two or more plates join.

Swimmerette - see pleopod.

Telson - the posterior-most segment of the abdomen; contains the anus in many species.

Tergum - the arched dorsal portion of the first five abdominal segments.

Thelycum - female genital structures (especially in shrimps) formed by the two posterior-most thoracic segments; structure is often important in speciesidentification.

Total length - the straight-line distance from the posterior edge of the eye socket (in lobsters) or the anterior tip of the rostrum (shrimps and crayfishes) to the posterior tip of the telson; TL.

Transverse suture - a line or groove running from ventral to dorsal surfaces, or from side to side (not length-wise along the body).

Uropod - paired appendages of the sixth abdominal segment which lie on either side of the telson, and with it form the tail fan.

Definitions for Snails

Aperture - the opening of the shell.

Apex - the narrow end of the shell which is formed first during development; apparent even in ramshorn-shaped shells.

Callus - a thickened area near the umbilicus.

Denticles - small tooth-like structures.

Dextral - a right-handed shell (aperture is on the right side when the shell is held with the apex up).

Keel - a raised ridge, often centrally located.

Narce - the pearly inner surface of the shell.

Pectin - comb-like spines or teeth.

Periostracum - the outer layer of the shell.

Shell base - the lower end of the shell, typically at the aperture and away from the apex.

Shell length - typically the greatest distance from the apex to the opposite end of the shell (adjacent to the aperture); sometimes measured in shell diameter (greatest distance across) in ramshorn-type snails.

Sinistral - a left-handed shell (aperture is on the left side when the shell is held with the apex up).

Spire - whorls near the apical tip (apex) of the shell.

Tooth - small raised portion of shell; tooth-like structure.

Umbilicus - the cavity or depression at the base of the shell along the central axis and around which the shell appears to coil; sometimes absent or filled.

Whorl - one spiral turn of the shell.

Definitions for Clams and Mussels

Alae - flared margins (wings) of bivalve shells.

Anterior end of the shell - the rounded end of the shell, typically nearest the beak and opposite the posterior end where the siphons protrude.

Beak - the umbone.

Bivalve - a pelecypod (family Pelecypoda or Bivalvia); also, having a shell with two parts or halves..

Cardinal teeth or true cardinal teeth - teeth on the hinge usually positioned below the umbo; often used in species like Asiatic clam and fingernail clams when lateral teeth occur both anterior and posterior to the cardinal teeth.

Dorsal side of the shell - typically where the shells hinge (except in mussels like Mytilidae).

Epidermis - the outer surface of the shells.

Fluting or fluted - channels or grooves on the shells.

Gape - the opening between the shells when in a closed position.

Hinge ligament - the flexible portion that connects the two shells.

Lateral teeth - ridges positioned along the upper margin of a shell, typically parallel to the hinge.

Narce - the pearly inner layer of the shells.

Posterior end of the shell - typically where the siphons protrude.

Pseudocardinal teeth - tooth-like structures on the anterior part of the hinge below the umbo; present in freshwater mussels of the family Unionidae; these structures have different embryonic origins than the true cardinal teeth seen in Asian clams (Corbiculidae) and fingernail clams (Sphaeriidae).

Shell length - the straight-line distance from the anterior to the posterior shell margin, often parallel to the hinge.

Shell width - the straight-line distance from the dorsal edge or the shell (at or near the hinge) to the ventral edge (opening).

Tubercles - knob-like projections on the shell.

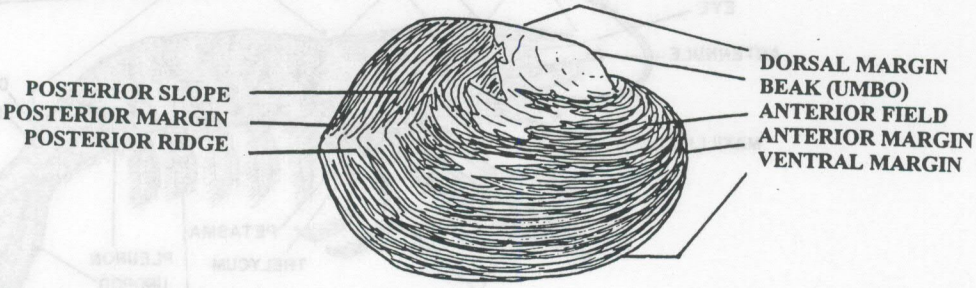
Umbone or umbo - the raised portion of the shell which forms a beak-like structure, typically adjacent to the hinge.

Valve - one of the two shells of a bivalve.

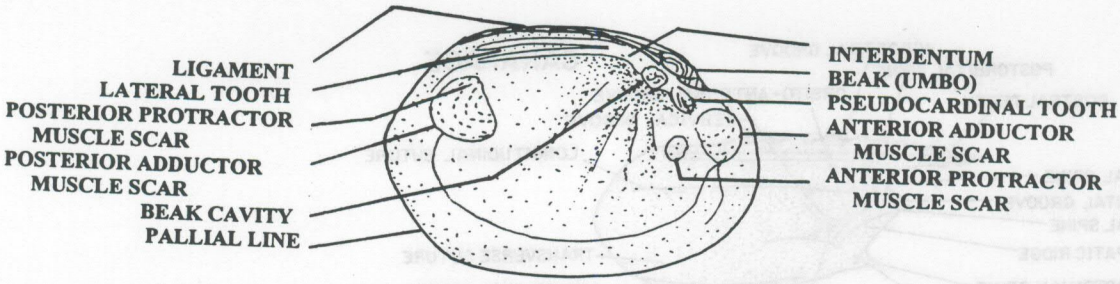
Ventral margin of the shell - typically where the shells open opposite the hinge.

NATIVE FRESHWATER MUSSELS (UNIONIDAE)

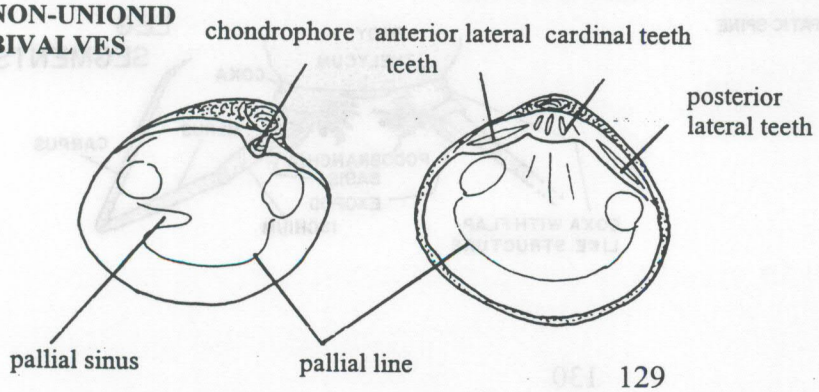
EXTERNAL SHELL FEATURES



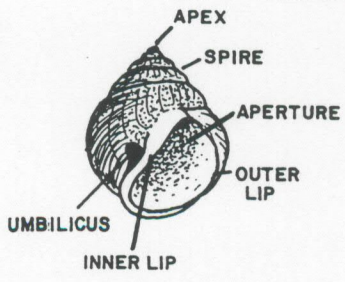
INTERNAL SHELL FEATURES

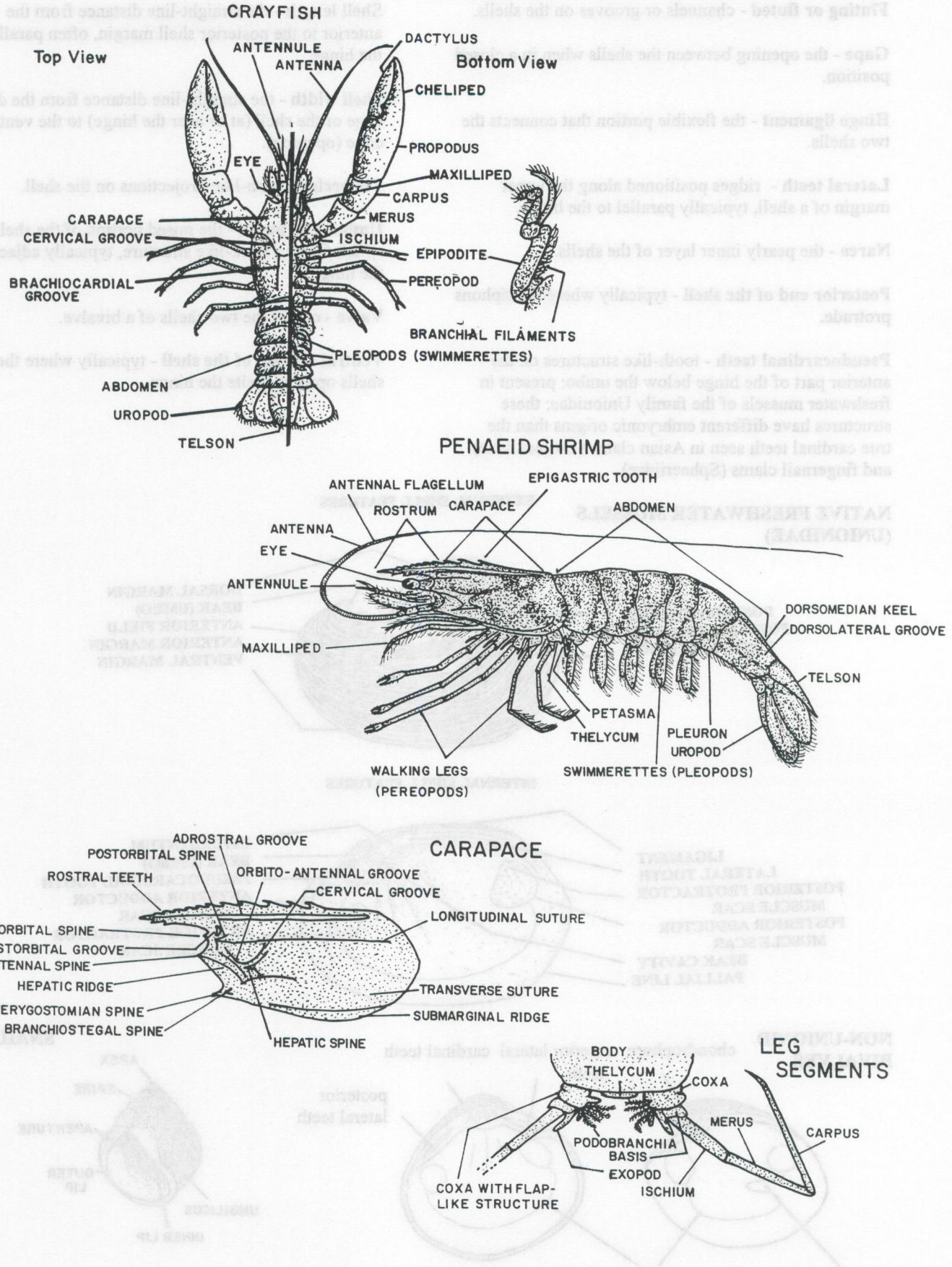


NON-UNIONID BIVALVES



SNAIL




CRAYFISH
Top View
Bottom View
ANTENNULE
ANTENNA
DACTYLUS
CHELIPED
PROPODUS
EYE
MAXILLIPED
CARPUS
CARAPACE
MERUS
CERVICAL GROOVE
ISCHIUM
EPIPODITE
BRACHIOCARDIAL GROOVE
PEREOPOD
BRANCHIAL FILAMENTS
PLEOPODS (SWIMMERETTES)
ABDOMEN
UROPOD
TELSON
PENAEID SHRIMP
ANTENNAL FLAGELLUM
EPIGASTRIC TOOTH
ROSTRUM
CARAPACE
ABDOMEN
ANTENNA
EYE
ANTENNULE
DORSOMEDIAN KEEL
DORSOLATERAL GROOVE
MAXILLIPED
TELSON
PETASMA
THELYCUM
PLEURON
UROPOD
WALKING LEGS (PEREOPODS)
SWIMMERETTES (PLEOPODS)
CARAPACE
ADROSTRAL GROOVE
POSTORBITAL SPINE
ROSTRAL TEETH
ORBITO-ANTENNAL GROOVE
CERVICAL GROOVE
LONGITUDINAL SUTURE
ORBITAL SPINE
POSTORBITAL GROOVE
ANTENNAL SPINE
HEPATIC RIDGE
TRANSVERSE SUTURE
PTERYGOSTOMIAN SPINE
SUBMARGINAL RIDGE
BRANCHIOSTEGAL SPINE
HEPATIC SPINE
LEG SEGMENTS
BODY
THELYCUM
COXA
MERUS
CARPUS
PODOBRANCHIA
BASIS
EXOPOD
ISCHIUM
COXA WITH FLAP-LIKE STRUCTURE

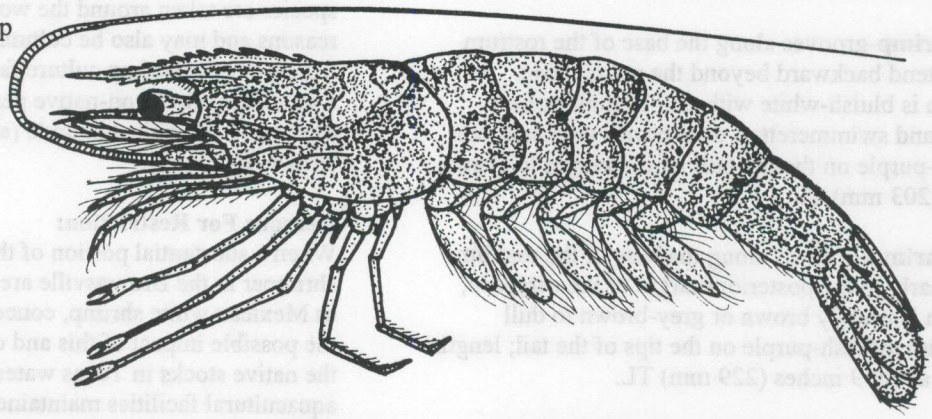
PENAEID SHRIMPS

Family: Penaeidae

All Species of the Genus *Penaeus*

Except *P. setiferus, P. aztecus and P. duorarum*

Mexican White Shrimp
Penaeus vanamei



Other Names:
Collectively, these species are known as edible or commercial shrimps. White shrimp *Penaeus setiferus* is also known as northern white shrimp; brown shrimp *P. aztecus* as grooved shrimp and northern brown shrimp; and pink shrimp *P. duorarum* as northern pink and pink spotted shrimp. Other penaeid shrimps are known by a variety of common names including the following: southern white shrimp *P. schmitti*; pink, red spotted and Caribbean brown shrimp *P. brasiliensis*; southern pink shrimp *P. notialis*; southern brown shrimp *P. subtilis;* Sao Paulo shrimp *P. paulensis*; Mexican white, Pacific white and white leg shrimp *P. vannamei*; western white shrimp *P. occidentalis*; blue shrimp *P. stylirostris*; red and crystal shrimp *P. brevirostris;* yellowleg shrimp *P. californiensis*; banana prawn *P. merguiensis*, Indian prawn *P. indicus*, giant tiger prawn *P. monodon* (= *monodo*); green tiger prawn *P. semisulcatus*; Japanese and Kuruma shrimp *P. japonicus*; oriental shrimp *P. orientalis*; Chinese shrimp *P. chinensis,* and horned shrimp *P. kerathurus*. Most have other local language names; many lack English common names.

The term "penaeoid" shrimps refers to the superfamily Penaeoidea which includes many families, genera, and species of shrimps (e.g., solenocerid shrimps, benthesicymid shrimps, gamba prawns, penaeid shrimps and rock shrimps in North America). The term "penaeid" shrimps refers to the family Penaeidae which includes the genus *Penaeus* and six other genera (in North America).

Specifics:
There are numerous species in the genus worldwide. Five species are native to North American waters and of these, at least three occur along the Texas coast. All species not native to Texas waters are prohibited. However, the restriction applies only to the genus *Penaeus*; other related penaeoid genera, even if non-native, are not restricted (e.g., *Metapenaeus*, etc.), nor are exotic prawns like *Macrobrachium rosenbergii*.

Range:
Brown shrimp ranges from Cape Cod, white shrimp from New York and pink shrimp from Chesapeake Bay south to the Texas and Mexican coasts and to the Caribbean Islands. Other species are found in African, Asian, Central American and South American waters. Mexican white shrimp P. vannamei from the Pacific coast of Mexico and Central America was collected in Texas waters at Brownsville prior to the December 1989 cold weather, but has not been reported since then (T.L. King, TPWD, pers. comm.). Several exotic shrimps are maintained by aquaculturists in Texas; however, only Mexican white shrimp appears to have escaped confinement. Mexican white shrimp and another called black tiger prawn have reportedly escaped into South Carolina waters.

Description:
Adult white, brown and pink shrimps are similar to other penaeids in appearance with a cephalothorax (carapace) possessing a rostrum toothed both dorsally and ventrally, a segmented abdomen, and a tail composed of a telson and uropods. Penaeids may or may not have a dorsally-grooved carapace, and the first three pair of legs have small, near-equal-sized claws (none are dramatically enlarged); antennae are long and slender. Size ranges to about 8 inches (203 mm), possibly longer in a few species; females are typically larger than males. Morphology of the male

reproductive structure (petasma) located on the first pair of swimmerettes or the female reproductive structure (thelycum) located on the body between the last pair of walking legs may be necessary for identification.

Unrestricted Native Penaeid Shrimps:

White shrimp-grooves along the base of the rostrum do not extend backward beyond the rostral base; coloration is bluish-white with red- or pink-tipped rostrums and swimmerettes, dark brown antennae, and brownish-purple on the fan tail; length ranges to about 8 inches (203 mm) TL.

Brown shrimp-grooves along the base of the rostrum extend nearly to the posterior margin of the carapace; coloration is usually brown or grey-brown to dull orange with reddish-purple on the tips of the tail; length ranges to about 9 inches (229 mm) TL.

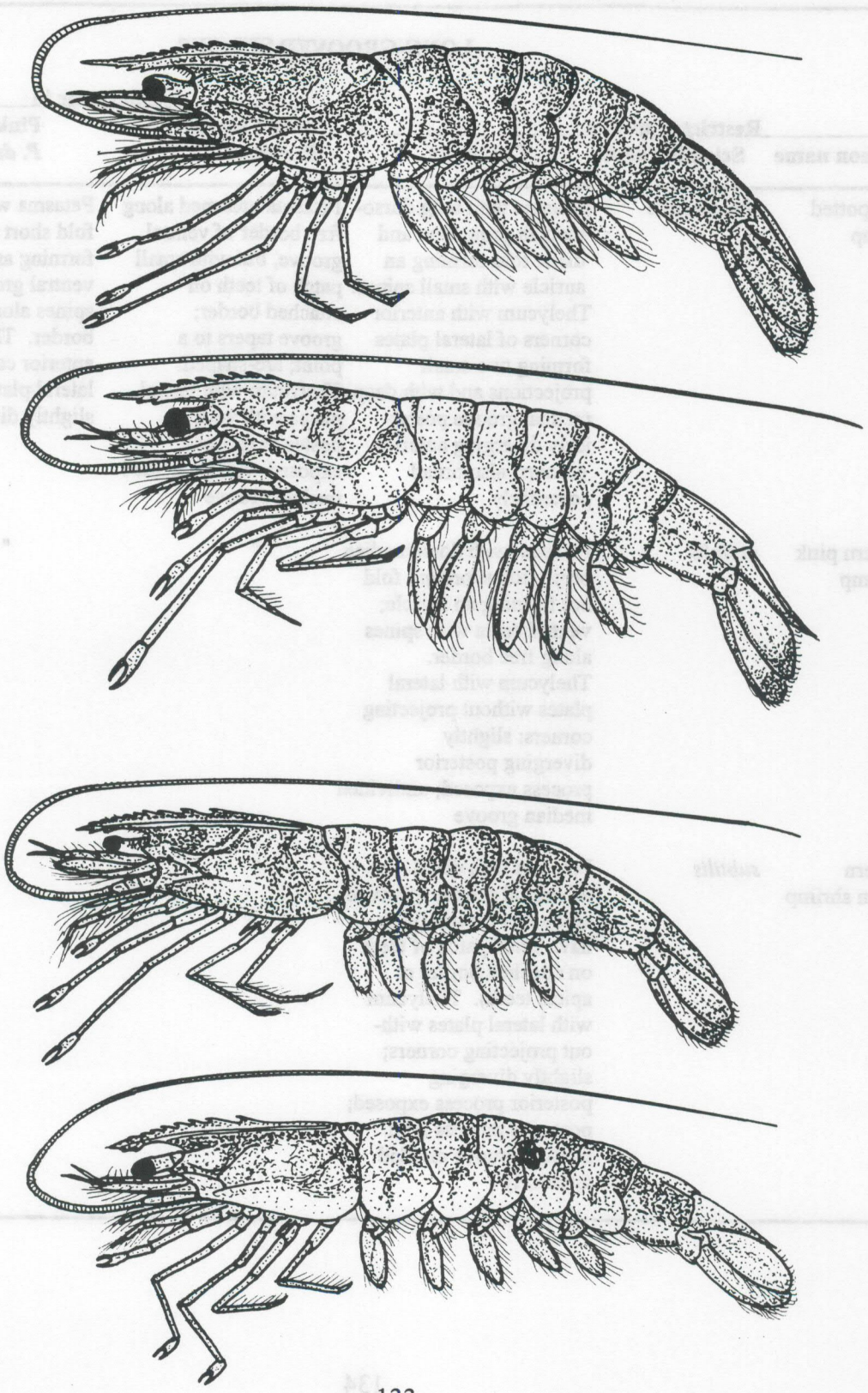
Pink shrimp-grooves along the base of the rostrum extend nearly to the posterior margin of the carapace; coloration is variable from grey to reddish-brown in smaller specimens to red, pink, blue, or white in larger specimens with darker banding patterns, the tail may be nearly transparent but with dark tips, and a dark characteristic red or purple spot on the 3rd-4th abdominal segments may be lacking entirely; length ranges to about 8 inches (203 mm) TL.

Biology:
Penaeid shrimps are marine and estuarine species which spend part of their lives in offshore waters where they mate and spawn. Their larvae and juveniles move into bays and estuaries to feed and grow before again returning to deeper waters. Many of the exotic penaeids have similar life cycles; however, the biology of many species is still largely unstudied. Larval stages are planktonic; older juveniles and adults settle to the bottom and lead a more benthic life. Larval and early postlarval stages include five nauplial, three protozoeal, three mysis and several postlarval stages; however, the number of stages may vary under certain conditions. Because of commercial importance and demand, aquacultural efforts with both native and exotic species are underway in Texas and elsewhere.

Commercial Importance:
White, brown and pink shrimps are important commercial species in Texas and in many waters where they occur from North Carolina south. They are taken by sport fishermen and shrimpers for food and use as bait and chum. An increasing number of aquaculturists are also turning efforts toward shrimp culture. Exotic species are taken around the world for these same reasons and may also be cultured in some areas. Several Texas shrimp culture facilities reportedly work with a number of non-native penaeids. None are of direct interest to the pet trade (although they may be used as fish food).

Reasons For Restriction:
When a substantial portion of the catch taken by a shrimper in the Brownsville area in 1989 was identified as Mexican white shrimp, concerns were voiced about the possible impact of this and other exotic shrimps on the native stocks in Texas waters. Because several aquacultural facilities maintained a number of non-native shrimps and their potential environmental impact, if released, was largely unknown and because the native shrimp fishery in the state is a major industry, steps were taken to restrict exotic penaeids.

Similar Species:
Differentiation of species of penaeid shrimps can be extremely difficult and identification keys to species from around the world have often been formatted on the basis of geographic region (problematic in the event of relocated aquacultural species); a quick guide to all species is nearly impossible to present. Certainly unrestricted white, brown and pink shrimps are most likely to be confused with other species of the genus *Penaeus* (which are prohibited), as well as with several other related genera in the family. Similarly, certain other less closely related shrimps could be confusing as well. Recognizing white, brown and pink shrimps, being suspicious of any shrimps that appear to be different, then seeking technical advise on identification is probably the best recommendation. Note that differentiation of early life stages is difficult and may sometimes be impossible. Early life stage descriptions are lacking for many species, and even where descriptions exist, differences between species may be unclear.



Mexican White Shrimp *Penaeus vannamei*

White Shrimp *Penaeus stiferus*

Brown Shrimp *Penaeus aztecus*

Pink Shrimp *duorarum*

Other Shrimps of the Genus *Penaeus*:

The following identification characters for selected examples were largely derived from keys and descriptions presented in Anderson and Lindner (1943), Williams (1965), and Farfante (1988). Characters apply to adults or large subadults. Simple characteristics were noted where known and where possible; however, some species require detailed examination for positive identification.

LONG-GROOVED SPECIES

Restricted species			Character in	
Common name	**Scientific name**	**Character**	**Brown shrimp *P. aztecus***	**Pink shrimp *P. duorarum***
Pink spotted shrimp	*brasiliensis*	Petasma with long dorso-median projection and distal fold forming an auricle with small spines. Thelycum with anterior corners of lateral plates forming two small projections and with deep median groove posteriorly diverging anterior corners; also broad posteriorly	Petasma unarmed along free border of ventral groove, but with small patch of teeth on attached border; groove tapers to a point; arc-shaped. Thelycum with lateral plates with widely posterior process exposed with undivided median groove	Petasma with dorsomedian fold short and not forming an auricle; ventral groove with spines along free border. Thelycum with anterior corners of lateral plates only slightly divergent;
Southern pink shrimp	*notialis*	Petasma with dorsomedian projection short and fold not forming an auricle; ventral costa with spines along free border. Thelycum with lateral plates without projecting corners; slightly diverging posterior process exposed; undivided median groove	"	"
Southern brown shrimp	*subtilis*	Petasma with distal part of ventral groove unarmed along free border (may have small patch of teeth on attached border or apical teeth). Thelycum with lateral plates without projecting corners; slightly diverging posterior process exposed; posterior process with median groove divided anteriorly	"	"

Continued

LONG-GROOVED SPECIES

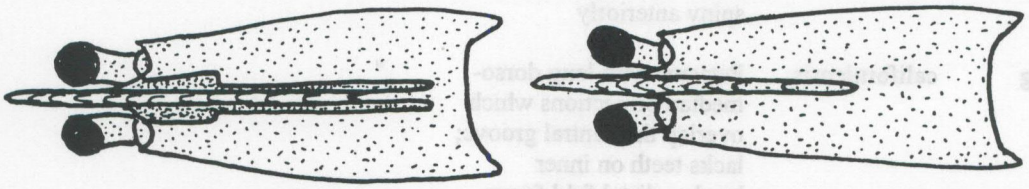
Restricted species			Character in	
Common name	**Scientific name**	**Character**	**Brown shrimp *P. aztecus***	**Pink shrimp *P. durorum***
San Paulo shrimp	paulensis	Petasma as in *P. aztecus* but with ventral groove blunt and almost straight, with irregular groups of teeth on free boarder. Thelycum as in P. aztecus but with broad anterior and posterior processes	"	"
Red shrimp	*brevirostris*	Petasma with well-developed dorsomedian projections short and barely overlapping ventral groove; blunt, with 1-4 teeth on inner border. Thelycum with lateral plates meeting in middle and spiny anteriorly	"	"
Yellowleg shrimp	californiensis	Petasma with long dorso-median projections which overlap the ventral groove; lacks teeth on inner border; distal fold forms large auricle with small spines. Thelycum with lateral plates lacking spines; posterior process with undivided median groove	"	"
Three-grooved shrimp	*trisulcatus*	Coxae of chelipeds armed	Coxae of chelipeds unarmed	Coxae of chelipeds unarmed
No common name	*canaliculatus*	Postocular crest turning at posterior end to form a loop	Postocular crest otherwise (absent)	Postocular crest otherwise (absent)
No common name	*marginatus*	Telson with three pairs of movable spines	Telson without spines	Telson without spines
Japanese prawn	*japonicus*	Telson with three pairs of movable spines; one ventral rostral tooth	Telson without spines; 2-3 ventral rostral teeth	Telson without spines; 2-3 ventral rostral teeth

Continued

LONG-GROOVED SPECIES

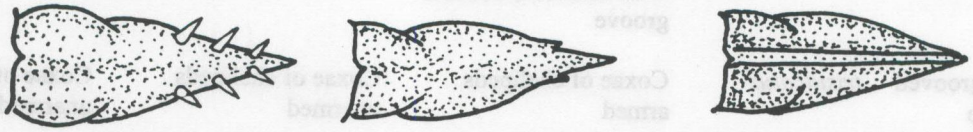
Restricted species			Character in	
Common name	Scientific name	Character	Brown shrimp *P. aztecus*	Pink shrimp *P. durorum*
No common name	*latisulcatus*	Telson with three pairs of movable spines; one ventral rostral tooth	Telson without spines; 2-3 ventral rostral teeth	Telson without spines; 2-3 ventral rostral teeth
No common name	*plebejus*	"	"	"
No common name	*maccullochi*	Carapace grooves cross to form an "X"; one ventral rostral tooth	Carapace grooves nearly parallel; 2-3 ventral rostral teeth	Carapace grooves nearly parallel; 2-3 ventral rostral teeth

CARAPACES (dorsal view)



Long-grooved Ungrooved

TELSONS

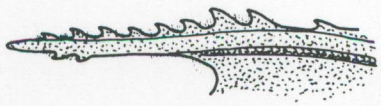


With Movable Spines With Fixed Spines Without Spines With Longitudinal Groove

ROSTRUM DETAIL

Mexican White Shrimp

White Shrimp



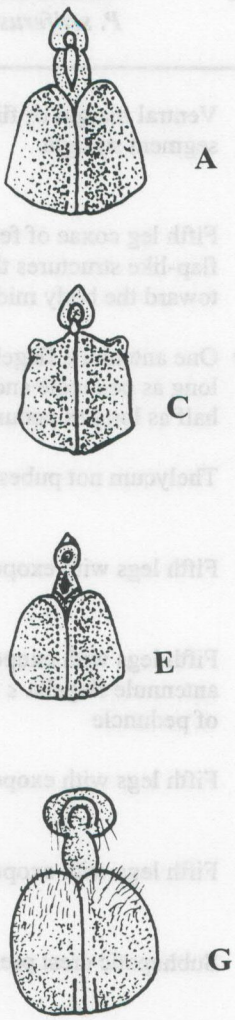
Brown Shrimp

UNGROOVED SPECIES

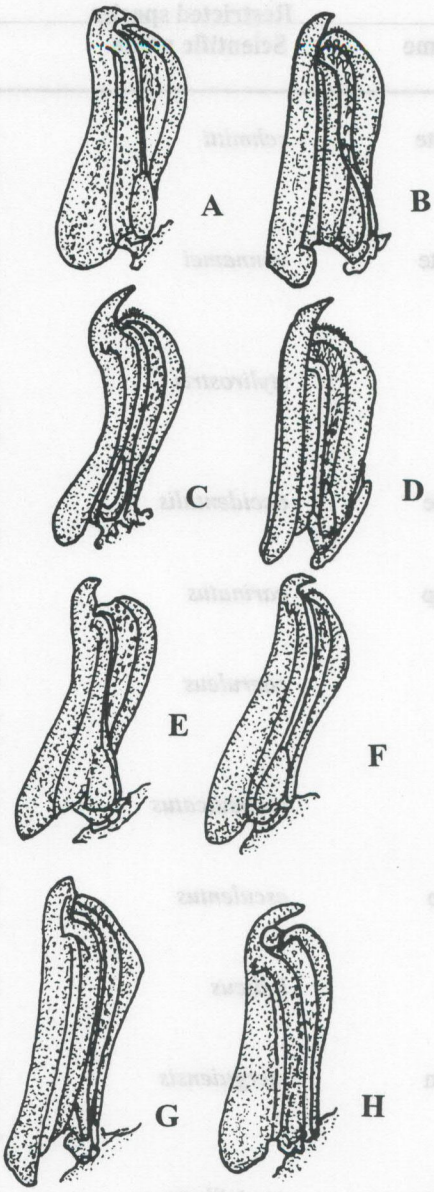
Restricted species			Character in white shrimp *P. setiferus*
Common name	**Scientific name**	**Character**	
Southern white shrimp	*schmitti*	Ventral margin of first abdominal segment concave	Ventral margin of first abdominal segment straight
Mexican white shrimp	*vannamei*	Fifth leg coxae of females without flap-like projections	Fifth leg coxae of females with flap-like structures that project toward the body midline
Blue shrimp	*stylirostris*	Antennule flagella longer than antennule peduncle (base)	One antennule flagellum about as long as peduncle and one about half as long as peduncle
Western white shrimp	*occidentalis*	Thelycum densely pubescent (spiny)	Thelycum not pubescent
Keeled shrimp	*carinatus*	Fifth legs without exopodites	Fifth legs with exopodites
Blue shrimp	*caeruleus*	Fifth legs without exopodites; antennule length > peduncle	Fifth legs with exopodites; antennule flagella ≤ length of peduncle
Green tiger prawn	*semisulcatus*	Fifth legs without exopodites	Fifth legs with exopodites
Edible shrimp	*esculentus*	Fifth legs without exopodites	Fifth legs with exopodites
Indian prawn	*indicus*	Carapace without subhepatic crest	Subhepatic crest present
Banana prawn	*merguiensis*	Rostral crest high and triangular; no subhepatic crest	Rostral crest not high or triangular; subhepatic crest present
Pencil shrimp	*penicillatus*	Rostral high but not triangular; sub-hepatic crest absent	Rostral not especially high and not triangular; sub-hepatic crest present
Giant tiger prawn	*monodon*	Maximum size > 8 in.; with bold dark bands	Maximum size ≤ 9 in.; dark bands may be present but are less pronounced

Note: Descriptions of *P. orientalis, P. chinensis,* and *P. kerathurus* were unavailable.

THELYCUM STRUCTURE



PETASMA STRUCTURE

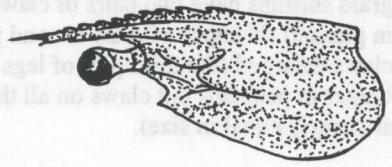


KEY:

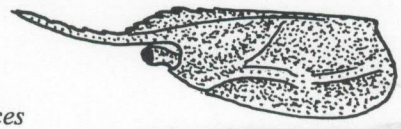
A. *Penaeus aztecus*
B. *P. duorarum*
C. *P. brasiliensis*
D. *P. notialis*
E. *P. subtilis*
F. *P. paulensis*
G. *P. brevirostris*
H. *P. californiensis*

Other Penaeoid Shrimps:

A number of other genera and species are generally similar to *Penaeus*. Several examples of the carapace and rostrum of similar genera are presented below. Many similar shrimps lack ventral spines on the rostrum, have a much longer rostrum, or have a major portion of the rostrum untoothed.



Pink Shrimp
Penaeus setiferus

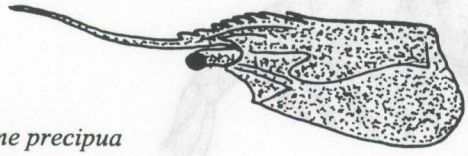


Giant Gamba Prawn
Aristaemorpha foliaces

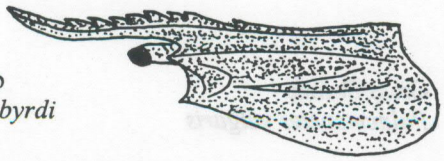
Purpleheaded Prawn
Aristeus antillensis

Scarlet Gamba Prawn
Plesiopenaeus edwardsianus

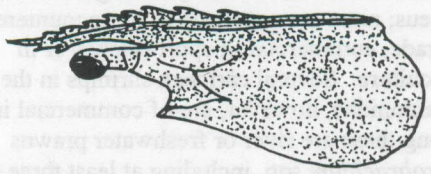
Stiletto Prawn
Artemesia longinaris



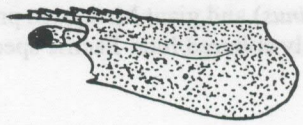
Titi Shrimp
Protrachypene precipua



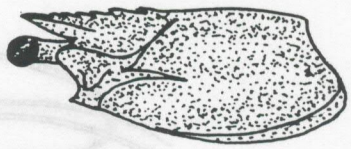
Carabali Shrimp
Trachypenaeus byrdi



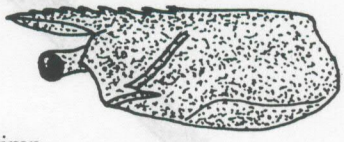
Brown Shrimp
Penaeus aztecus



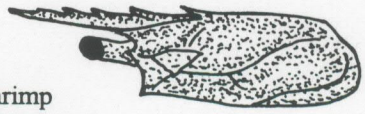
Rose Shrimp
Rarapenaeus longirostris



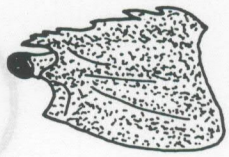
Little Humpbacked Shrimp
Solenocera mutator



Argentine Red Shrimp
Pleoticus muelleri



Chilean Knife Shrimp
Haliporoides diomedeae

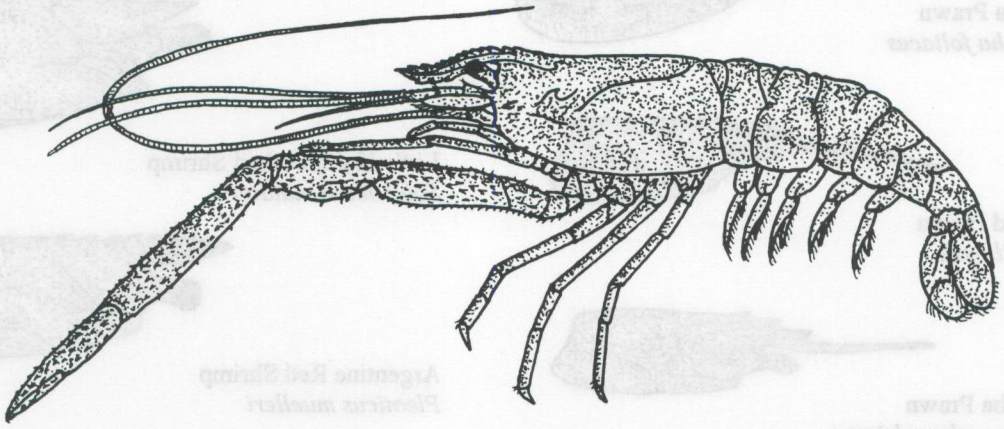


Brown Rock Shrimp
Sicyonia brevirostris

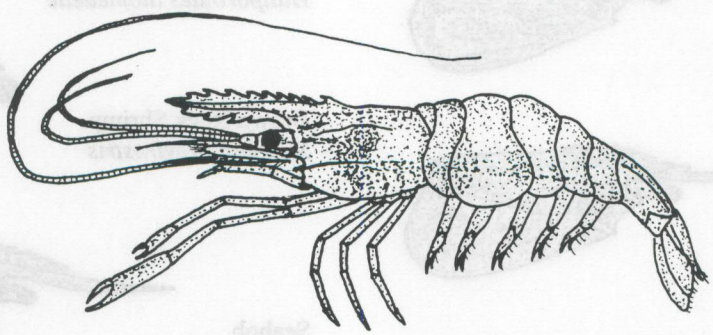
Seabob
Xiphopenaeus riveti

Non-penaeoid Shrimps:

There are many types of decapods called shrimps. Many are smaller, occur in deep or cold waters or have characteristics which readily distinguish them from Penaeus; most are not likely to be encountered in the pet trade, commercial or sport catches or in aquaculture. Several caridean shrimps in the family Paleamonidae, however, are of commercial interest. Among these are river or freshwater prawns *Macrobrachium* spp. including at least three species native to Texas (cinnamon river shrimp *M. acanthurus*, Ohio shrimp *M. ohione*, and bigclaw river shrimp *M. carcinus*) and giant Malaysian prawn *M. rosenbergii* (a widely cultured Indo-Pacific species). Some river shrimps reach about 10 inches (254 mm) in body length; many possess an elongated and enlarged second pair of legs with well-developed claws. Other members in this family include the grass shrimps (also called shore, glass or ghost shrimps) *Palaemonetes* spp. with species in marine, estuarine and fresh waters. Grass shrimps are relatively small (under 2 inches/51 mm in length) and typically almost transparent. Grass shrimps are sold in the pet trade, as bait and may be collected in the wild or reared by aquaculturists. Both river and grass shrimps have two pairs of clawed legs (three pairs in penaeid shrimps) with the second pair of legs and claws enlarged (the third pair of legs may be slightly longer in penaeids but claws on all three pairs of legs are nearly equal in size).



Cinnamon River Shrimp
Macrobrachium acanthurus



Grass Shrimp
Palaemonetes vulgaris

Technical Notes:

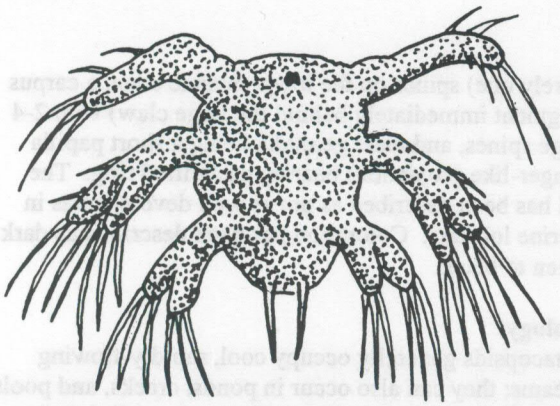
(1) Early life stages of penaeid shrimps can be difficult or impossible to positively identify. Such early developmental stages differ dramatically from adults. Note, for example, that the rostrum in some stages lacks both dorsal and ventral spines, and that the telson may not be pointed and may have spines (telsons in white, brown and pink shrimps are pointed and without either movable or fixed spines in adults).

(2) The anterior untoothed portion of the rostrum is longer in Mexican white shrimp and white shrimp than in brown shrimp (based upon specimens examined by TPWD) or pink shrimp (based upon illustration in Williams 1965). In Mexican white shrimp the first dorsal rostral tooth is positioned just slightly in advance of the last ventral rostral tooth and the untoothed dorsal surface of the rostrum is < 50% rostrum length. In white shrimp all dorsal rostral teeth are located behind the last ventral rostral tooth and the untoothed dorsal surface of the rostrum is about 60% rostral length. In brown and pink shrimp the first dorsal rostral tooth is located nearly over the last ventral rostral tooth and the untoothed part of the rostrum is relatively short (< 45%). Note the first dorsal tooth may be quite small and easily overlooked.

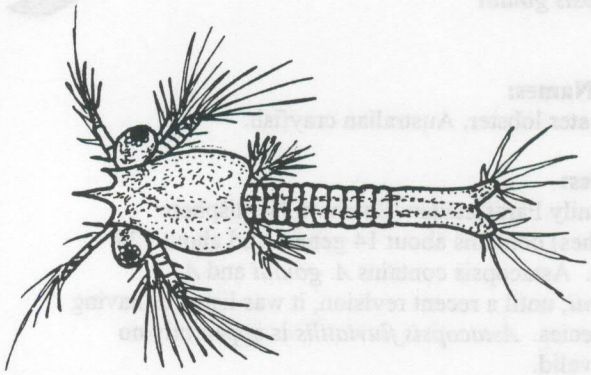
References:

Anderson and Lindner 1943; Cook 1966; Cook and Murphy 1971; Farfante 1988; Holthuis 1952; Howells 1992; Sandifer 1972; Williams 1965.

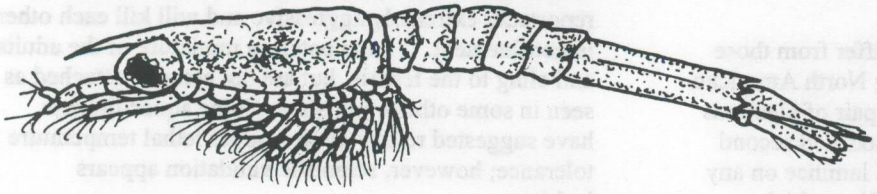
BROWN SHRIMP (*Penaeus aztecus)* EARLY LIFE STAGES



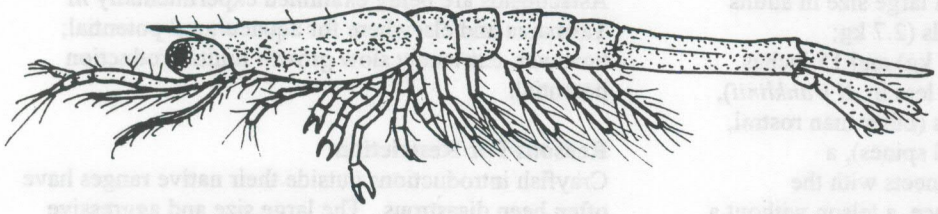
Nauplius (0.014"/0.36 mm)



Protozoea (0.065"/1.65 mm)

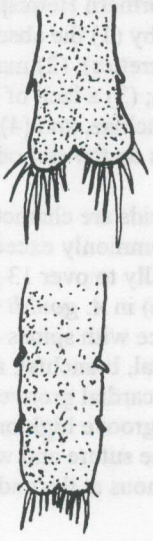


Mysis (0.144"/3.66 mm)



Postlarva (0.157"/3.99 mm)

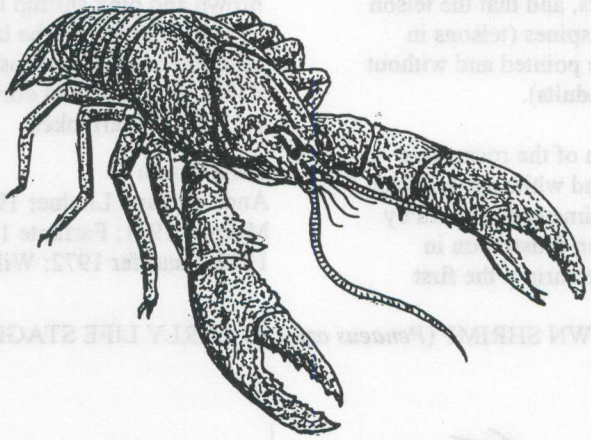
Telson Detail



TASMANIAN GIANT CRAYFISHES

Family: Parastacidae

All Species of the Genus *Astacopsis*



Tasmanian
Giant Crayfish
Astacopsis gouldi

Other Names:
Freshwater lobster, Australian crayfish.

Specifics:
The family Parastacidae (Southern Hemisphere crayfishes) contains about 14 genera and about 120 species. Astacopsis contains *A. gouldi* and *A. franklinii*; until a recent revision, it was listed as having four species. *Astacopsis fluviatilis* is apparently no longer valid.

Range:
A. gouldi is found in northern Tasmania; *A. franklinii* is more widely distributed across the island, except in the northwest corner.

Description:
All Southern Hemisphere crayfishes differ from those in the Northern Hemisphere (including North American species) by (1) the absence of the first pair of pleopods (swimmerettes); (2) males having unmodified second pleopods; (3) a lack of bilobed, plaited laminae on any podobranchiae, and (4) the presence of branchial filaments on the epipodite of the first maxillipeds.

Astacopsids are characterized by a large size in adults which commonly exceeds 6 pounds (2.7 kg; unofficially to over 13 pounds/5.7 kg) and 15 inches (381 mm) in *A. gouldi* (somewhat less in *A. franklinii*), a carapace with spines or tubercles (other than rostral, postorbital, branchial, and cervical spines), a branchiocardial groove which connects with the cervical groove high on the carapace, a telson without a transverse suture and which is completely calcified (not membranous at the end), chela (large claws) with two (rarely one) spines on the lower outside edge, a carpus (segment immediately behind the large claw) with 2-4 large spines, and male genitalia being a short papilla (finger-like projection) bearing a calcified ring. The tail has been described as not as well developed as in marine lobsters. Coloration has been described as dark green to black.

Biology:
Astacopsids generally occupy cool, rapidly-flowing streams; they can also occur in ponds, creeks, and pools associated with larger rivers. They reportedly rarely burrow, but can do so in response to falling water levels. Recent investigations have found that they are more terrestrial than once thought, and often walk on stream banks after rains in search of food. They are reportedly extremely aggressive and will kill each other in confinement. Young hatch as miniature of the adults and cling to the female, but are not actually attached as seen in some other crayfishes. Some aquaculturists have suggested relatively low upper lethal temperature tolerance; however, scientific validation appears lacking.

Commercial Importance:
Astacopsids are being examined experimentally in Tasmania and elsewhere for aquacultural potential; however, extremely slow growth limits production potential.

Reasons For Restriction:
Crayfish introductions outside their native ranges have often been disastrous. The large size and aggressive behavior of Tasmanian giant crayfishes suggested a need for restriction. In addition, the IUCN

(International Union for Conservation of Nature and Natural Resources) red book lists *A. gouldi* as "vulnerable", and export of live crayfishes from Australia is apparently prohibited; restriction in Texas may help protect the status of wild Tasmanian stocks. Note that Australian crayfishes of the genus *Cherax* are being cultured in Texas and are not restricted at this time.

Similar Species:
Tasmanian giant crayfishes would probably be most likely confused with native North American crayfishes and several Australian crayfishes presently cultured in the U.S. True lobsters *Homarus* spp. are exclusively marine; giant crayfishes do not live in marine situations.

Native North American crayfishes have:
- first pair of pleopods present.
- modified second pleopod pair in males.
- bilobed laminae on pseudobranchiae.
- a lack of branchial filaments on the epipodite of the first maxillipeds.
- a transverse suture on the telson, except in *Fallicambarus* spp. (native to Texas); this transverse suture is also lacking in *Cambaroides* spp. from eastern Asia and Japan, and *Pacifastacus* spp. from the U.S. Pacific drainage and headwaters of the Missouri River (otherwise usually present in Northern Hemisphere crayfishes).

Other Australian crayfishes:
The two largest crayfishes are *Euastacus armatus* (to about 6 pounds/2.7 kg) and marron *Cherax tenuimanus* (to about 4 pounds/1.8 kg). The marron has been imported into the U.S. and is being reared by aquaculturists; two smaller (6 inches/152 mm, 0.3 pounds/0.14 kg) Australian crayfishes called yabbies *C. destructor* and *C. albidus* have apparently also been introduced into the U.S. The term "yabbies" is sometimes loosely used to include all Australian crayfishes or all *Cherax*.

Genus *Cherax* (yabbies and marron) with about 39 species:
- Telson has a transverse suture (usually) and the posterior part is membranous (the end is not calcified).
- Carapace is smooth or finely granulated and without spines or tubercles except for rostral, postorbital, branchial, and cervical spines.
- Lower outside margins of the large claws lack spines.
- *C. tenuimanus* is longer and more slender than the other two giant crayfishes.
- Coloration in *C tenuimanus* is usually dark black to red-brown; red and cobalt blue variants have been reported.

Genus *Euastacus* with about 27 species:
- Telson has a transverse suture and the posterior part is membranous.
- Telson has spines on the upper surface.
- Carapace has spines other than the rostral,postorbital, branchial, and cervical spines.
- Lower outside margins of the large claws have a single row of spines.
- *E. armatus* has characteristic white claws and white-tipped spines on the tail and body; basic color is often dark blue or green.

Unrestricted crayfishes in the U.S. (cultured or wild) should have:
- **Swimmerettes (pleopods) on the first abdominal segment (Northern Hemisphere species), or**
- **Membranous posterior end of telson.**

Restricted Tasmanian giant crayfishes have:
- **First pair of swimmerettes lacking, and**
- **Telson calcified its entire length.**

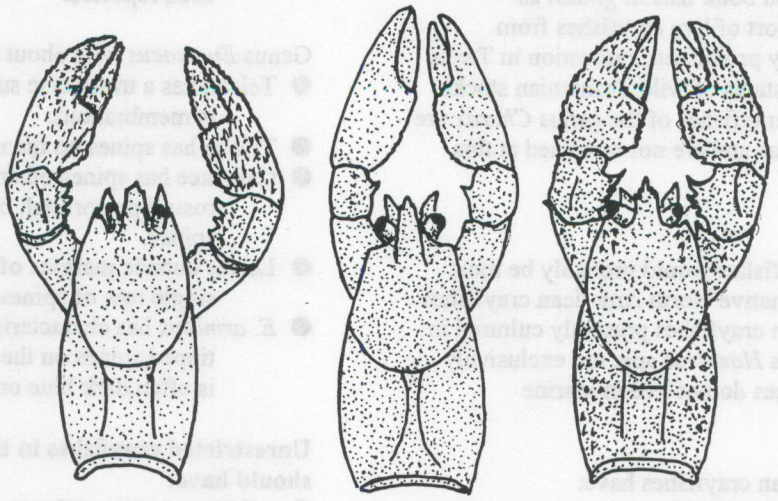
Technical Notes:

(1) More has been reported in the scientific literature on Australian *Cherax* than on Tasmanian *Astacopsis*. Many *Cherax* species are burrowers, and some have even been described as semiaquatic or terrestrial. They may readily move across land from one water body to another. *C. destructor* may dig burrows over 10 feet (3 m) deep and has been known to survive in these burrows through eight years of drought and dewatering. This species has been known to tolerate dissolved oxygen levels of 0.4 ppm, is highly tolerant of salinity (for limited periods) and survives water temperatures of 33.8-95.0°F(1-35°C); upper lethal has been reported as 96.8°F (36°C). Reportedly, due to invasive and destructive habits, yabbies may cause problems if introduced. Extreme caution should be used to prevent escape of *Cherax* spp. being cultured in Texas.

(2) An additional species of Australian giant crayfish has been imported into the U.S. and is being handled by aquaculturists as Australian redclaw *Cherax quadricarcinatus*.

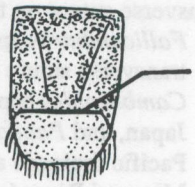
References:
Anonymous 1983; Bouchard 1978; Dupree and Huner 1984; Hobbs 1974, 1976; Holdich and Lowery 1988; Penn and Hobbs 1958.

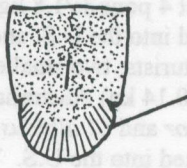
GIANT CRAYFISHES



Astacopsis sp. *Cherax* sp. *Euastacus* sp.

TELSONS



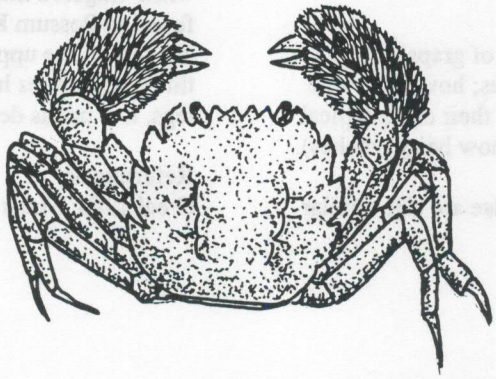


Australian Yabbie
Cherax destructor

MITTEN CRABS

Family: Grapsidae

All Species of the Genus *Eriocheir*



Mitten Crab
Eriocheir sinensis

Other names:
Chinese mitten crab.

Specifics:
The family contains 13 genera and 25 species native to North America and an even larger number of species elsewhere, especially in the tropics. The number of species of Eriocheir is unclear.

Range:
Chinese mitten crab *E. sinensis* was originally native to China, but was apparently introduced unintentionally into European waters via ship ballast in 1912. In North America, it was first found in the Great Lakes in the early 1970's; however, that introduction is believed to have failed. It has subsequently appeared at sites the U.S. Pacific coast.

Description:
Adults are basically crab-like in shape with a carapace that is nearly circular; each side of the carapace has four spines with saw-edges. Mitten crabs lack swimming legs (all are pointed for walking, none are flattened on the last segment). The claws are nearly equal in size and are more or less hairy, giving the appearance of having a muff or mitten; males reportedly have more pronounced hairy growths than females. Carapace width may reach about 90 mm (3.5 inches) in width.

Biology:
Mitten crabs occur in shallow water along rivers, canals and lakes. They are burrowers and are largely nocturnal. Mitten crabs will cross land to avoid obstructions. They are largely omnivorous, but vegetation often makes up a major portion of their diet. Like many estuarine and marine crabs, they often attack trapped or netted fish. Although adults may live in fresh water, they migrate in large numbers down-river in mid-summer to river mouths where they mate and spawn. Planktonic larvae remain in salt water. Juveniles migrate back up-river to fresh water where they feed and mature.

Commercial Importance:
Neither aquaculturists or aquarists have utilized mitten crabs.

Reasons For Restriction:
Although considered a delicacy in China and occasionally used for fodder or fertilizer, mitten crabs have typically been considered a pest where introductions have occurred. Burrowing activity undermines dikes and dams, and they often damage fish captured in nets. Techniques to capture and remove them are expensive and often ineffective. Because of environmental impacts observed in Europe and with U.S. introduction having already occurred, restriction seemed advisable. California has already placed mitten crabs on their restricted list, and the U.S. Fish and Wildlife Service plans prohibition as well.

Similar Species:
Although basically similar to many other crabs, the hairy, mitten-like claws on mitten crabs should readily distinguish them from swimming crabs like blue crab *Callinectes sapidus* or lady crab *Ovalipes ocellatus* (which also have swimming legs that are absent in mitten crabs), and from non-swimming crabs like green crab *Carcinus maenas*, mud crabs (genera *Rithropanopeus, Panopeus, Eurypanopeus*, etc.), and other native grapsid crabs like marsh crabs *Sesarma* spp. and gulfweed crabs *Planes* spp. Crabs that do possess hairs on the claws or arms have substantially less than seen in mitten crab.

Technical Notes:

(1) A small (0.6 inch/15 mm) grapsid crab (*Hemigrapsus estellinensis*) endemic to Estelline Spring

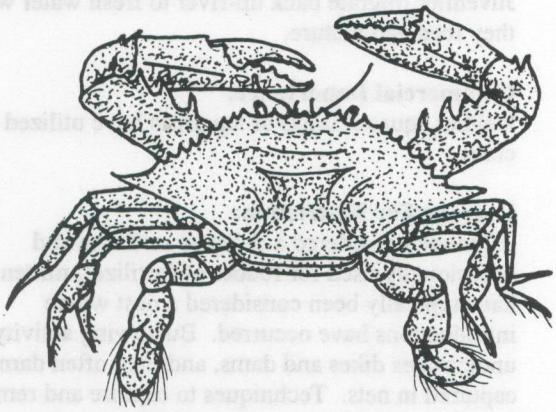
in Hall County in the Texas panhandle had a hairy patch on the ventral claw surface in males. However, this species is believed to have become extinct by 1962 due to U.S. Army Corps of Engineers' attempts to modify flow in the spring.

(2) A number of genera and species of grapsid crabs are native to the U.S., including Texas; however, none have the extremely hair "mittens" on their chela typical of mitten crabs (though a few may show hairy patches).

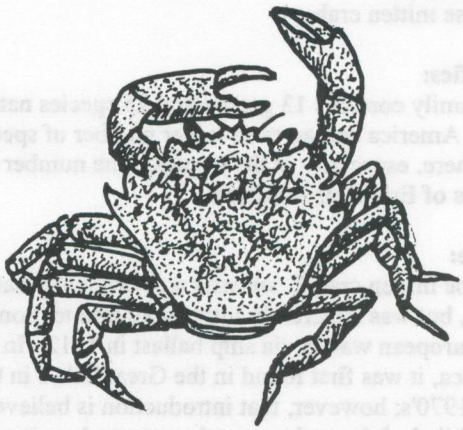
(3) Mud crabs of the family Xanthidae are also similar in general size and appearance. Numerous genera and species occur in the U.S., including Texas. Again, all lack the hairy chela typical of mitten crabs. In late summer 1998, an apparently-established population of white-fingered mud crabs *Rithropanopeus harrisii* was found in Possum Kingdom Reservoir on the main channel of the upper Brazos River, Texas. Although this species does have some "hairs" on its chela and legs, it is not as densely hairy as mitten crab.

References:

Creel 1964; Muus 1967; Toman and Felix 1974.

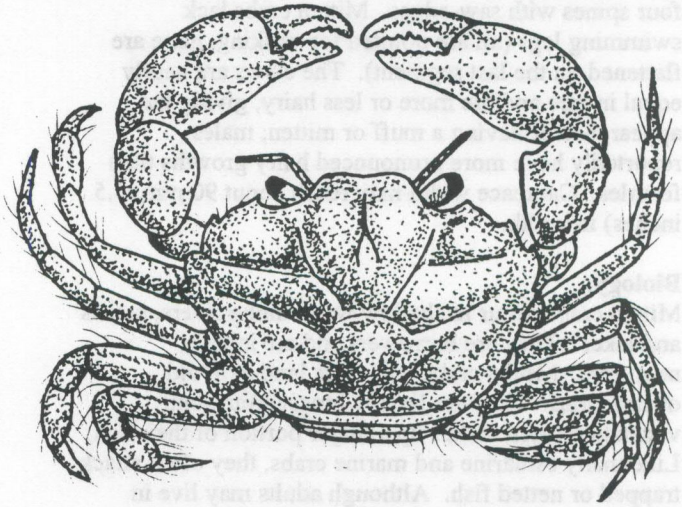


Blue Crab
Callinectes sapidus



Green Crab
Carcinus maenas

Marsh Crab
Sesarma reticulatum

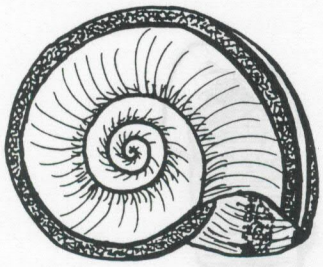


White-fingered Mud Crab
Rithroponopeus harrisii

Giant Ramshorn Snails

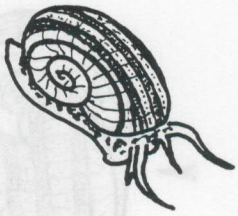
Family: Ampullariidae (Pilidae)

All Species of the Genus *Marisa*



Giant Ramshorn Snail
Marisa cornuarietis

Operculum



Other Names:
Columbian ramshorn snail.

Specifics:
The number of species in the family and genus is unclear. Recent experts appear divided as to which family to assign this genus. The Columbian ramshorn snail of the pet trade is typically given as *M. rotula*; however, this may not be different from the *M. cornuarietis* introduced in U.S. waters and studied for noxious vegetation control.

Range:
Giant ramshorn snails are native to South America, with introductions into Puerto Rico, Florida and Texas (San Marcos and Comal rivers), and probably elsewhere.

Description:
The giant ramshorn snail reaches about 38 mm (1.5 inches) in diameter and is coiled like a ram's horn. An operculum (trap door) is present on the foot. The foot is often pale in color. Shell coloration is usually a pattern of dark stripes on a lighter background, but completely dark brown to almost black specimens occur commonly, and others which are totally light yellowish-tan (blonde) are seen occasionally.

Biology:
These snails have been sold for many years in the pet trade as aquarium scavengers. Although some older aquarium literature indicated that they did not destroy aquatic plants, they not only consume plants, but have been studied as possible controls for noxious aquatic vegetation. They will consume almost anything organic, and will sometimes prey upon other snails. In some portions of the San Marcos River where giant ramshorn snails are abundant, other snails are often present only in limited numbers except for smaller burrowing forms. Giant ramshorn snails have largely been dismissed as vegetation control agents due to the large numbers needed for control and limited tolerance to cold; lower lethal temperature is about 48°F (8.9 °C). They lay large egg masses in warm weather near shore.

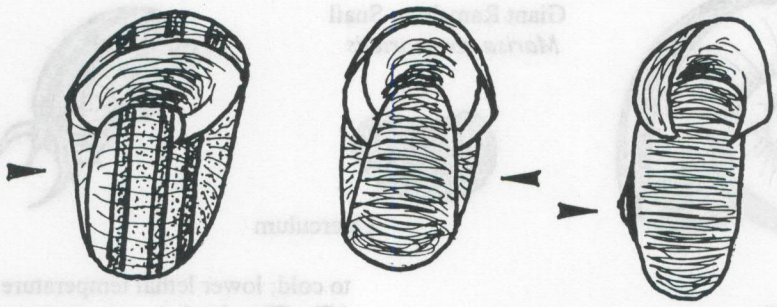
Commercial Importance:
Because use in vegetation control has largely been abandoned, the remaining interest in this snail is in the aquarium trade. Although not in extremely high demand, they have been regularly available for many years both in Texas and elsewhere.

Reasons For Restriction:
Established populations in Texas have reportedly damaged aquatic vegetation in the New Braunfels area, and may have impacted native snail populations in San Marcos. Both areas are ecologically sensitive and support a number of threatened and endangered species. Although already established, continued importation of the species and distribution through the pet trade could only enhance the possibility of other introductions. Established populations could present threats to crops like rice *Oryza sativa*, or to waterfowl habitat in marsh lands.

Similar Species:
Other ram's horn-shaped native snails like *Planorbula* spp. and *Helisoma* spp. do not grow as large (usually less than 0.5 inch/13 mm) as *Marisa cornuarietis*; most are uniformly dark in shell color and have dark feet. A red (erythristic) domestic mutation of a small undetermined ramshorn snail is sometimes available in the pet trade; red morphs of giant ramshorn snail have not been reported. Other freshwater snails are either much smaller, or have shells that coil in different patterns. Other native snails with an operculum are shaped differently. Also note that *Marisa* sp. coils to the right (dextral) while *Planorbella* spp. coils to the left (sinistral).

References:
Burch 1989; Dundee 1974; Horne et al. 1992; Howells 1992.

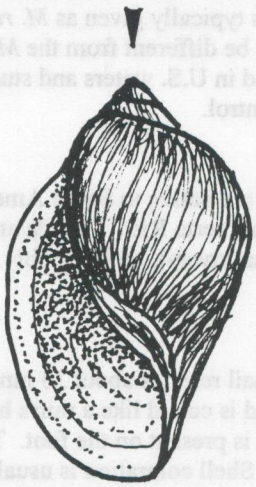
RAMSHORN SNAILS
(Arrow Indicates Apex)



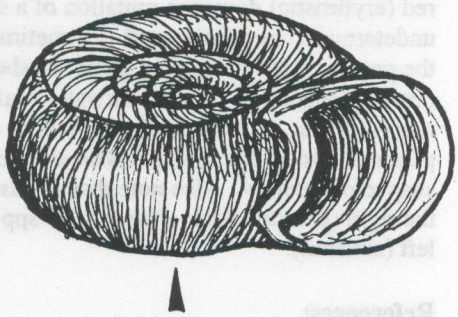
Marisa sp. *Planorbella* sp. *Planorbula* sp.

RIGHT- AND LEFT-HANDED SHELLS

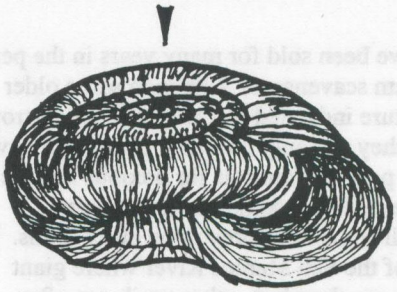
Stagnicola sp.
Right-handed or Dextral



Physella sp.
Left-handed or Sinistral



Planorbella sp.

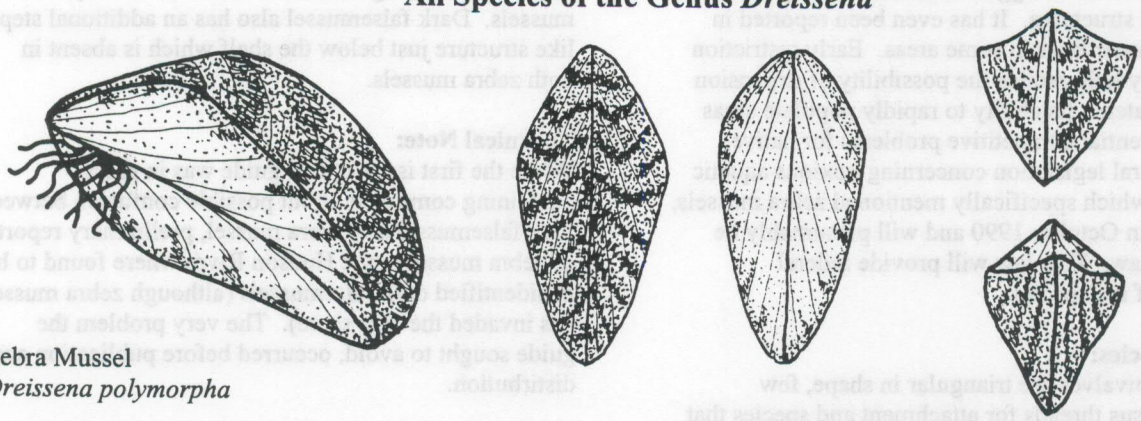


Planorbula sp.
(and *Helisoma*)

Zebra Mussels

Family: Dreissenidae

All Species of the Genus *Dreissena*



Zebra Mussel
Dreissena polymorpha

Other Names:
Zebra mussel *Dreissena polymorpha* is also called many-shaped dreissena and triangular clam; quagga mussel *D. bugensis*. Collectively, both species are called "zebra mussels."

Specifics:
The number of species in the family (containing three genera) and genus is unclear. Zebra mussel and quagga mussel now both occur in North America.

Range:
Previously restricted to the Black, Caspian, and Azov seas of eastern Europe, zebra mussel has invaded and colonized much of Europe since the 1800's. It was first found in Lake St. Clair in the Great Lakes area in 1988 and has rapidly expanded its range within the system. It has also moved through the Erie Canal to the Hudson River, entered the upper Susquehanna River, and invaded the Mississippi River Basin. Locally, zebra mussel populations occur in Louisiana, Arkansas, and Oklahoma, but have not been documented in Texas to date. Age of shells indicated the first introduction probably occurred in 1985. Quagga mussels were identified in the Great Lakes more recently, but have already been reported in the upper Mississippi River.

Description:
Zebra mussel is roughly triangular in cross section with both valves (shells) equal in size and with a strong dorsal keel on one side and relatively flattened on the opposing side. Some larger shells are slightly expanded dorsally (near the hinge) on the flat side. They are relatively small in size (to about 1.5-2.0 inches/38-51 mm). Concentric growth rings are described as the only sculpturing on the shell (presumably these may be more or less pronounced in some weathered specimens). The color of the foot may vary from yellow to dark brown; the shell color is often tan or yellow with a greenish-brown pattern of wavy or angular lines (though some specimens show nearly uniform bars with little zig-zag pattern); as their name implies, coloration is extremely variable from nearly uniformly dark to boldly banded with alternating dark and light bars. Shells connect to the substrate (including other clams) with adhesive byssus threads (a feature commonly seen in marine species, but uncommon in freshwater bivalves). Quagga mussels are very similar but lack the flat side which is characteristic of zebra mussel.

Biology:
Zebra mussels are unusual among most freshwater bivalves in producing byssus threads for attachment and in having a free-swimming veliger (larval) stage. They have high fecundity (over 30,000 eggs per female) and begin releasing eggs at about 0.4 inch (10 mm, or smaller; minimum adult shell size) in size and one year of age when water temperatures reach 55.4 °F (13°C), with peak egg production around 71.6°F (22°C). Fertilization occurs externally and veligers (the planktonic larval stage) remain planktonic for 10-15 days, after which they transform into postveligers and descend to the bottom where they may remain active for several days longer until a suitable attachment site is located. They may attach to a variety of substrates including shells of living native bivalves and crustaceans. The Great Lakes population has been described as having a high level of genetic variability, suggesting a large number of founding individuals. Introduction was likely through ship ballast water.

Commercial Importance:
Commercial, aquacultural, or pet trade uses are thus far unreported.

Reasons For Restriction:
This mussel is an extremely invasive species and has

been problematic in many locations in Europe. Indeed, although U.S. introduction is rather recent, zebra mussel has already become so abundant at some locations that it has clogged industrial water pipes and water intake structures. It has even been reported in residential water lines in some areas. Early restriction in Texas may help reduce the possibility of expansion into local waters. Its ability to rapidly populate areas suggests potential competitive problems for native fauna. Federal legislation concerning noxious aquatic organisms, which specifically mentioned zebra mussels, was passed in October 1990 and will presumably be signed into law. This law will provide federal regulation of the species.

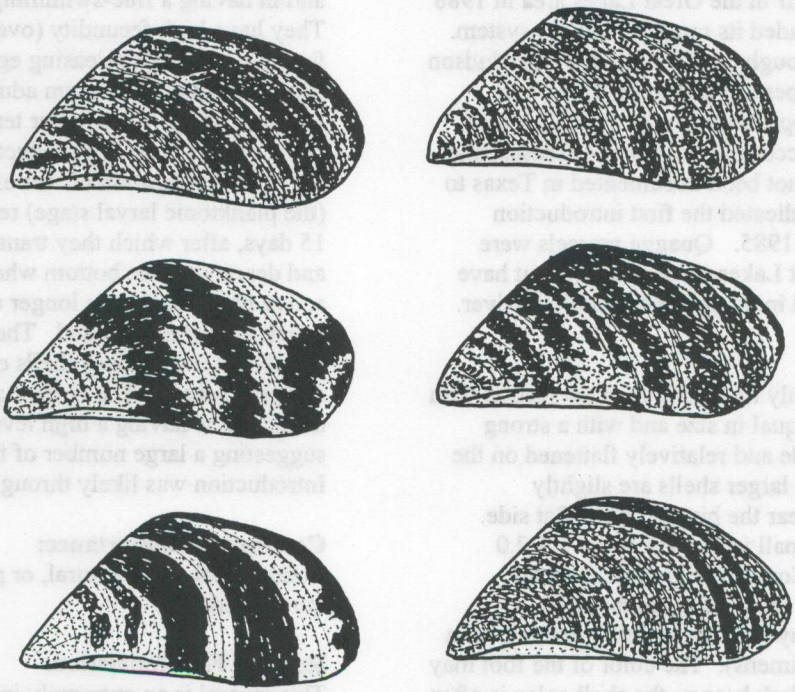
Similar Species:
Few native bivalves are triangular in shape, few produce byssus threads for attachment and species that are patterned with greenish-brown on a lighter background generally show a pattern of concentric rings or radiating bars (not angled or wavy lines).

Dark or Conrad's falsemussel *Mytilopsis leucophaeata*: a small (0.6 inche/15 mm) mussel, found from New York to Florida and Texas is in the same family as zebra mussel, and has been confused with zebra mussel, but is shaped more like a marine blue mussel *Mytilus edulis* (more elongated and less triangular). Coloration is generally an unpatterned light or dark brown; however, some Texas specimens occasionally show a faint banding pattern along the hinge. It is typically found only in brackish waters, but has been reported at inland locations. Zebra and quagga mussels and dark falsemussel have a shelf-like structure inside each valve just below the hinge which is absent in true mytiliid mussels. Dark falsemussel also has an additional step-like structure just below the shelf which is absent in both zebra mussels.

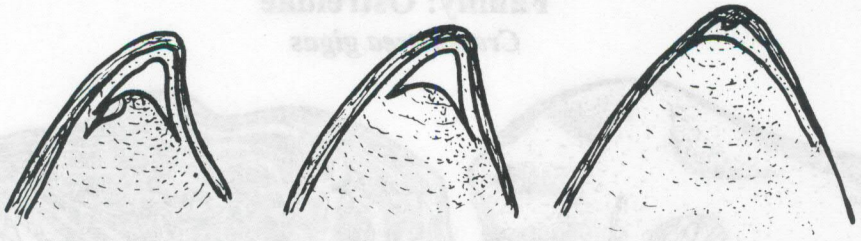
Technical Note:
While the first issue of this guide was in press containing comments about possible confusion between dark falsemussel and zebra mussel, preliminary reports of zebra mussel in the Hudson River where found to be misidentified dark falsemussels (although zebra mussel has invaded the area since). The very problem the guide sought to avoid, occurred before publication and distirbution.

References:
Hebert et al. 1989; Howells et al. 1996; Nalepa and Schloesser 1993; Nitzel et al. 1984; Reeders et al 1989; Roe and MacIsaac 1977. Note: The National Aquatic Nuisance Species Clearinghouse (previously the Zebra Mussel Clearing House; New York Sea Grant Extension, SUNY College at Brockport, Brockport, New York 14420) produces the newsletter "*Dreissena*!" and maintains a current reference library on zebra mussels and other nuisance species. Additionally, a large array of references are currently available on the Internet.

VARIATION IN ZEBRA MUSSEL COLOR PATTERNS



INNER BEAK STRUCTURES



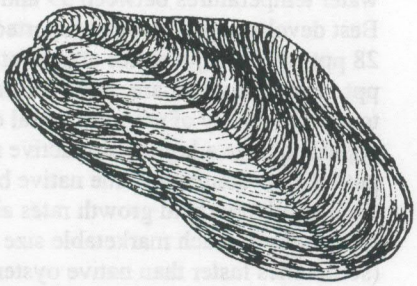
Dark Falsemussel
Mytilopsis leucophaeata

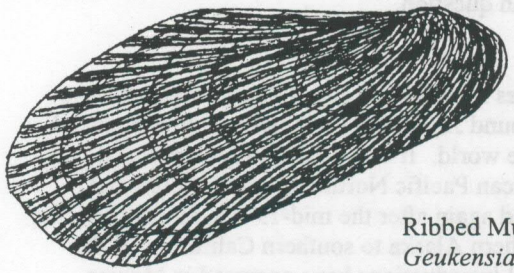
Zebra Mussel
Dreissena sp.

Mytilid Mussel
Mytlus and *Perna*

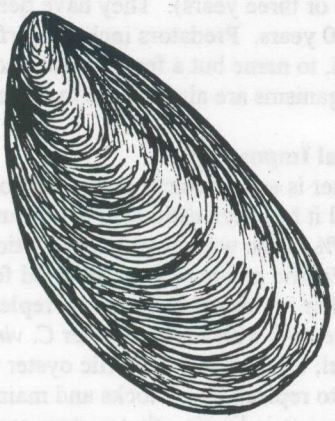
Blue Mussel *Mytilus edulis*

American
Horsemussel
(Tulip Mussel)
Modiolus
americanus

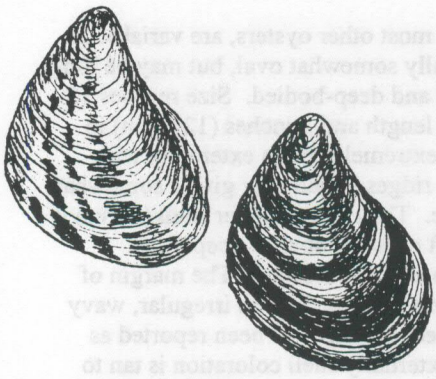




Ribbed Mussel
Geukensia dimissa



Dark Falsemussel
Mytilopsis leucophaeata



Quagga Mussel
Dreissena bugensis

PACIFIC OYSTER

Family: Ostreidae

Crassostrea gigas

Pacific Oyster
Crassostrea gigas

Other Names:
Giant Pacific oyster, Japanese oyster, Miyagi oyster.

Specifics:
The family contains about nine or 10 genera and 50 species, with five genera and eight or nine species in U.S. waters. Although experts differ in classification of some oyster species, the status of Pacific oyster appears not to be in question.

Range:
The species is native to coastal marine and estuarine waters around Japan, but has been widely introduced around the world. It was deliberately introduced into the American Pacific Northwest in the 1920's and 1930's, and again after the mid-1940's, and now occurs from southern Alaska to southern California. Other intentional introductions have occurred in Mexico, France and Australia, with an apparent accidental introduction in New Zealand.

Description:
Pacific oysters, like most other oysters, are variable in shape; they are usually somewhat oval, but may be long and slender or short and deep-bodied. Size reaches 12 inches (305 mm) in length and 5 inches (127 mm) in width. The shell is extremely rough externally with irregular concentric ridges which may give a somewhat shingled appearance. The right or upper shell (valve) is flattened and the left or lower shell is deeper and typically attached to a solid substrate. The margin of the shell has usually been described as irregular, wavy or angularly scalloped, but has also been reported as smooth and thin. Externally shell coloration is tan to grayish-white, occasionally with purplish-brown spots. Internally shells are white with a purple spot at the muscle scar.

Biology:
The species generally occurs intertidally on solid substrates where it filters microscopic organisms from the water. Spawning begins at 66-68°F (18.9-20°C) and peaks at 73-77°F (22.8-25°C). Their minute larvae live a planktonic existence and swim weakly with fine cilia (tiny hairlike structures). Older, larger larvae crawl about on the bottom with a footlike structure until they locate a solid object, and attach. They tolerate water temperatures between 59 and 86°F (15-30°C). Best development has been reported at salinities of 23-28 ppt; spat set (juveniles attach) at salinities of 15-18 ppt. Pacific oysters are noted for their ability to adapt to a wide variety of environmental conditions. They appear to have a high reproductive rate and the potential to dominate some native bivalve communities. Comparatively rapid growth rates allow some specimens to reach marketable size within 18 months (sometimes faster than native oysters which may require two or three years). They have been reported to live up to 20 years. Predators include starfish and oyster drills, to name but a few; fungus and other diseases organisms are also known to infect the species.

Commercial Importance:
Pacific oyster is an extremely important commercial species, and it has been estimated to account for as much as 80% of the world oyster production. American Pacific native oysters declined for unknown reasons earlier in this century. Initial replacement stocking attempts with eastern oyster *C. virginica* were unsuccessful; ultimately the Pacific oyster was introduced to replace local stocks and maintain the fishery. Reports indicating that eastern oyster stocks on the American East Coast may be declining now as well. If true, could suggest possible impetus for the introduction of Pacific oyster into American Atlantic

propagation are well established.

Reasons For Restriction:
Reasons for restriction in Texas are unclear, but likely reflect the greater similarity between Pacific oyster and the Texas-native eastern oyster than to species native to the Pacific Northwest. Pacific oyster is only slightly larger and may offer limited advantages over the native commercial species in the state; native Pacific coast species were much smaller and had already declined prior to the introduction of Pacific oyster (introduction of an exotic shellfish may have been more reasonable on the West Coast than in Texas waters). Fast growth and reproductive rates and the potential to displace native species suggests caution should be applied to possible introductions of Pacific oyster in Texas. Additionally, other oyster transfers have occasionally resulted in the introductions of oyster diseases which have harmed local stocks and fisheries. Although Pacific oyster has apparently not been implicated in any such disease transfers, any importation of oysters from other regions could carry certain risk potentials.

Similar Species:
Pacific oyster could most easily be confused with other oysters in the same family. Because many oysters are extremely variable in size and shape, identification can sometimes be problematic. Pacific oyster reaches a larger maximum size and is usually rough in texture on outer shell surfaces than native species.

Eastern oyster *C. virginica*: Irregularly oval to slightly elongate in shape; to 10 inches (254 mm) in length and 4 inches (102 mm) in width; shells usually much more smooth and thicker than Pacific oyster, and may show some radial ridges; shell margins smooth and usually sharp; external shell coloration usually grayish-white with optional purple marks at the muscle scar; ranges from the St. Lawrence to Florida, Texas, and the Bahamas, with introductions on the Pacific coast. May occur intertidally to depths of about 100 feet (45 m). Another native species in Texas waters, crested oyster *Ostreola equestris*, is smaller (to about 2 inches/51 mm), often paler in color, has a row of small denticles (toothlike structures) on the upper shell, and occurs subtidally.

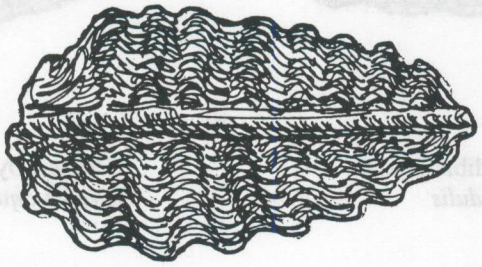
Native Pacific oyster *Ostrea lurida* (Olympic or California oyster; apparently considered *Ostreola conchaphalia* by the American Fisheries Society): Usually irregularly oval in shape; to 2.75 inches (70 mm) in length and 2.25 inches (57 mm) in width; externally shells rough and scaly, sometimes with ridges; the right valve with fine teeth near the ligament and the left valve with corresponding pits; shell margin typically saw-toothed or scalloped; external shell color grayish-white to brown with occasional purplish rays; and internal coloration grayish-white with a green tinge (Pacific oyster is not green internally); ranges from Alaska to Baja California.

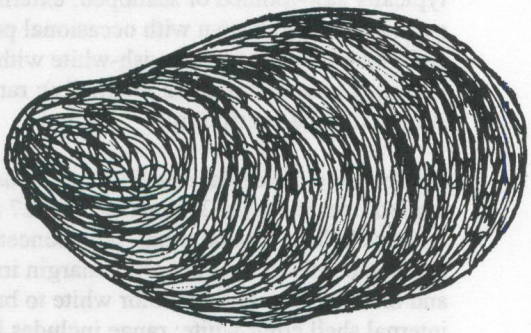
European edible or flat oyster *Ostrea edulis:* Irregularly oval to oval in shape; 3-5 inches (76-127 mm) in length; shells thick and rough with concentric ridges, and sometimes radial ribs; shell margin irregular, thin and brittle; external shell color white to brown, and internal shell color white; range includes European coastal waters with introductions in New England and on the Pacific coast. Unlike Eastern and Pacific oysters, this species tolerates little tidal exposure; subtidal.

Coon or frond oyster *Dendrostrea* (*Ostrea*) *frons*: Irregularly oval in shape; to 3.5 inches (89 mm) in length and 3 inches (76 mm) in width; external shell surfaces with course radiating folds on the upper shell and fingerlike spines for attachment on the lower shell (absent in Pacific oyster); shell margin strongly fluted (series of slightly projecting channels and ridges; absent in Pacific oyster); external coloration yellowish-white to rosy or brown; ranges from North Carolina through the West Indies.

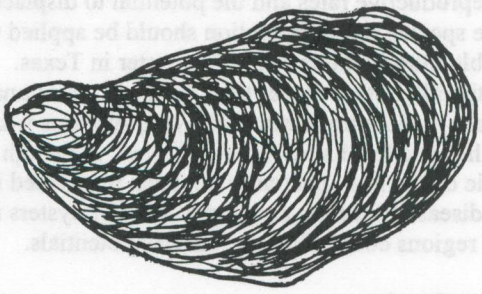
References:
Chew 1990; Fitch 1953; Rehder 1981; Sowerby 1870-1871.

Coon Oyster
Dendrostrea frons

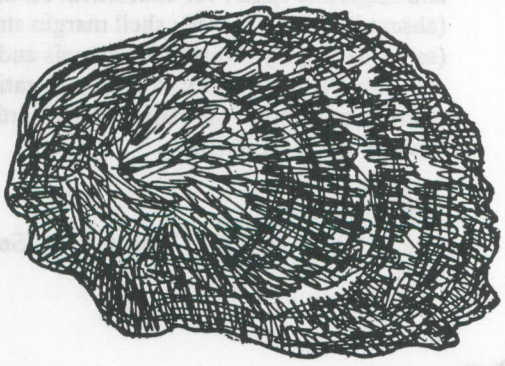




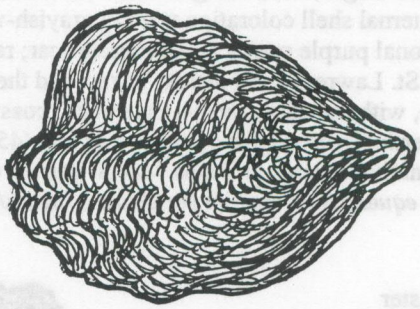
Eastern Oyster
Crassostrea virginica



Native Pacific Oyster
Ostrea lurida



European Edible Oyster
Ostrea edulis



Crested Oyster
Ostreola aquestris

SPECIES ACCOUNTS: PROHIBITED AQUATIC PLANTS

Definitions

Acute - sharply pointed.

Annual - typically a plant surviving one season from seed to death.

Ascending - rising upwards.

Axis - the main or central line of development, often the stem.

Callus - a hard swelling at the base.

Capsule - dried fruit from a compound pistil.

Carpels - the units of a compound pistil.

Compound leaves - leaves in which the blades consist of two or more parts.

Corolla - the inner whorl of floral envelopes.

Deciduous - falling off in autumn, early or easily; loosing leaves annually.

Dioecious - unisexual with staminate (male) and pistillate (female) flowers on different plants.

Emergent - growing partially in water or extending above the surface.

Fruit - the ripened ovary or ovaries.

Herbaceous - not woody.

Imperfect flower - a flower lacking either stamens or pistils.

Inflorescence - a flower cluster.

Joint - the articulation or swelling on a stem.

Monoecious - having both male and female flowers on the same plant (sometimes within the same flower).

Opposite - having two leaves or buds at a node.

Palmate - radiating like a fan.

Peduncle - the stem of a single flower.

Perfect flower - a flower having both stamens and pistils.

Perianth - the entire floral envelope.

Persistent - remaining attached; also meaning difficult to remove or eradicate.

Pinnate - feather-like.

Pistil - the female seed-bearing organ with a style and stigma.

Pistillate - having pistils but not stamens.

Rhizome - an underground stem, especially a horizontal underground stem.

Runner - a horizontally growing stem that trails along the surface of the ground; a small daughter plant that arises from a runner.

Sessile - without a stalk.

Stamen - the pollen-bearing male organ of a flower.

Staminate flower - a flower having anthers but not pistils; male flower.

Stigma - the part of a pistil that receives the pollen (distil tip).

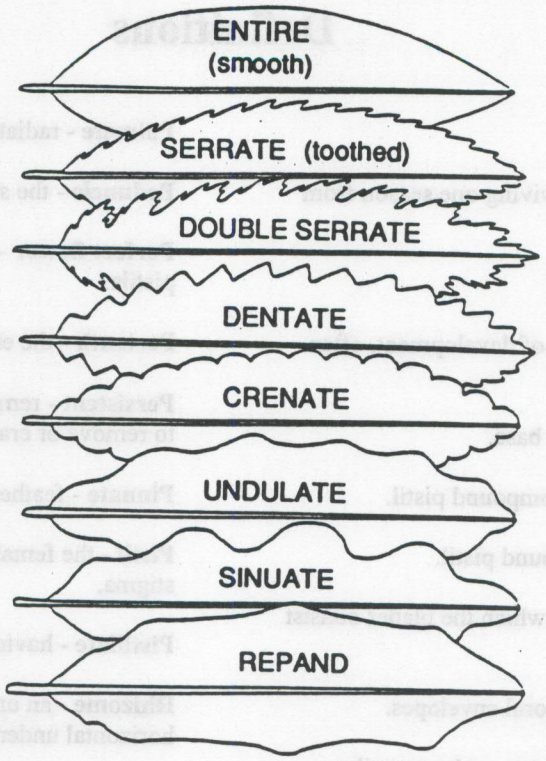
Stipe - the stock of a pistil.

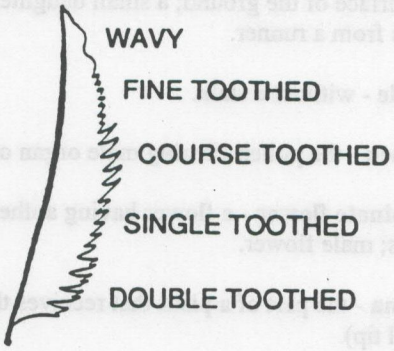
Terminal - at the end of a branch or stem.

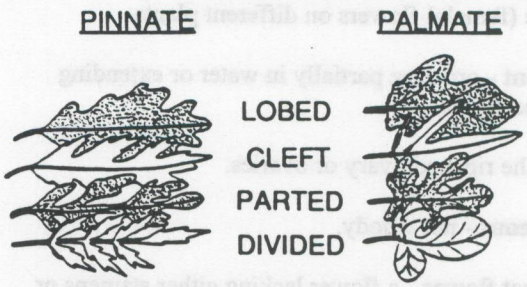
Whorl - a ring of leaves, flower parts or flowers occurring at a single node.

Whorled - having leaves arranged in groups of three or more at a single node.

LEAF TYPES







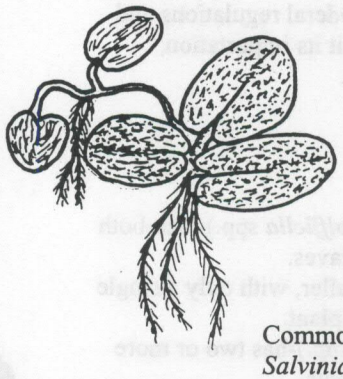
PARALLEL PALMATE PINNATE ARCUATE

SALVINIAS

Family: Salviniaceae

All Species of the Genus *Salvinia*

Giant Salvinia
Salvinia molesta



Common Salvinia
Salvinia minima

Other Names:
Water fern; *S. auriculata*= butterfly fern, watermoss; *S. minima*=water spangles.

Specifics:
Salvinia auriculata (*S. rotundifolia*) has occasionally been listed as *S. natans;* however, *S. natans* applies to European salvinia. A number of other tropical and temperate salvinias are recognized; the family contains about 11 species. Other occasionally encountered species include: *S. minima*, *S. molesta,* and *S. oblongifolia*.

Range:
All salvinias, except *S. natans*, are native to warmer waters around the world. *Salvinia minima* is believed to have been introduced into the southeastern U.S. from South or Central America; it was found in Texas waters in the early 1990s and *S. molesta* appeared in 1997-98.

Description:
All Salviniaceae are actually a small, aquatic ferns that floats at the surface with a "hairy" root-like leaf dangling below. Floating leaves are in 2's, oblong to nearly round, about 0.4-0.8 inch (10-20 mm) long (larger in *S. molesta*); a third leaf is positioned below the water surface in place of roots (there are no true roots). Floating leaves are bluish-green and covered with stiff hairs and bump-like projections. A crease usually runs down the center of each leaf. Multiple sets of three leaves may be connected along a common axil.

Other salvinias include:
S. auriculata (*=hispida=biloba=rotundifolia*)-larger leaves (0.6-1.0 inches/15-25 mm); from Cuba and Central and South America.
S. minima-leaves round to oval, creased, leaf hairs with free tips.
S. cucullata-leaves cup-shaped; from Sumatra, India, and Borneo.
S. natans (*=europea=elegans=sprengeli =vulgaris*)-leaves small (often to 0.6 inches/15 mm), oblong or ovate, and with brown hairs; from Europe, North Africa, and Java. This is a temperate species with reproduction by fertile spores.
S. molesta (giant salvinia)-mature leaves to about 2.0 inches (50 mm), more upright, in 2's or in multiple lettuce-leaf clusters; younger leaves may lay flatly on the water surface; largely cosmopolitan in warm waters due to introductions.
S. oblongifolia-leaves more elongated, often three to four times longer than wide; South America (Amazon).

Leaf hairs have free tips in *S. oblongifolia* and *S. minima*, but are joined at the tip to form small cages in *S. molesta, S. auriculata,* and *biloba* and others.

Biology:
Salvinias are found in quiet-water areas in ponds and bayous. Reproduction by spores (on root-like leaves) occurs in *S. natans,* otherwise propagation is by asexual budding. Fragmented leaf clusters can produce new plants as well. Most have limited value to fish or wildlife. All salvinias do better at warmer temperatures than does European salvinia, but some species like *S. molesta* may tolerate freezing.

Commercial Importance:
Salvinias have been reared at aquaculture facilities and collected in the wild for sale in the aquarium and fish-pond trade, but usually to a very limited extent. Watch for these plants at water-garden centers.

Reasons For Restriction:
Dense populations of salvinias may shade out other more desirable aquatic plants. Giant salvinia has become a major noxious aquatic plant in other countries where it has reproduced rapidly; it has been known to over-grow even species like water hyacinth *Eichhornia crassipes*. U.S. federal regulations and others in several states prohibit its importation, cultivation and transportation.

Similar Species:
Other similar floating plants:

Wolffias (*Wolffia* spp. and *Wolffiella* spp.)-lack both roots and root-like leaves.
Duckweeds (*Lemna* spp.)-smaller, with only a single unbranched root per plant.
Giant duckweeds (*Spirodela* spp.)-has two or more long, filament-like roots.
Water lettuce (*Pistia* sp.)-much larger, many-grooved leaves in a rosette.
Water sprite (*Ceratopteris* spp.)-much larger, leaves often fern-like (even wide-leafed varieties have indented edges).

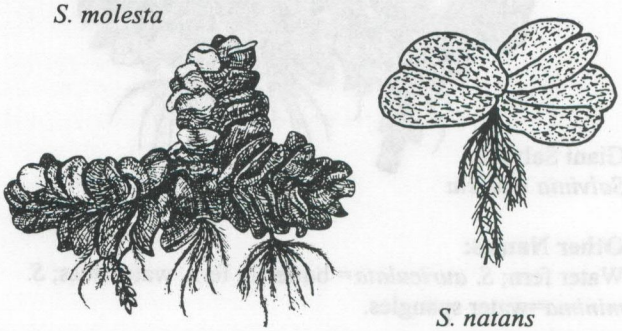
Technical Note:
Differentiating between salvinia species, especially if plants are not mature, can be extremely difficult. Botanists use the shape and arrangement of sporocarps and chromosome counts to identify species.

References:
Correll and Correll 1972; Fassett 1957; Hatch et al. 1990; Prescott 1969; Reed 1988a, b; Tarver et al. 1979; Westerdahl and Getsinger 1988.

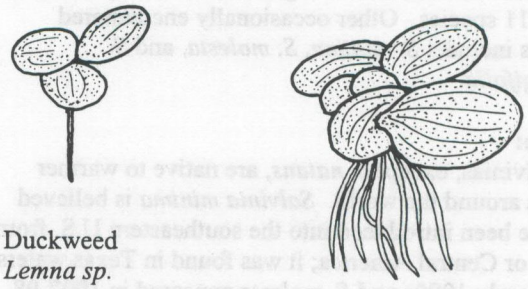
OTHER SALVINIAS

S. oblongifolia

Giant Salvinia
S. molesta



S. natans

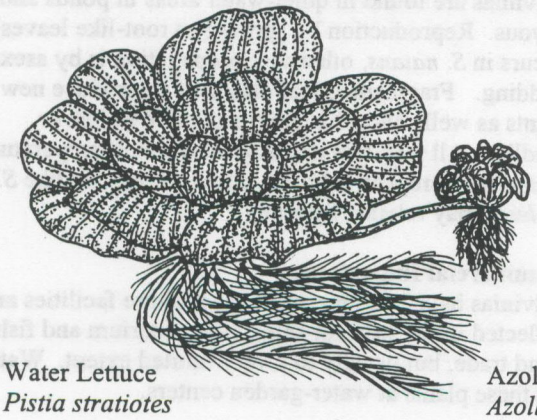


Duckweed
Lemna sp.

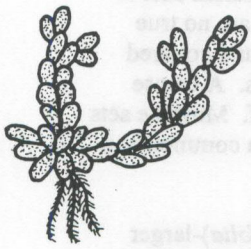
Giant Duckweed
Spirodela sp.

Wolffia
Wolffia sp.

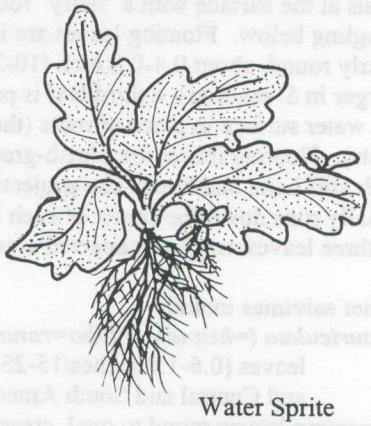
Wolfiella
Wolfiella sp.



Water Lettuce
Pistia stratiotes



Azolla
Azolla caroliniana

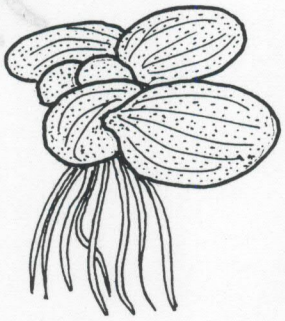


Water Sprite
Ceratopteris sp.

GIANT DUCKWEED

Family: Lemnaceae

Spirodela oligorhiza



Giant Duckweed
Spirodela oligorhiza

Other Names:
Duck-meat, large duckweed, common duckmeat.

Specifics:
This species and a second, *S. polyrhiza*, are recognized in U.S. waters. There are approximately six cosmopolitan species in the genus.

Range:
Giant duckweed is cosmopolitan, except in South America. It is apparently native to the U.S., being reported from Missouri and rarely in East Texas (Shelby County).

Description:
Leaves are in groups of 2-5 (rarely singly) or more; they are small (0.08-0.2 inch/2-5 mm), flattened, and rounded, and float at the surface with two or more filament-like roots dangling below. Leaves have 5-11 prominent nerves, and are green above and reddish below. One female (pistillate) and two male (staminate) flowers may be present in pouches on each side of the leaf base. Seeds are produced, but reproduction usually occurs by vegetative budding.

Biology:
Giant duckweed is one of the largest of several types of duckweeds. It floats on small ponds and quiet backwaters of bayous and streams. It can be an important food source to several species of waterfowl.

Commercial Importance:
It is occasionally available in the pet trade or through aquacultural sources.

Reasons For Restriction:
Problems sometimes occur in small ponds where giant duckweed may produce dense growths that may block light needed by more desirable aquatic plants. It may produce growths thick enough to block access to wildlife and livestock, as well as to angling and other recreational uses.

Similar Species:
Other small, floating aquatic plants:

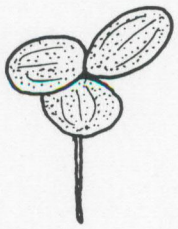
Wolffia (*Wolffia* spp. and *Wolffiella* spp.)-lacks roots.
Duckweed (*Lemna* spp.)-has only a single root, is not reddish on lower leaves.
Salvinia (*Salvinia* spp.)-leaves usually larger (0.4-0.8 inch/10-20 mm or more), floating leaves often in 2's, feathery root-like leaf below (no true roots), usually much smaller.
Other giant duckweeds (*S. polyrhiza*)-has 2-4 lateral veins (5-11 in *S. oligorhiza*), leaves sometimes larger (0.1-0.4 inch/3-10 mm), leaves glossy green (more yellow green in *S. oligorhiza*), and with 4-12 roots; common across the U.S., including Texas.

Larger floating aquatic plants:
Most other floating aquatic plants like water hyacinth *Eichhornia crassipes*, water lettuce *Pistia stratiotes,* and water sprite *Ceratopteris* spp. are substantially larger (> 0.5-1.0 inch/13-25 mm).

Technical Note:
Taxonomic characteristics for four of the six cosmopolitan species are unavailable at this time; therefore, caution should be used in identifying *Spirodela oligorhiza* because other species are not restricted in Texas.

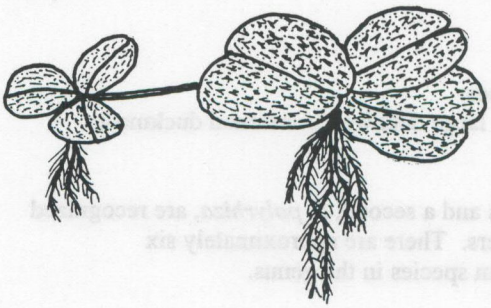
References:
Correll and Correll 1972; Fassett 1957; Hatch et al. 1990; Muenscher 1967; Prescott 1969; Reed 1988a, b; Riemer 1984; Stodola 1967; Tarver et al. 1979; Westerdahl and Getsinger 1988.

Duckweed
Lemna minor



Wolfiella
Wolfiella sp.

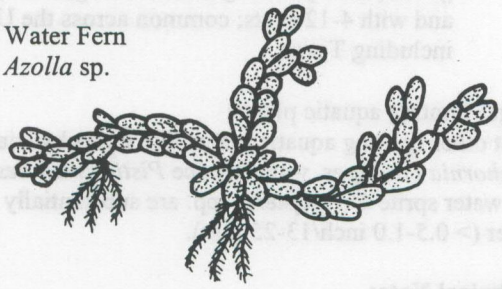
Ivy Duckweed
Lemna trisculca

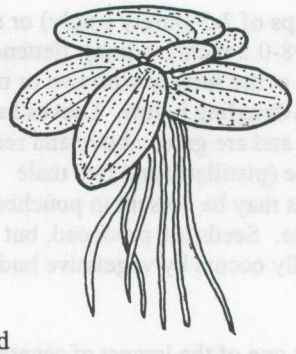


Wolffia
Wolffia sp.

Salvinia
Salvinia sp.

Water Fern
Azolla sp.



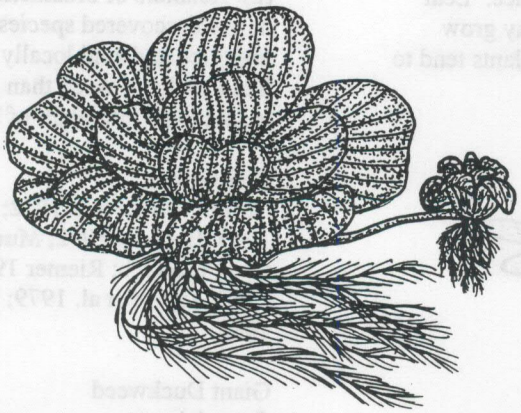


Giant Duckweed
Spirodela polyrihza

WATER LETTUCE

Family: Araceae

Pistia stratiotes



Water Lettuce
Pistia stratiotes

Other Names:
Water bonnet, waterlettuce, water-lettuce.

Specifics:
This genus is monotypic.

Range:
Water lettuce is reported as cosmopolitan in tropical waters, listed as native to Texas by the U.S. Fish and Wildlife Service and Texas A&M University and known from fossil records in several locations in North America; however, some botanists still consider it an introduced species. It presently occurs from Florida through Texas and into Central and South America.

Description:
Although related to other arums like sweet flag *Acorus calamus*, water lettuce does not closely resemble them. Its leaves are 4-8 inches (102-203 mm) in length, have a velvety surface due to very small hair-like structures, have a generally smooth edge, and form rosettes resembling a lettuce head. Leaves also have about 10 distinct veins radiating outward from the narrowed leaf base; they are spongy to facilitate buoyancy. Several plants may be connected along a common axil called a stolen. Roots which dangle below are feather-like, but unbranched. Plants produce numerous very small flowers in the center of the rosette. Leaf color is green.

Biology:
Water lettuce floats on quiet waters of ponds, lakes and bayous; it prefers soft, acid waters and is generally intolerant of freezing conditions. It can reproduce by seed, or by buds from the parent plant or along the stolon (a slender horizontally-growing stem). Dense growths with dangling roots may provide cover for small fishes and it is eaten by muskrats *Ondatra zibethicus*, but generally has limited value for wildlife.

Commercial Importance:
Water lettuce is occasionally sold in the pet trade but is often difficult to maintain in aquaria. It now appears on sale for use in water gardens and goldfish ponds.

Reasons For Restriction:
Excess production under favorable conditions can sometimes completely cover ponds, bays and small lakes blocking recreational access, wildlife and shading more desirable aquatic plant species.

Similar Species:
Water lettuce has much larger leaves than seen in many other floating water plants like wolffia *Wolffia* spp. and *Wolffiella* spp., duckweed *Lemna* spp., giant duckweed *Spirodela* spp., and water fern *Azolla* sp. The 10 or so unbranched leaf veins in water lettuce differ from those in the smaller species where leaf veins are either fewer in number (one) or lacking, except in some giant duckweeds.

Floating water hyacinth *Eichhornia crassipes* may be similar in size but has inflated leaf stems (lacking in water lettuce), leaves which lack the approximately 10 bold leaf veins seen in water lettuce and large flower spikes which project above the plant.

Another similar plant called water sprite (*Ceratopteris thalictroides*, *C. pteridoides*, *C. deltoides*) is often

called water lettuce, floating fern or water fern when sold in the pet trade; one or more species occur naturally in Florida and the Gulf Coast states. It may have finely-divided fern-like leaves or may occur in a broad-leafed form; however, even the broad-leafed plants have indentations on the leaf edge. Its veins are branching, not radial as seen in water lettuce. Leaf surfaces lack small hairs. Water sprite may grow floating or rooted on the bottom; rooted plants tend to develop thinner, more elongated leaves.

Technical Notes:

(1) Be cautious with aquarium plants sold as water lettuce which are more likely to be unrestricted broad-leafed water sprite than restricted water lettuce.

(2) Retailers of ornamental fish-pond plants report a newly descovered species of water hyacinth is being imported and sold locally. It apparently appears more like a pickerel weed than either prohibited species and is said to be intolerant of Texas winters.

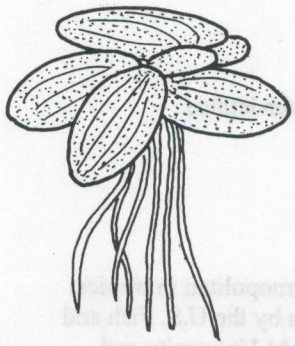
References:

Correll and Correll 1972; Fassett 1957; Hatch et al. 1990; Howells 1992; Muenscher 1967; Prescott 1968; Reed 1988a, b; Riemer 1984; Stoddard 1989; Stodola 1967; Tarver et al. 1979; Westerdahl and Getsinger 1988.

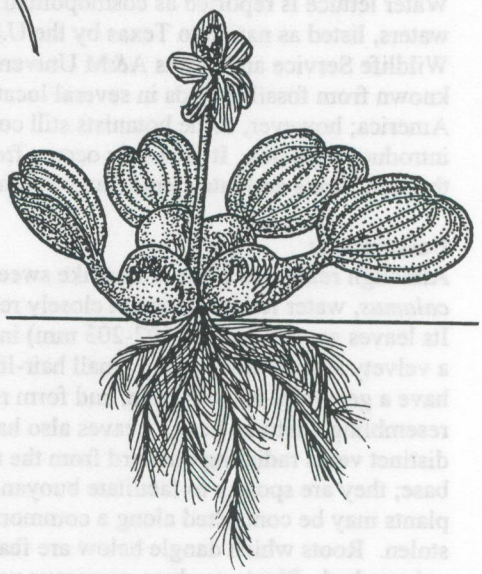
Wolffia
Wolffia sp.

Wolffiella
Wolffiella sp.

Giant Duckweed
Spriodela sp.

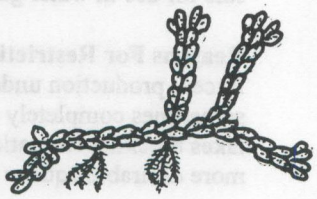


Water Hyacinth
Eichhornia crassipes

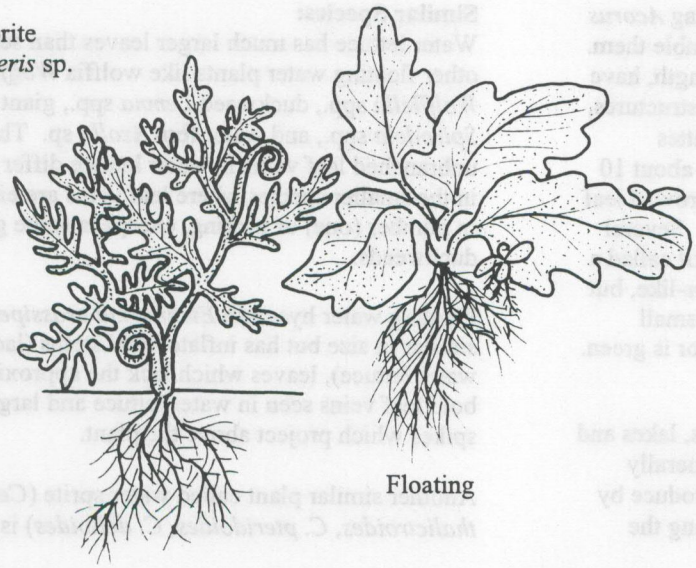


Duckweed
Lemna sp.

Water Fern
Azolla sp.



Water Sprite
Ceratopteris sp.



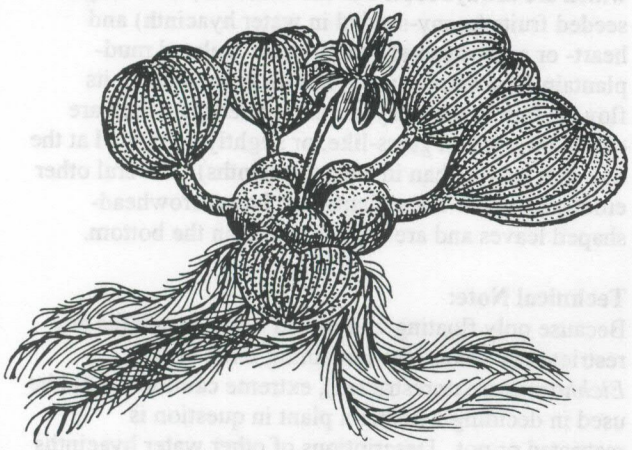
Rooted

Floating

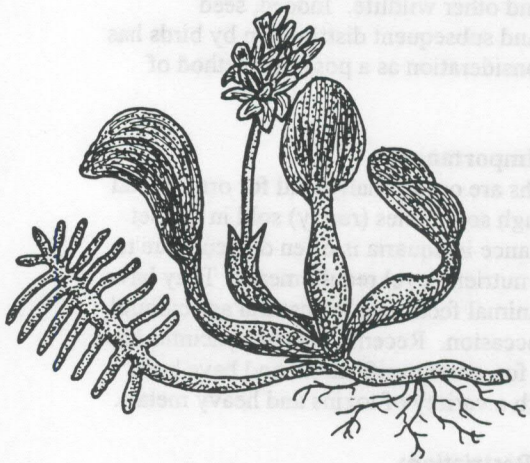
WATER HYACINTHS

Family: Pontederiaceae

Floating Water Hyacinth *Eichhornia crassipes* and Rooted Water Hyacinth *E. azurea*



Floating Water Hyacinth
Eichhornia crassipes



Rooted Water Hyacinth
Eichhornia azurea

Other Names:
Floating water hyacinth is often called simply water hyacinth (also waterhyacinth and water-hyacinth); rooted water hyacinth is sometimes called anchored water hyacinth. Recent U.S. Fish and Wildlife Service literature has used common water-hyacinth and saw-petal water-hyacinth, respectively, for these plants.

Specifics:
The genus (also spelled *Eichornia*) contains 6-7 species with only two restricted in Texas. Both species were called *Pontederia* in older literature (see Similar Species), with rooted water hyacinth listed as *P. aquatica* and floating water hyacinth as *P. azurea* (and also as *Heteranthera formosa* and *Piaropus crassipes*). Both species have mutually been confused. Other species include: *E. natans*, *E. paradoxa*, *E. paniculata,* and *E. diversifolia*, with the status of *E. major*, *E. martiana*, and *E. speciosa* unclear and probably invalid. None of the additional species are restricted in Texas.

Range:
Both restricted species were apparently native to South America, but with numerous introductions into Central and North America, and of floating water hyacinth into Africa and elsewhere. African water hyacinth *E. diversifolia* is found in Africa, with the remaining species in Central and South America. Apparently only *E. crassipes* and *E. azurea* have expanded significantly beyond their native ranges.

Description:
Water hyacinths have generally smooth-edged leaves of dark green which project above the water surface, and with feathery roots dangling below or rooted into the substrate.

Floating water hyacinth has leaves up to about 8 inches (203 mm) in length which are nearly circular to elliptical in shape. Leaf stems have inflated, spongy bulbs. Leaves and stems together may extend 3 feet (0.9 m) or more above the water. Roots are very fibrous and many branched. Flowers occur in spikes and are violet-blue in color with yellow markings.

Rooted water hyacinth is very similar but lacks the inflated leaf stems, and has leaves (2-6 inches/51-152 mm long) that tend to be more pointed (rarely elongated under totally submerged conditions) and flowers which are similar to those in floating water hyacinth but often less robust and more blue in color.

Biology:
Water hyacinths are notorious as noxious aquatic pests. Floating water hyacinth was reportedly brought from South America to the U.S. in 1884 for display in the Cotton States Exposition in New Orleans that year. Through escapes and deliberate introductions, it spread rapidly and was already causing problems by 1887, with subsequent funding for control by 1889. Most species float, including rooted water hyacinth at times; however, even floating species may attach to the

bottom in very shallow waters. They can survive in a variety of habitat types, but prefer quiet backwater areas and protected bays and canals. Reproduction can be by seed or vegetative production of daughter plants. Water hyacinths provide cover and habitat for many types of fish and other aquatic animals; they are eaten by manatees and other wildlife. Indeed, seed consumption and subsequent distribution by birds has come under consideration as a possible method of dispersal.

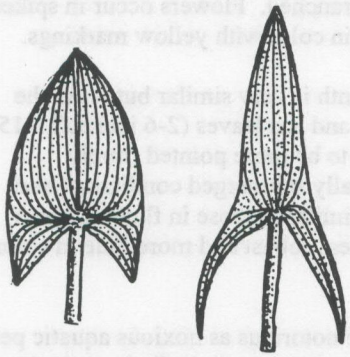
Commercial Importance:
Water hyacinths are occasionally sold for ornamental ponds. Although sometimes (rarely) sold in the pet trade, maintenance in aquaria is often difficult due to high light and nutrient level requirements. They have been used as animal feeds and for natural agricultural fertilizers on occasion. Recently, water hyacinths have come into use for water purification, and have been found to absorb a variety of toxins and heavy metals.

Reasons For Restriction:
The list of problems associated with excessive growths of water hyacinths is extremely long; it ranges from blocking navigation, limiting water access and recreation, shading and competing with more desirable aquatic plants, providing habitat for mosquitos and causing increased water loss from the system through transpiration. Exemptions for use in water purification have been incorporated into TPWD regulations.

Similar Species:
Water hyacinths differ from true pickerel-weeds *Pontederia* spp., and similar species like arrowhead *Sagittaria* spp. and arrow-arum *Peltandra virginica*, which are always rooted in the substrate, have single-seeded fruits (many-seeded in water hyacinth) and heart- or arrowhead-shaped leaves. Related mud-plantain *Heteranthera* spp. has three stamens in its flowers (six in water hyacinth) and leaves which are either narrow and grass-like, or slightly expanded at the tips (but less so than in water hyacinths). Several other emergent, shore-zone plants also have arrowhead-shaped leaves and are always rooted in the bottom.

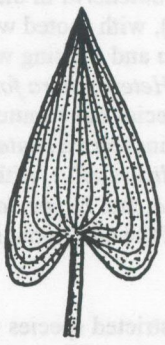
Technical Note:
Because only floating and rooted water hyacinths are restricted in Texas (the remaining three or four *Eichhornia* are unrestricted), extreme caution should be used in deciding whether a plant in question is restricted or not. Descriptions of other water hyacinths are unavailable at this time.

References:
Cook et al. 1974; Correll and Correll 1972; Hatch et al. 1990; Holm et al. 1969; Howells 1992; Muenscher 1967; Reed 1988a, b; Riemer 1984; Sculthorpe 1985; Stodola 1967, 1987; Tarver et al. 1979;.



Arrowhead
Sagittaria spp.

Arrow-arum
Peltandra sp.



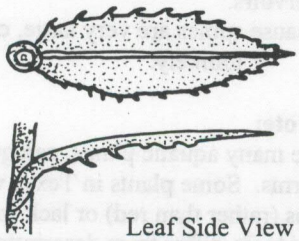
Pickerel-weed
Pontederia sp.

HYDRILLA (FLORIDA ELODEA)

Family: Hydrocharitaceae

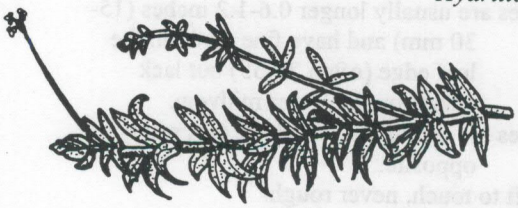
Hydrilla verticillata

Leaf Top View



Leaf Side View

Hydrilla
Hydrilla verticullata



Other Names:
Florida elodea, star vine, oxygen plant.

Specifics:
This plant has also been called *Serpicula verticillata*, *H. alternifolia* and *H. dentata*. The number of species in the genus is unclear.

Range:
Hydrilla may have originated in Africa, but is now largely cosmopolitan, especially in warmer waters. It is a major noxious species in Texas reservoirs.

Description:
Hydrilla is very similar to *Elodea* spp. and *Egeria densa*. It often produces long stems which branch freely. Leaves are 0.4-0.8 inch (10-20 mm) long and 0.08-0.2 inch (2-5 mm) wide with toothed edges (often 10-15 teeth) and (usually) with a toothed midrib on the lower leaf surface. Some specimens in Texas may have only 1-3 small spines on the lower midrib, others may have only small bumps and occasionally spines and bumps are entirely lacking on the midrib. Hydrilla usually feels rough to the touch. Leaves on the middle and upper stem segments occur in whorls of 2-8 (often 4-5). Flowers (bisexual) are in sets of 3's with three white petals about 0.16-0.17 inch (4.1-4.3 mm) across. Coloration is green with leaf midveins often being red; however, numerous specimens with green midveins occur in Texas and in aquarium plants grown under reduced light levels.

Biology:
This species is fully aquatic and cannot withstand extensive drying; however, it may float at the surface where it forms dense mats. Hydrilla can survive under a variety of conditions including reduced light levels, brackish waters and in still or flowing waters. Reproduction can be by seed or vegetatively by fragmentation, winter buds (turions) or from stolons and rhizomes. It is sometimes eaten by waterfowl, provides cover for fish and other aquatic organisms and produces oxygen, but in general has limited value to wildlife.

Commercial Importance:
Hydrilla is believed to have been introduced through the aquarium trade, and it may still appear for sale on occasion (often inadvertently through confusion with *Elodea* spp.). Although it can be a source of dissolved oxygen in aquarium and fish pond culture, its reputation for noxious, invasive habits has helped limit its popularity. Its ability to reproduce by fragmentation has resulted in accidental introduction by boat trailers and other means to many locations.

Reasons For Restriction:
Because hydrilla tolerates low light levels and salinity, and often grows so rapidly that it crowds or shades more desirable aquatic plants, it has long been restricted in Texas and elsewhere.

Similar Species:
Hydrilla is most easily confused with *Elodea* spp. (unrestricted) and *Egeria densa* (unrestricted). *Egeria densa* has been introduced in Texas and *Elodea* spp. has been reported, but recent references suggest in may not occur in Texas waters.

Elodea spp. (called elodea, American elodea, waterweed, Dutchmoss); several species:
Leaves (to 0.8 inch/20 mm long) have fine teeth on the leaf edge but lack teeth on the lower midrib.
Leaves are usually in whorls of 3 (rarely 4-5) in *E. canadensis* and *E. nuttallii*, but opposite in *E. bifloliata* (from New Mexico) and *E. longivaginata* (from Arizona).
Is soft to the touch, never rough.

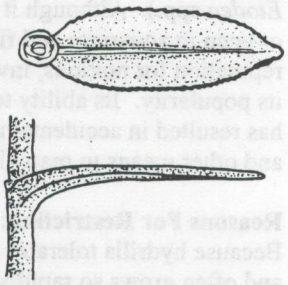
Leaf midribs are usually not red.
Male flowers (separate flower sexes) are small (to about 0.06 inch/1.5 mm), petals are small and colorless, and are pollinated under water.

- *Egeria densa* (called egeria, Brazilian elodea, anacharis, *Elodea densa*):
  Leaves are usually longer 0.6-1.2 inches (15-30 mm) and have fine teeth on the leaf edge (often 25-35) but lack spines on the lower midvein.
  Leaves are usually in whorls of 4-6; rarely are opposite.
  Is soft to touch, never rough.
  Midribs are green, never red.
  Male flowers in 2-4's with three petals (to 0.3 inch/8 mm wide), female flower petals are 0.4-0.8 inches (10-20 mm) wide, pollination occurs above the water surface by insects.

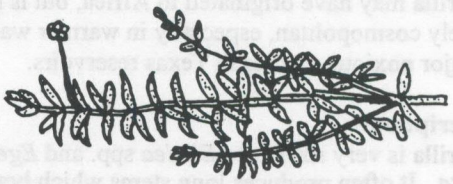
- *Najas marina* (spiny naiad):
  Leaves have large spines on the leaf edges and lower midvein, and stems are spiny; leaves may reach about 1.8 inches (46 mm) in length.
  Very rough to touch.
  Midribs typically not red.
  Occurs in coastal waters and some Texas reservoirs.
  Because spines are very large, confusion is unlikely.

Technical Note:
Hydrilla, like many aquatic plants, can grow in a variety of forms. Some plants in Texas which have green midribs (rather than red) or lack spines on the lower leaf midvein differ from descriptions given in some books. When grown under certain conditions (e.g., very low light levels), hydrilla can grow in a very elongated form.

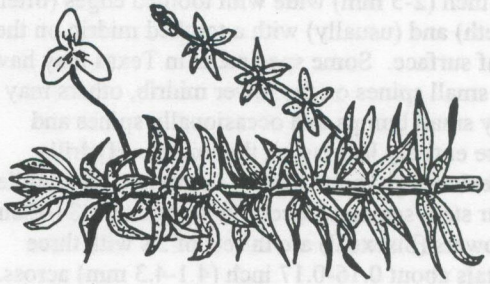
References:
Correll and Correll 1972; Fassett 1957; Hatch et al. 1990; Howells 1992; Muenscher 1967; Prescott 1968; Reed 1988a, b; Riemer 1984; Stodola 1967; Tarver et al. 1979; Westerdahl and Getsinger 1988.

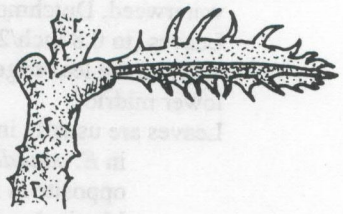


Waterweed *Elodea* sp.

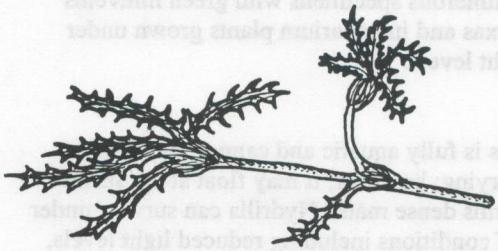


Egeria *Egeria* sp.



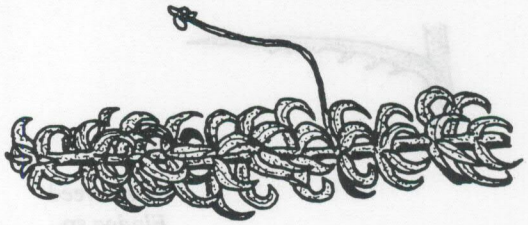


Spiny Naiad *Najas marina*



LAGAROSIPHON
Family: Hydrocharitaceae
Lagarosiphon major

Lagarosiphon
Lagarosiphon major



Leaf Top View

Other Names:
African elodea.

Specifics:
Lagarosiphon is sometimes listed as *L. muscoides* var. *major*; and incorrectly as *Elodea crispa*. The number of species in the genus is unclear.

Range:
It is native to southern Africa and Madagascar and has been introduced into Europe, Australia and New Zealand. Apparently it has not established in the U.S.

Description:
Lagarosiphon is very similar in appearance to elodea *Elodea* spp. and hydrilla *Hydrilla verticillata*. It has long stems (to 3+ feet/0.9+ m) which grow rooted on the bottom. Leaves are long (0.6-0.8 inch/15-20 mm) and somewhat lance-shaped (linear-lanceolate) with edges that are slightly serrated (crispate) or smooth. Leaves often curl downward; leaf arrangement may be alternate, opposite, subwhorled, or flat whorled. Plants are relatively fragile. Leaf color is usually green with a green midrib. Male flowers are small and have three, turned-back petals; female flowers (on different plants) are similar.

Biology:
Lagarosiphon may occur in still-water lakes and ponds or in flowing streams and rivers, or even in larger temporary ponds. Like elodea, it requires moderate levels of calcium and potassium for optimum growth. Pollination takes place at the surface where female flowers that have grown upwards contact the floating male flowers. Reproduction may be by seed or vegetatively through fragmentation of stems or rhizomes.

Commercial Importance:
This plant has been sold for many years in the pet trade but appears not to have held interest for aquaculturists.

Reasons For Restriction:
Lagarosiphon has become problematic in New Zealand and Australia by out-competing native aquatic plants. Availability in the pet trade and noxious growths elsewhere suggested restriction may help avoid problems already seen with hydrilla. This plant is also restricted in Florida.

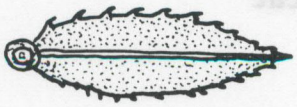
Similar Species:
Lagarosiphon is probably most similar to elodea, hydrilla and egeria *Egeria densa*; however, all three have leaves in definite whorls (otherwise in lagarosiphon). Leaves often curl back farther in African elodea than in other genera. Leaf edges are smooth or slightly serrate in lagarosiphon, but are toothed in elodea, hydrilla and egeria. The lower leaf midvein is green and untoothed in lagarosiphon but may be red and is usually toothed in hydrilla.

Technical Note:
Because the number of species of *Lagarosiphon* is unclear, as are differences between species, and because only *L. major* is restricted in Texas, caution should be used in concluding that a specimen in question is actually *L. major*.

References:
Correll and Correll 1972; Prescott 1969; Reed 1988a, b; Riemer 1984; Stodola 1967; Tarver et al. 1979.

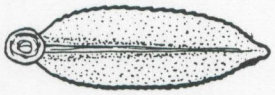
Leaf Top View

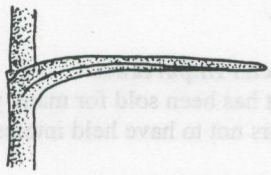
Hydrilla
Hydrilla verticulata

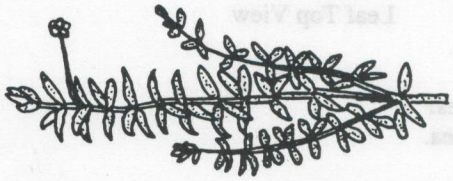


Leaf Side View

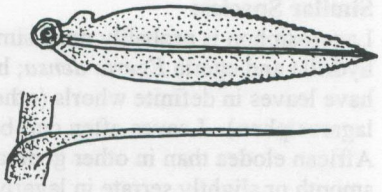
Waterweed
Elodea sp.

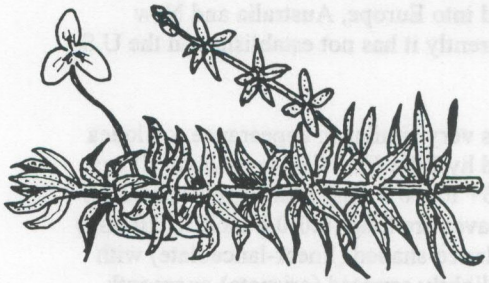






Egeria
Egeria sp.

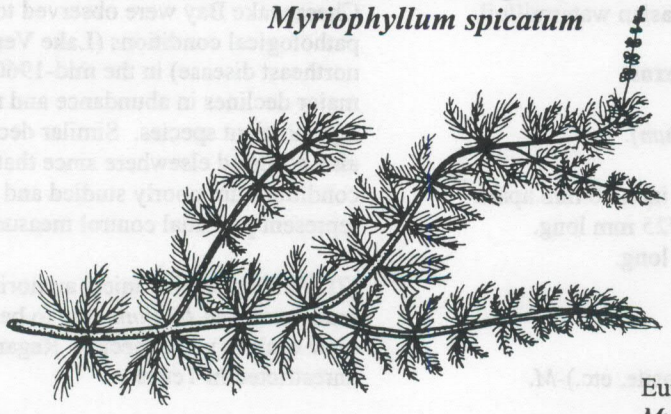




EURASIAN WATERMILFOIL

Family: Haloragaceae

Myriophyllum spicatum



Eurasian Watermilfoil
Myriophyllum spicatum

Other Names:
European watermilfoil, parrot-feather, fox-tail.

Specifics:
The genus contains 40-45 species with at least six species found in Texas waters. Numerous other species have been incorrectly called *M. spicatum*.

Range:
Eurasian watermilfoil was originally from Europe and Asia, but now is almost cosmopolitan due to introductions, except in Central America, South America and Australia where other species dominate. First identified in U.S. waters in the 1880's, it became problematic in the mid-1950's in Chesapeake Bay.

Description:
Eurasian watermilfoil produces long (6-10 feet/1.8-3.0 m), branching stems with feather-like leaves (0.4-1.0 inch/10-25 mm long) with 6-16 (usually about 12) pairs of leaflets (each less than about 0.6 inch/15 mm long) spaced 0.03-1.00 inch (0.8-25 mm) apart. Leaves grow in whorls of 3-6 (often 4). Stems are often reddish-brown to purple in color and become reddish-brown to pink on drying; leaves are usually green but become brown when dead or dying. Flower spikes arise from leaf axils and project above the surface of the water; pistillate flowers are 0.06-1.00 inch (1.6-25 mm) long with a tuft of white or pink on stigma lobes.

Biology:
Although this species can provide breeding habitat and cover for fishes and other aquatic animals, and is sometimes eaten by birds, it often becomes noxious. Although Eurasian watermilfoil flowers, its fruits rarely ripen and most reproduction is vegetatively through fragmentation. Mechanical attempts to remove it from water bodies often cause extensive fragmentation with subsequent production of many new plants. It can be an important source of dissolved oxygen, but requires high light levels for good growth. Unlike some native milfoils, it tolerates brackish water to about 12-13 ppt salinity (about one-third sea water).

Commercial Importance:
This and other watermilfoils are sometimes sold in the pet trade or by aquaculturists for use in fish ponds; however, other watermilfoil species are more popular than Eurasian watermilfoil. Because most watermilfoils require cool temperatures and high light levels, they tend to drop leaves, become straggly or die in aquarium culture under warm temperatures and low light levels. Subsequently, although watermilfoils are sold in the pet trade, relatively short life expectancy in aquaria has helped restrict demand and availability.

Reasons For Restriction:
Eurasian watermilfoil has become noxious in Chesapeake Bay, Florida, many Tennessee Valley Authority reservoirs, Texas and in many other locations around the country and around the world.

Similar Species:
Other aquatic plants with finely divided leaves include water marigold *Megalodonta* spp., water buttercup *Ranunculus* spp., lake cress *Neobeckia* spp., mermaid weed *Prosperinaca* spp., bladderwort *Utricularia* spp., hornwort or coontail *Ceratophyllum* spp., and fanwort *Cabomba* spp. Leaf divisions differ in form from those in watermilfoils in all of these genera except mermaid weed; however, feather-like leaves in mermaid weed are in alternate positions on the stem (not whorled as in most watermilfoils).

Other Watermilfoils: Identification of watermilfoil species can be extremely difficult and may depend upon flower parts or plants that are growing under "optimum" conditions. Plants growing under poor light

or low nutrient conditions, or which are not flowering, may be difficult or impossible to accurately identify. In general, five other species found in Texas water are most likely to be confused with Eurasian watermilfoil.

Watermilfoils in Texas:

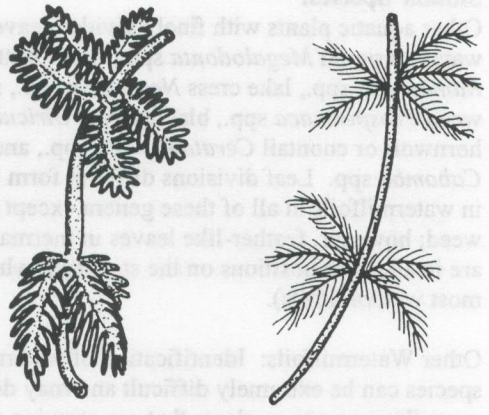
- Eurasian watermilfoil (*M. spicatum*).
  All leaves whorled.
  Midstem leaf whorls > 0.4 inch/10 mm apart.
  Midstem leaves < 1.0 inch/25 mm long.
  Leaflets < 0.6 inch/15 mm long.
  Leaflets long and slender.

- Other Texas watermilfoils.

All leaves not whorl (alternate, opposite, etc.)-*M. pinnatum* (*M. scabratum*).
Midstem leaf whorls < 0.4 inch/10 mm apart-*M. verticillatum*, *M. heterophyllum,* and *M. pinnatum*.
Midstem leaves > 1.0 inch/25 mm long-*M. exalbescens*.
Leaflets > 0.6 inch/15 mm long-*M. exalbescens*.
Leaves and leaflets short and stout-*M. brasiliense*.

Other American and pet trade watermilfoils:

M. alterniflorum-in the northeastern U.S. and the Great Lakes (also found in Europe).
M. farwellii (also spelled *harwellii*)-in the northeastern U.S. and the Great Lakes; in acid bogs.
M. humile-in the northeastern U.S.
M. tenellum-in the northeastern U.S.; in acid bogs.
M. elatinoides-from Mexico to Brazil, and New Zealand, and Tasmania.
M. ussuriense (*M. japonicum*)-in Japan and eastern Asia; occasionally imported for aquarium culture.
M. hippuroides (if valid).
M. laxum.
M. proserpinacoides-from southern South America; probably synonymous with *M. brasiliense*.



M. brasiliense *M. spicatum*

Technical Notes:

(1) Noxious Eurasian watermilfoil infestations in Chesapeake Bay were observed to suffer from two pathological conditions (Lake Venice disease and northeast disease) in the mid-1960's with subsequent major declines in abundance and return of some native aquatic plant species. Similar declines have apparently also occurred elsewhere since that time. These conditions are poorly studied and understood, but may represent potential control measures in the future.

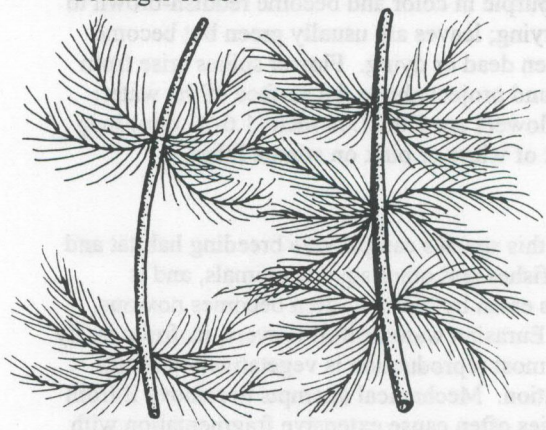
(2) While some botanical authorities consider *M. scabratum* and *M. pinnatum* to be synonyms, others view each as valid species. Regardless, both are unrestricted in Texas.

(3) Some authorities have considered *M. exalbescens* and *M. spicatum* to be varieties or subspecies of the same species (*M. spicatum*); however, a survey of a number of aquatic plant taxonomists during the writing of this guide indicated that all queried considered both to be valid species.

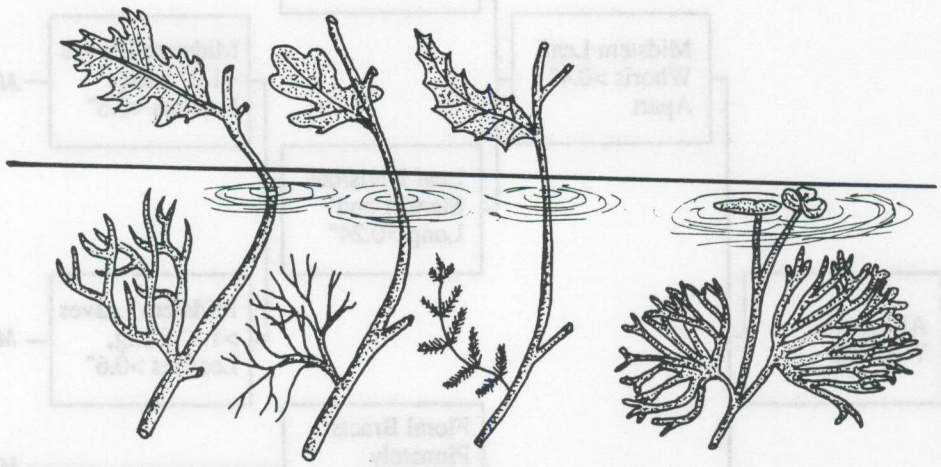
(4) Historically, most botanical authorities recognized both *M. spicatum* and *M. exalbescens* to be present in Texas; however, a recent U.S. Fish and Wildlife Service publication listed only *M. spicatum* for the state (without comment), and some botanists have indicated a failure to confirm *M. exalbescens* in Texas waters. This guide represents that this issue is not resolved at the present time. It is suggested that individuals identifying milfoils consider both species may occur in Texas.

References:

Aiken et al. 1979; Bailey et al. 1968; Bean et al. 1973; Ceska and Ceska (undated); Cook et al. 1974; Elser 1967; Fassett 1957; Hatch et al. 1990; Howells 1992; Muenscher 1967; Prescott 1969; Reed 1988a, b; Riemer 1984; Stodola 1967; Tarver et al. 1979; Westerdahl and Getsinger 1988.



M. exalbescens *M. verticillatum*

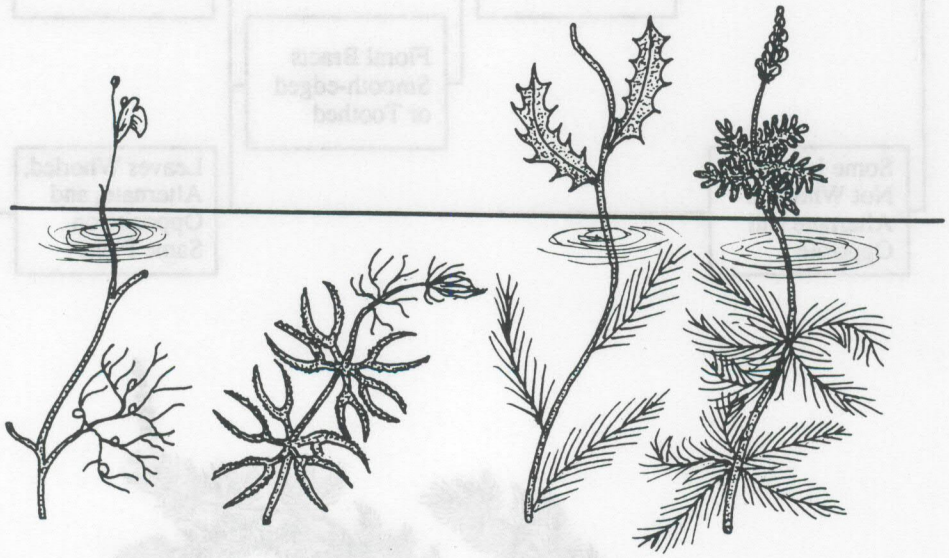


Water Marigold *Megalodonta* sp.

Water Buttercup *Ranunculus* sp.

Lake Cress *Neobeckia* sp.

Fanwort *Cabomba* sp.



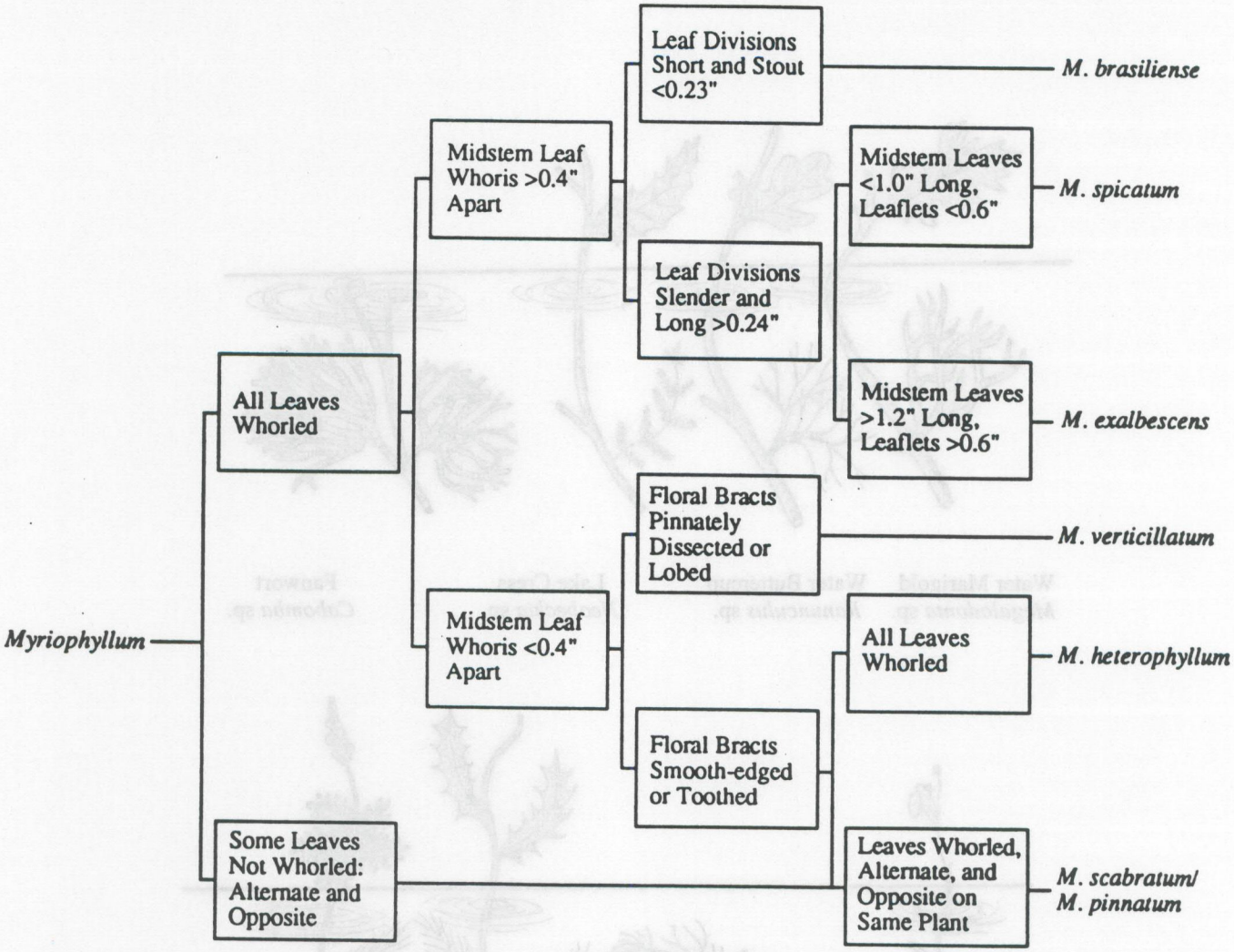
Bladderwort *Utricularia* sp.

Hornwort *Ceratophyllum* sp.

Mermaid Weed *Prosperinaca* sp.

Watermilfoil *Myriophyllum* sp.

WATERMILFOIL IDENTIFICATION KEY

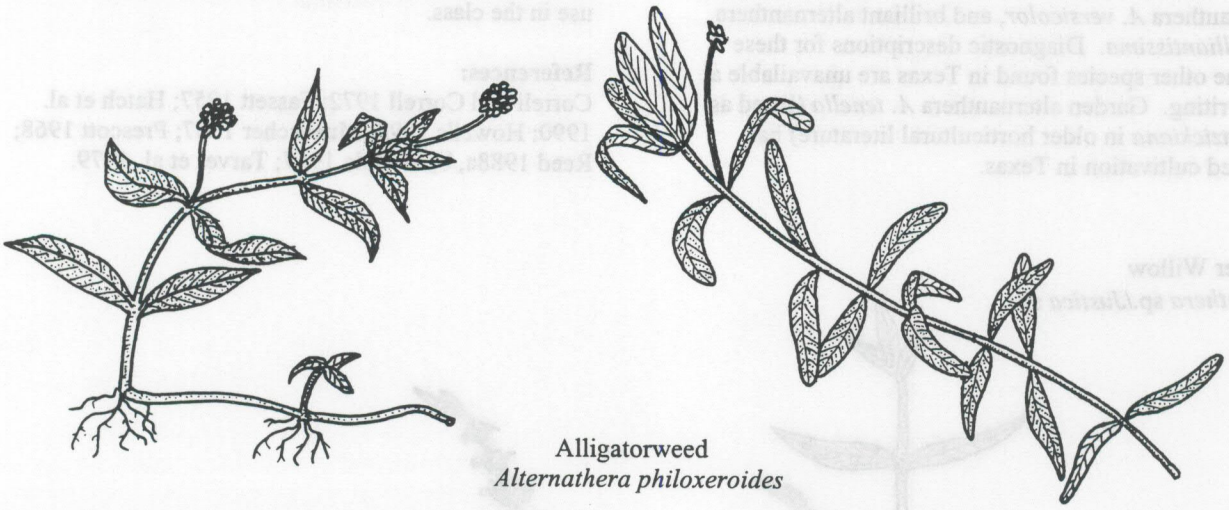


Eurasian Watermilfoil
Myriophyllum spicatum

ALLIGATORWEED

Family: Amaranthaceae

Alternanthera philoxeroides



Alligatorweed
Alternathera philoxeroides

Other Names:
Alligator weed, alligator-weed, chaff-flower.

Specifics:
The genus contains about 200 species. *A. philoxeroides* has also been known as *Achyranthes philoxeroides* and *Thelanthera philoxeroides*. Two native species found in Texas include: *A. paranychioides* (*A. polygonoides*) and *A. caracasana* (*A. peploides*, *A. repens*). Two other introduced alternantheras, *A. pungens* and *A. tenella* (*A. bettzichiana*), have been reported in Texas.

Range:
Alligatorweed is native to South America and was introduced into U.S. waters in the 1950's, probably through ship ballast. It presently occurs from Virginia to Florida and Texas, with populations also present in California, and in Central America. It has become noxious in southeastern Texas.

Description:
This plant produces long, tangled mats which often root from the joints (nodes). Upright stems (to 24 inches/610 mm above the water) may be hollow if submerged or solid in more terrestrial situations; stems may be branching or straight. Leaves are oppositely positioned on the stem, thick and fleshy, smooth edged and oval to lance shaped (0.8-4.3 inches/20-109 mm long and 0.2-0.8 inch/5-20 mm wide). Small, white clusters (0.5 inch/13 mm wide) of 6-20 flowers occur on long stems which arise from leaf axils. Plants are usually yellow-green in color, but submerged leaves may be reddish-brown.

Biology:
Alligatorweed grows in still lakes or in flowing streams and rivers. It may grow rooted to the bottom, in floating mats or even on dry land. It prefers fertile areas and can grow in fresh or brackish waters, with greater salinity tolerance reported in flowing-water situations. Apparently U.S. introductions rarely produce viable seed; most reproduction is vegetative.

Commercial Importance:
Although it is sometimes eaten by wildlife and domestic animals, alligatorweed is generally considered to be of little value. It is of no interest to the aquarium trade or to aquaculturists.

Reasons For Restriction:
Because it can form dense mats that block access to water and to boat traffic, and infestations in Texas have required control, alligatorweed has been restricted in the state.

Similar Species:
Other alternantheras in Texas all possess sessile flowers (with little or no stems); alligatorweed has long flower stems. Several other emergent aquatic plants could be mistaken for alligatorweed including: *Ludwigia* spp., *Lysimachia* spp., *Lythrum* spp., *Dianthera* spp., and *Polygonum* spp. However, most are smaller in size and have different flower types. Dense, well-established growths of alligatorweed usually do not present major identification problems, but small, individual sprigs that are just beginning to grow could be more difficult.

Technical Notes:

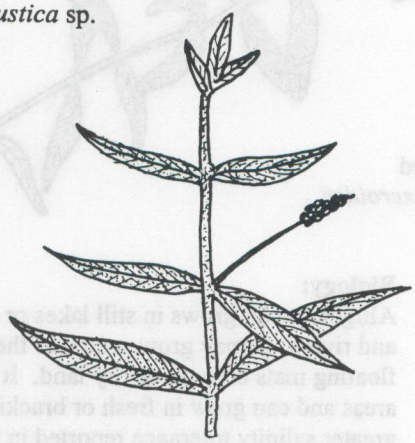
(1) Other species in the genus occasionally mentioned in botanical literature include tomthumb alternanthera *A. amoena*, rabbitmeat alternanthera *A. ficoidea*, copper alternanthera *A. versicolor*, and brilliant alternanthera *A. brilliantissima*. Diagnostic descriptions for these and the other species found in Texas are unavailable at this writing. Garden alternanthera *A. tenella* (listed as *A. bettzickiana* in older horticultural literature) has escaped cultivation in Texas.

(2) Efforts to control alligatorweed locally with insects has reportedly seen some noteworthy successes. Control has been so successful in some areas, one TPWD employee conducting a noxious weed training class in 1997 had difficulty locating a fresh specimen to use in the class.

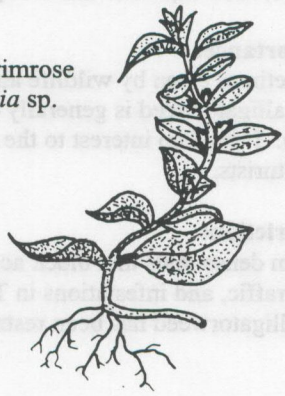
References:

Correll and Correll 1972; Fassett 1957; Hatch et al. 1990; Howells 1992; Muenscher 1967; Prescott 1968; Reed 1988a, b; Stodola 1967; Tarver et al. 1979.

Water Willow
Dianthera sp./*Justica* sp.

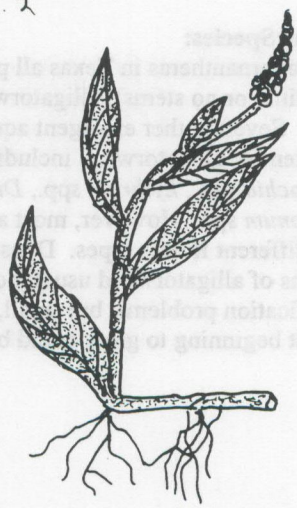


Water Primrose
Ludgwigia sp.



Purple Loosestrife
Lythrum salicaria

Knotweed
Polygonum sp.



Yellow Loosestrife
Lysimachia sp.

PAPERBARK (MELALEUCA)

Family: Myrtaceae

Melaleuca quinquenervia

Paperbark
Melaleuca quinquenervia

Other Names:
None.

Specifics:
The number of species in the genus is unclear; one botanical reference lists 34 species; however, these have apparently not been problematic in the U.S. and identification problems have not been reported.

Range:
Paperbark was originally native to coastal Australia and New Guinea, but has been introduced worldwide through agricultural use as a windbreak and through ornamental plantings. It is established in Florida, and has been planted ornamentally in Texas.

Description:
This Australian tree may reach 50 feet/15.2 m tall (rarely to 75 feet/22.9 m), but often grows as a shrub or smaller tree. Bark is pale brown to whitish in color and forms in spongy layers. Leaves are alternate, elliptical in shape, 2.4-4.0 inches (61-102 mm) long, with parallel veins (5), and short leaf-stems, aromatic when crushed and are dark green in color. Flowers have five white petals, one stigma and 30-40 stamens, and may form a 4-inch (102-mm) "bottle brush." Woody seed capsules are found along the thinner branches.

Biology:
Because of rapid reproduction from seed (250 seeds per capsule) and vegetatively through root and trunk sprouts, paperbark has been planted as a windbreak to protect agricultural crops. Seedlings germinate in shallow water or on damp ground and can form dense thickets; these may help stabilize soil but can also block access to water and wetland areas. Some plants in Texas may attempt to flower in December with subsequent frost damage to flowers and tender leaves.

Commercial Importance:
Paperbark is of no interest to aquaculturists or the pet trade, but is sometimes planted agriculturally and horticulturally. This is one of the few restricted plants in Texas that may be found for sale at garden centers for home planting.

Reasons For Restriction:
Introduced paperbarks have become problematic in Florida, including the Everglades where in some areas native vegetation is rapidly being displaced by paperbark thickets. This is one of the most recently restricted plant species in Texas.

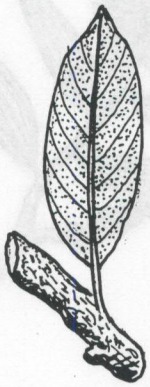
Similar Species:
Leaves of some willows *Salix* spp. and oaks *Quercus* spp. may be similar but have feather-like veins (pinnate) rather than parallel veins as seen in paperbark. Some domestic magnolia *Magnolia* spp. varieties may also have relatively slender leaves, but again veins are pinnate, as are leaves of mangroves *Rhizophora* spp. and tupelos *Nyssa* spp. Bottle-brush bushes *Callistemon* spp. have red flower clusters, not white as seen in paperbark.

Technical Note:
The parallel veins in oppositely positioned leaves seen in paperbark are atypical of most native and locally-grown horticultural trees and shrubs.

References:
Tarver et al. 1979.

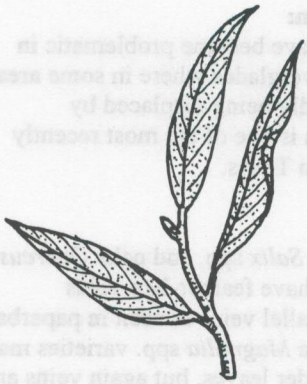
Tupelo
Nyssa sp.

Magnolia
Magnolia sp.



Willow
Salix sp.

Willow Oak
Quercus sp.



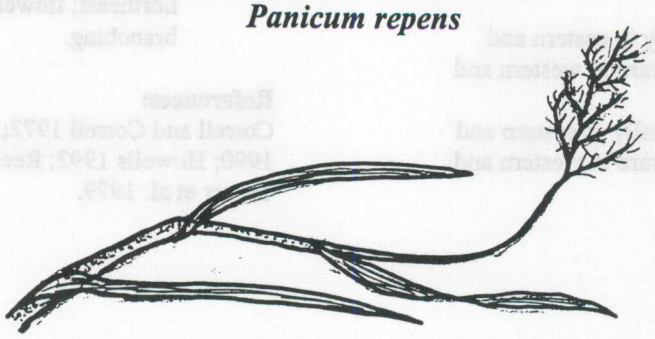
Mangrove
Rhizophora sp.

Bottle-brush
Callistemon sp.

TORPEDOGRASS

Family: Gramineae

Panicum repens



Torpedograss
Panicum repens

Other Names:
None.

Specifics:
The family is one of the largest among flowering plants. Panic grasses *Panicum* spp. may contain as many as 500 species, with over 20 found in wetland situations in Texas. This genus is sometimes placed in the family Poaceae.

Range:
Originally native to Australia, torpedograss has been introduced along the Gulf coast in U.S. waters and in Central and South America.

Description:
The growth habit of torpedograss is typical of many grasses with stems (to 28 inches/711 mm or more) arising from nodes (joints) or horizontal rhizomes. Leaves are about 0.08-0.28 inch (2-7 mm) wide and may be flattened or folded. Blades are usually green but often have a dull purplish tinge. The flower spike is 2.8-4.7 inches (71-119 mm) tall with spikelets (branches) 0.09-0.10 inch (2.3-2.5 mm) long; flower spikes are often tinted purple.

Biology:
Torpedograss grows along stream and lake margins in damp soil. Growth may be rapid and invasive, and plants may form floating mats out into open water. It may also do well in completely terrestrial settings. Reproduction may be by seed or vegetatively from rhizome sprouts. Torpedograss is grazed by livestock and wildlife, and seeds are rarely eaten by birds; however, many native species are potentially far more beneficial.

Commercial Importance:
There is no aquacultural, horticultural or pet trade interest in this species.

Reasons For Restriction:
Because torpedograss grows rapidly and can attain noxious levels quickly, and because it can be extremely difficult to eradicate, it was recommended for restriction in Texas.

Similar Species:
Torpedograss is most commonly confused with other panic grasses, especially maidencane *P. hemitomon*.

- Spikelets shorter than in torpedograss (< 0.09-0.10 inch/2.3-2.5 mm):

P. dichotomum
P. leucothrix
P. lanuginosum
P. ensilfolium
P. polyanthes
P. dichotomiflorum

- Spikelets longer than in torpedograss (> 0.09-0.10 inch/2.3-2.5 mm):

P. ravenelii
P. paludivagum
P. gymnocarpon
P. amarulum
P. virgatum

- Spikelets similar in length but blades wider than in torpedograss (> 0.08-0.28 inche/2.0-7.1 mm):

P. scoparium
P. commutatum
P. hemitomon
P. anceps (sometimes)
P. rigidulum (sometimes)
P. tenerum (sometimes)
P. capillare (sometimes)

- Both spikelet and blade width similar to torpedograss:

P. geminatum-widely found in the eastern half of

Texas; flower spike not widely spaced and branching.

P. hians-usually restricted to eastern, southeastern and northcentral Texas; not widely spaced and branching.

P. anceps (sometimes)-usually in eastern and southeastern Texas, rare in western and northcentral areas.

P. rigidulum (sometimes)-usually in eastern and southeastern Texas, rare in western and northcentral areas.

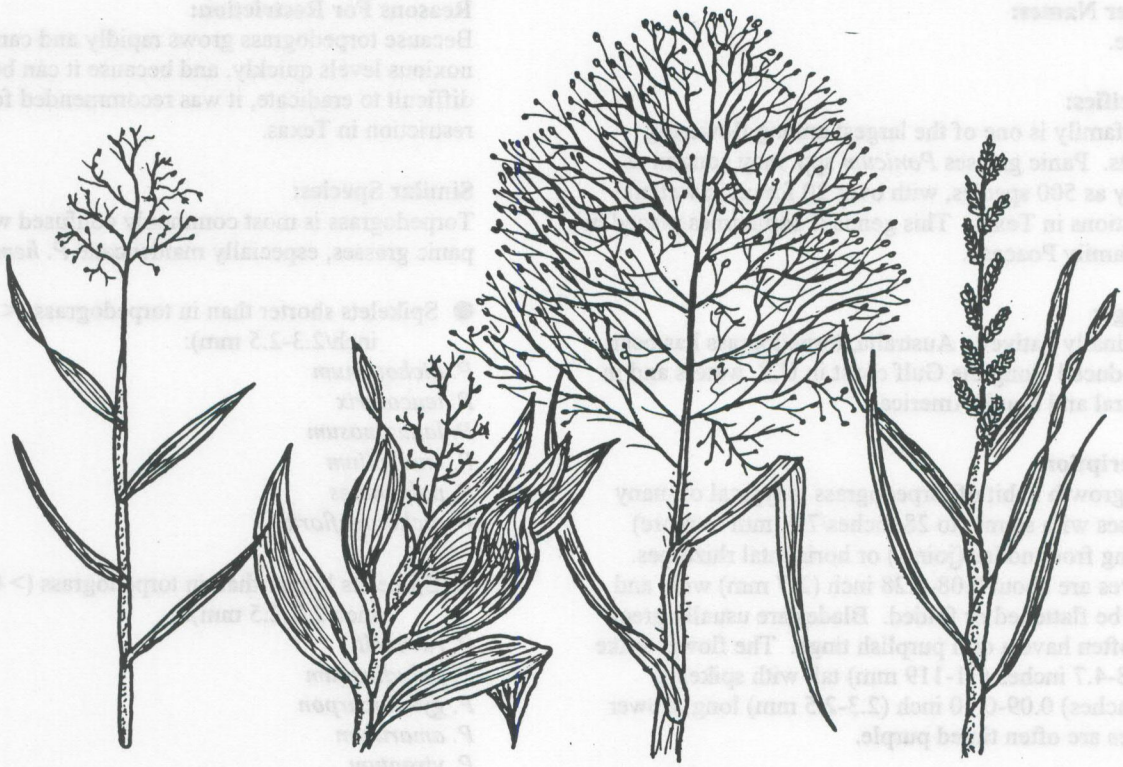
P. tenerum (sometimes)-rare in eastern and southeastern Texas, in pine-barrens areas.

P. capillare (sometimes)-in the Texas Trans-Pecos and plains areas, less common in the east and northeast; flower spike is very large, branching.

References:

Correll and Correll 1972; Eleuterius 1980; Hatch et al. 1990; Howells 1992; Reed 1988a, b; Stodola 1967; Tarver et al. 1979.

OTHER PANIC GRASSES

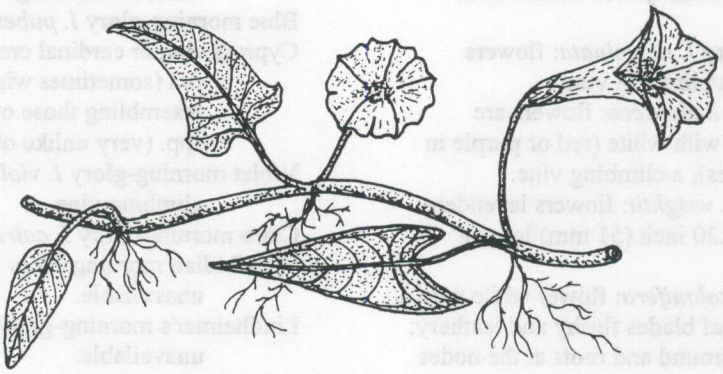


P. dichotomum *P. commutatum* *P. capillare* *P. geminatum*

WATER SPINACH

Family: Convolvulaceae

Ipomoea aquatica



Water Spinach
Ipomoea aquatica

Other Names:
Aquatic morning-glory.

Specifics:
This genus contains over 600 species world-wide and is sometimes split into 6 to 10 marginal genera. Some older literature listed 13 morning-glories in Texas; more recently (1988) the U.S. Fish and Wildlife Service listed 18 for Texas and Oklahoma.

Range:
Water spinach was originally probably native to southeastern Asia and southern China, but is now found in the Old World tropics from Australia to western Africa. It has been introduced into some Pacific islands, including Hawaii. The species has apparently not been reported from Texas waters.

Description:
Water spinach is a herbaceous vine, but has not been described as twining or climbing as is typical of most other morning-glories. Stems are hollow and trail over muddy banks or float on the water surface. Roots appear at the nodes (stem joints). Leaves are variable in form from nearly oval to lance- or arrowhead-shaped with pointed tips; they occur alternately on the stem. Leaf stocks are long (2.4-6.0 inches/61-152 mm) and flowers arise from leaf stem axils (where leaf stocks join the stem). Tuberous roots are not produced. Flowers are composed of five petals jointed in a funnel shape typical of many morning-glories; flowers are pink in color, sometimes purplish, and often with a purple center; sepals at the flower base are five in number, green in color, and 0.24-0.31 inch (6-8 mm) in length.

Biology:
Water spinach may grow in water or in soggy soils in low-land marshes and along stream and river banks. The hollow stems may float in water or extend over muddy banks. Although it flowers, successful fruit and seed production is reportedly rare. Reproduction is usually vegetative through branching and fragmentation. This species is apparently very intolerant of frost and cold.

Commercial Importance:
This plant is not cultivated by aquaculturists or handled in the aquarium plant trade. It is cultivated extensively in Asia, and on some Pacific islands, including Hawaii, where it is eaten as a leafy vegetable.

Reasons For Restriction:
Like many other restricted aquatic plants, water spinach can grow rapidly and cover the surface of an entire water body. It has been a major agricultural pest in rice fields. The State of Florida also prohibits water spinach. Although known as a cold-sensitive species, some areas in southern Texas and certain thermally-stable spring waters or heated reservoirs might potentially support water spinach if introduced.

Similar Species:
Water spinach would most likely be confused with other morning-glories *Ipomoea* spp.; none are actually aquatic, but may occur in wetland situations. Although

most morning-glories have variable-shaped leaves, most tend to be heart-, ivy- or arrowhead-shaped.

Red morning-glory or scarlet creeper *I. coccinea*: flowers red-orange or red with a yellow throat; a climbing vine.
Ivy-leaf morning-glory *I. hederifloia*: flowers red-orange.
Pointed-leaf morning-glory *I. acuminata*: flowers reddish-purple; a climbing vine.
Ivy-leaf morning-glory *I. hederacea*: flowers are lavender to blue with white (red or purple in domestic varieties); a climbing vine.
Wright's morning-glory *I. wrightii*: flowers lavender-pink; sepals to 0.20 inch (51 mm) long; a climbing vine.
Beach morning-glory *I. stolonifera*: flower white with a yellow center; leaf blades fleshy and leathery; trails along the ground and roots at the nodes (not climbing).
Beach or goatfoot morning-glory *I. pes-caprae*: flowers rosy to purple; leaf blades thick and fleshy; trails along the ground and roots at the nodes (not climbing).
Wild potato or wild sweet potato vine *I. pandurata*: flowers white with a purple center; trailing or climbing, but with a woody, tuberous root.
Saltmarsh morning-glory *I. sagittata*: flowers-reddish purple; a climbing vine; leaves strongly arrowhead shaped and narrow.
Red-centered morning-glory *I. amnicola*: flowers white with a reddish-purple center; a climbing vine.
Small-flowered pink morning-glory *I. trichocarpa*): flowers rosy-lavender to rosy-purple with a dark center (rarely white); a climbing vine.
Small-flowered morning-glory *I. lacunosa*): flowers white (rarely rosy); a climbing vine; has a long taproot.
Alamo vine *I. sinuata*: flowers white with reddish-purple centers; a trailing to low-climbing vine.
White morning-glory or moon flower *I. alba*: flowers white; a climbing vine.
Blue morning-glory *I. pubescens*: flowers blue.
Cypress vine or cardinal creeper *I. quamoclit*: flowers red (sometimes white); leaves deeply cut and resembling those of bald cypress *Taxodium* spp. (very unlike other morning-glories).
Violet morning-glory *I. violacea*: flowers violet; a climbing vine.
Cairo morning-glory *I. cairica*: description unavailable.
West Indian morning-glory *I. indica*: description unavailable.
Lindheimer's morning-glory *I. lindheimeri*): description unavailable.

Technical Notes:

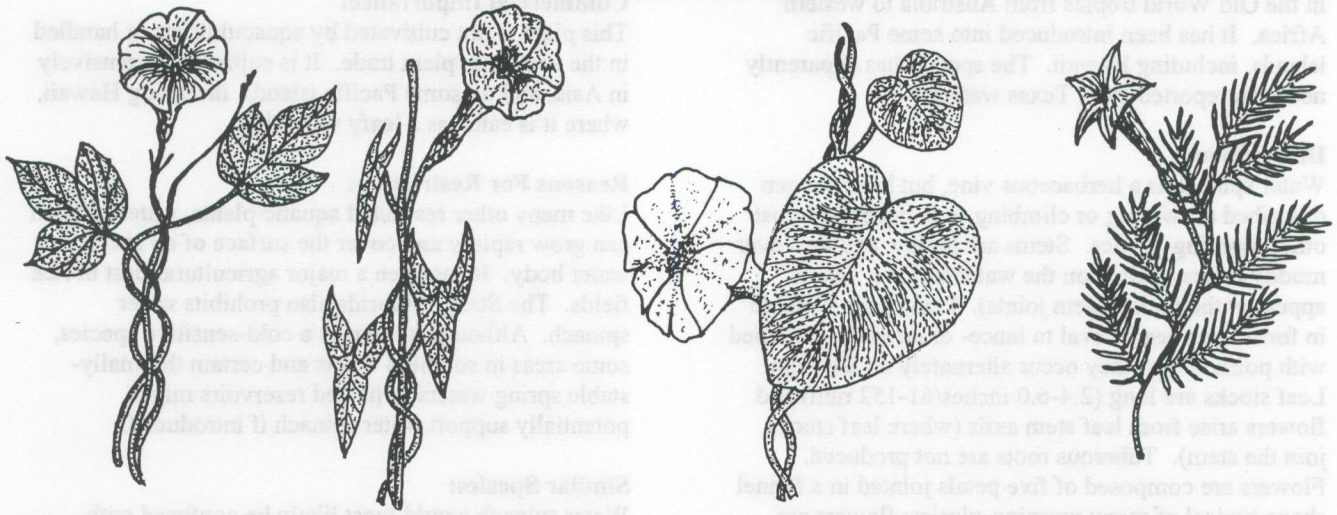
(1) The name *I. bicolor* is sometimes applied to domestic blue-, red- and white-flowered morning-glories.

(2) A cultivated tropical morning-glory called moonflower *I. calonyction* has large, white, night-blooming flowers and large, heart-shaped leaves and is sometimes cultured in Texas.

References:

Correll and Correll 1972; Stodola 1967; Tarver et al. 1979.

OTHER MORNING-GLORIES



Ivy-leaf
I. hederacea

Saltmarsh
I sagittata

Common Domestic
I. purpurea

Cypress Vine
I. quamoclit

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APPENDIX I

HARMFUL OR POTENTIALLY HARMFUL EXOTIC FISH SHELLFISH, AND AQUATIC PLANTS PROCLAMATION

20 August 1998

The new rules are adopted under Parks and Wildlife Code, Chapter 66, Subchapter A, §66.007 which gives the commission the authority to regulate the possession and sale of exotic fish and shellfish. **CAUTION:** These regulations can change at any time. When questions arise, ALWAYS check to be certain the most-recent regulations are being considered.

§57.111. Definitions.

The following words and terms, when used in these rules, shall have the following meanings, unless the context clearly indicates otherwise

1. Aquaculture or fish farming - The business of producing and selling cultured species raised in private facilities.
2. Certified Inspector - An employee of the Texas Parks and Wildlife Department or the Texas A&M Sea Grant College Program who has satisfactorily completed a department-approved course in clinical analysis of shellfish.
3. Clinical Analysis Checklist - An inspection form provided by the department specifying sampling protocols and listing certain characteristics which may constitute manifestations of disease.
4. Cultured species - Aquatic plants or wildlife resources raised under conditions where at least a portion of their life cycle is controlled by an aquaculturist.
5. Department - The Texas Parks and Wildlife Department or a designated employee of the department.
6. Director - The Executive Director of the Texas Parks and Wildlife Department.
7. Disease - Contagious pathogens or injurious parasites which may be a threat to the health of natural populations of aquatic organisms.
8. Disease Free - A status, based on the results of an examination conducted by a department-approved shellfish disease specialist that certifies a group of aquatic organisms as being free of disease.
9. Exotic Species -A nonindigenous plant or wildlife resource not normally found in public water of thisstate.
10. Fish farm - The property including all drainage ditches and private facilities from which cultured species are produced, held, propagated, transported, or sold.
11. Fish farm complex - A group of two or more separately owned fish farms located at common site and sharing privately owned water diversion or drainage structures.
12. Fish farmer - Any person engaged in aquaculture or fish farming
13. Grass carp - The species *Ctenopharyngodon idella.*
14. Harmful or potentially harmful exotic fish -

(A) Lampreys Family: Petromyzontidae	All species except *Icthyomyzon castaneus* and *I. gagei*
(B) Freshwater Stingrays Family: Potamotrygonidae	All species
(C) Arapaima Family: Osteoglossidae	*Arapaima gigas*
(D) South American Pike Characoids Family Characidae	All Species of genus *Acestrorhyncus*
(E) African Tiger Fishes Subfamily: Hydrocyninae	All Species
(F) Piranhas and Priambebas Subfamily: Serrasalminae	All Species
(G) Rhaphiodontid Characoids Subfamily: Rhaphiodontinae genera	All Species of *Hydrolycus* and *Rhaphiodon* (synonymous with *Cynodon*)
(H) Dourados Subfamily: Bryconinae	All Species of genus *Salminus*
(I) South American Tiger Fishes Family: Erythrinidae	All Species
(J) South American Pike Characoids Family Ctenolucidae	All Species of genera *Ctenolucius* and *Luciocharax* (synonymous with *Boulengerella* and *Hydrocinus*)

(K) African Pike Characoids Families: Hepsetidae [and] Ichthyboridae	All Species
(L) Electric Eels Family: Electrophoridae	*Electrophorus electricus*
(M) Carps and Minnows Family: Cyprinidae	All species and hybrids of species of genera *Abramis, Aristichthys, Aspius, Aspiolucius, Blicca, Catla, Cirrhina, Ctenopharyngodon, Elopichthys, Hypophthalmichthys, Leuciscus, Megalobrama, Mylopharyngodon, Parabramis, Pseudaspius, Rutilus, Scardinius, Thynnichthys, Tor*, and the species *Barbus tor* (synonymous with *Barbus hexagonolepis*)
(N) Walking Catfishes Family: Clariidae	All Species
(O) Electric Catfishes Family: Malapteruridae	All Species
(P) South American Parasitic Candiru Catfishes Subfamilies: Stegophilinae [and] Vandelliinae	All Species
(Q) Pike Killifish Family: Poeciliidae	*Belonesox belizanus*
(R) Marine Stonefishes Family: Synanceiidae	All Species
(S) Tilapia Family: Cichlidae	All Species of genus *Tilapia* (including *Sarotherodon* and *Oreochromis*)
(T) Asian Pikeheads Family: Luciocephalidae	All Species
(U) Snakeheads Family: Channidae	All Species
(V) Walleyes Family: Percidae	All Species of the genus *Stizostedion* except *Stizostedion vitreum* and *S. canadense*
(W) Nile Perch Family: Centropomidae	All Species of genera *Lates* and *Luciolates*
(X) Drums Family: Sciaenidae	All species of genus *Cynoscion* except *C. nebulosus*, *C. nothus*, and *C. arenarius*
(Y) Whale Catfishes Family: Cetopsidae	All Species
(Z) Ruff[e] Family: Percidae	All Species of genus *Gymnocephalus*
(AA) Air sac Catfishes Family: Heteropneustidae	All Species of genus *Heteropneustes*
(BB) Swamp eels, rice eels, one-gilled eels Family: Synbranchidae	All species
(CC) [Freshwater eels] Family: Anguillidae	All species except *Anguilla rostrata*
15. Harmful or Potentially Harmful Exotic Shellfish -	
(A) Crayfishes Family: Parastacidae	All Species of genus *Astacopsis*
(B) Mitten crabs Family: Grapsidae	All Species of genus *Eriocheir*
(C) Giant Ram's-horn Snails Family: Pilidae (synonymous with Ampullariidae)	All species of genus *Marisa*
(D) Zebra Mussels Family: Dreissenidae	All species of genus *Dreissena*
(E) Penaeid Shrimp Family: Penaeidae	All species of genus *Penaeus* except *P. setiferus, P. aztecus*, and *P. duorarum*
(F) Pacific Oyster Family: Ostreidae	*Crassostrea gigas*

16. Harmful or Potentially Harmful Exotic Plants -

(A) Giant Duckweed Family: Lemnaceae	*Spirodela oligorhiza*
(B) Salvinia Family: Salviniaceae	All species of genus *Salvinia*
(C) Waterhyacinth Family: Pontederiaceae	*Eichhornia crassipes*
(D) Waterlettuce Family: Araceae	*Pistia stratiotes*
(E) Hydrilla Family: Hydrocharitaceae	*Hydrilla verticillata*
(F) Lagarosiphon Family: Hydrocharitaceae	*Lagarosiphon major*
(G) Eurasian Watermilfoil Family: Haloragaceae	*Myriophyllum spicatum*
(H) Alligatorweed Family: Amaranthaceae	*Alternanthera philoxeroides*
(I) Rooted Waterhyacinth Family: Pontederiaceae	*Eichhornia azurea*
(J) Paperbark Family: Myrtaceae	*Melaleuca quinquenervia*
(K) Torpedograss Family: Gramineae	*Panicum repens*
(L) Water Spinach Family: Convolvulaceae	*Ipomoea aquatica*

17. Harmful or potentially harmful exotic species exclusion zone - That area south of SH 21 from its intersection with the Texas/Louisiana border, approximately five miles due east of Milam, Texas, not including that area of Brazos County south of SH 21, to San Marcos; thence south of IH-35 to Laredo.
18. Immediately - Without delay; with no intervening span of time.
19. Manifestations of disease - Manifestations of disease include, but are not limited to, one or more of the following: heavy or unusual predator activity, empty guts, emaciation, rostral deformity, digestive gland atrophy or necrosis, gross pathology of shell or underlying skin typical of viral infection, fragile or atypically soft shell, gill fouling, or gill discoloration.
20. Nauplius or nauplii - A larval crustacean having no trunk segmentation and only three pairs of appendages.
21. Operator - The person responsible for the overall operation of a wastewater treatment facility.
22. Place of business - A permanent structure on land where aquatic products or orders for aquatic products are received or where aquatic products are sold or purchased.
23. Postlarva - A juvenile crustacean having a full complement of functional appendages.
24. Private facility - A pond, tank, cage, or other structure capable of holding cultured species in confinement wholly within or on private land or water, or within or on permitted public land or water.
25. Private facility effluent - Any and all water which has been used in aquaculture activities.
26. Private pond - A pond, tank, lake, or other structure capable of holding cultured species in confinement wholly within or on private land.
27. Public aquarium - An American Association of Zoological Parks and Aquariums accredited facility for the care and exhibition of aquatic plants and animals.
28. Public waters - Bays, estuaries, and water of the Gulf of Mexico within the jurisdiction of the state, and the rivers, streams, creeks, bayous, reservoirs, lakes, and portions of those waters where public access is available without discrimination.
29. Quarantine condition - Confinement of exotic shellfish such that neither the shellfish nor the water in which they are or were maintained comes into contact with other fish or shellfish.
30. Triploid grass carp - A grass carp (*Ctenopharyngodon idella*) which has been certified by the United States Fish and Wildlife Service as having 72 chromosomes and being functionally sterile.
31. Waste - Waste shall have the same meaning as in Chapter 26 §26.001(b) of the Texas Water Code.
32. Wastewater treatment facility - All contiguous land and fixtures, structures or appurtenances used for treating wastewater pursuant to a valid permit issued by the Texas Natural Resources Conservation Commission.
33. Water in the state - Water in the state shall have the same meaning as in Chapter 26, §26.001(5) of the Texas Water Code.

§57.112. General Rules.

(a) Scientific reclassification or change in nomenclature of taxa at any level in taxonomic hierarchy will not, in and of itself, result in redefinition of a harmful or potentially harmful exotic species.

(b) Except as provided in §57.113 of this title (relating to Exceptions), it is an offense for any person to release into public waters, import, sell, purchase, transport, propagate, or possess any species, hybrid of a species, subspecies, eggs, seeds, or any part of any species defined as a harmful or potentially harmful exotic fish, shellfish or, aquatic plant.
(c) Violation of any provision of a permit issued under these rules is a violation of these rules.

§57.113. Exceptions.
(a) A person who holds a valid Exotic Species permit issued by the department may possess, propagate, sell, and transport to the permittee's private facilities exotic harmful or potentially harmful fish, shellfish, and aquatic plants only as authorized in the permit provided the harmful or potentially harmful exotic species are to be used exclusively:
(1) as experimental organisms in a department approved research program; or
(2) for exhibit in a public aquarium approved for display of harmful or potentially harmful exotic fish, shellfish, and aquatic plants.
(b) A person may possess exotic harmful or potentially harmful fish or shellfish without a permit if the intestines of thefish or shellfish have been removed.
(c) A person may possess grass carp harvested from public waters that have not been permitted for triploid grass carp, without a permit, if the intestines have been removed.
(d) A Fish Farmer who holds a valid Exotic Species Permit issued by the department may possess, propagate, transport, or sell triploid grass carp (*Ctenopharyngodon idella*), silver carp, (*Hypophthalmichthys molitrix*), black carp (*Mylopharyngodon piceus*, also commonly known as snail carp), bighead carp (*Aristichthys/ Hypophthalmichthys nobilis*), blue tilapia (*Tilapia aurea*), Mozambique tilapia (*Tilapia mossambica*), Nile tilapia (*Tilapia nilotica*), or hybrids between the three tilapia species as provided by conditions of the permit and these rules.
(e) A Fish Farmer who holds an exotic species permit issued by the department may possess, propagate, transport, or sell Pacific white shrimp (*Penaeus vannamei*) provided the exotic shellfish meets disease free certification requirements listed in §57.114 of this title (relating to Health Certification of Shellfish) and as provided by conditions of the permit and these rules.
(f) An operator of a wastewater treatment facility in the possession of a valid exotic species permit may possess and transport Waterhyacinth (*Eichhornia crassipes*) to their facility only for the purpose of wastewater treatment.
(g) A person may possess Mozambique tilapia in a private pond subject to compliance with §57.116(d) of this title (relating to Exotic Species Transport Invoice).
(h) The holder of a valid triploid grass carp permit issued by the department may possess triploid grass carp as provided by conditions of the permit and these rules.
(i) A licensed retail or wholesale fish dealer is not required to have an exotic species permit to purchase or possess:
(1) live individuals of species or hybrids of species listed in Section (c) of this section held in the place of business, unless the retail or wholesale fish dealer propagates one or more of these species. However, such a dealer may sell or deliver these species to another person only if the intestines or head of the fish have been removed.
(2) Live Pacific white shrimp (*Penaeus vannamei*) held in the place of business if the place of business is not within the Harmful or Potentially Harmful Exotic Species Exclusion Zone. However, such a dealer may only sell or deliver this species to another person only if the shrimp are dead and packed on ice or frozen.
(j) The department is authorized to stock planktivorous fish including silver carp (*Hypophthalmichthys molitirix*) and bighead carp (*Aristichthys/Hypophthalmichthys nobilis*) if necessary in Lake Rita Blanca, Hartley County, in order to investigate their utility as biological agents to improve water quality and enhance fishery management.
(k) The department is authorized to stock triploid grass carp into public waters in situations where the department has determined that there is a legitimate need and when stocking will not affect threatened or endangered species, coastal wetlands, or specific management objectives for other important species.
(l) A fish farmer who holds a valid exotic species permit issued by the department may possess, propagate, transport, and sell Pacific blue shrimp (*Penaeus sylirostris* [*sic..stylirostris*]) provided the exotic shellfish are cultured under quarantine conditions in private facilities located outside the harmful or potentially harmful exotic species exclusion zone, and meet disease free certification requirements listed in §57.114 of this title (relating to Health Certification of Exotic Shellfishes) and as provided by conditions of the permit and these rules.
(m) Any person who, as of the effective date of these rules, holds a valid exotic species permit issued by the department to possess, propagate, transport, or sell *Anguilla japonica* may continue to conduct such activities as authorized by the conditions of the permit. The permit may not be transferred to any other person, site, or entity.

§57.114. Health Certification of Exotic Shellfish.
(a) All disease free certification of exotic shellfish must be conducted by a shellfish disease specialist approved by the department.
(b) Any person importing live exotic shellfish from facilities outside the state must prior to importation:
(1) provide documentation to the department that the shellfish to be imported have been inspected and certified as disease-free by a department-approved shellfish disease specialist; and
(2) receive acknowledgment from the department that the requirements of paragraph (1) of this section have been met.
(c) Any person in possession of exotic shellfish for the purpose of production of postlarvae must provide to the department monthly certification that nauplii and postlarvae have been examined and certified to be disease-free. If certification cannot be

provided, the exotic shellfish must be maintained in quarantine condition until the department acknowledges in writing that the stock is disease -free or specifies in writing conditions(s) under which quarantine can be removed.

(d) Any person in possession of exotic shellfish stocks who observes one or more of the manifestations of disease appearing on the clinical analysis checklist provided by the department shall:
  (1) immediately quarantine the entire facility, immediately notify the department, and immediately request an inspection from a department approved examiner; or
  (2) immediately quarantine the entire facility, immediately notify the department, and immediately submit samples of the affected shellfish to a department approved shellfish disease specialist for analysis. Results of such analyses shall be forwarded to the department immediately upon receipt.

(e) Upon receiving a request from a permit holder under subsection (d)(1) of this section, the department approved examiner shall inspect the private facility, complete the clinical analysis checklist provided by the department, and submit copies of the checklist to the department and the permit holder.

(f) Before discharging any waste for the first time in any calendar year into or adjacent to water in the state, the permittee shall:
  (1) have a department approved examiner inspect the entire facility and examine samples of the shellfish from each pond or other structure containing exotic shellfish no more than 72 hours prior to the discharge and shall submit the results of the examination to the department on the department approved clinical analysis checklist; or
  (2) submit samples of shellfish from each pond or other structure containing exotic shellfish to a department approved shellfish disease specialist for analysis no more than ten days prior to the first discharge and submit the results of such analyses to the department immediately upon receipt.

(g) If the results of an inspection performed under subsection (f)(1) of this section indicate the presence of one or more manifestations of disease, the permittee shall immediately place the entire facility under quarantine and immediately submit samples of the shellfish from the affected portion(s) of the facility to a department approved shellfish disease specialist for analysis. Results of such analyses shall be forwarded to the department immediately upon receipt.

(h) If the results of analyses performed under subsection (f)(2) of this section indicate the presence of disease, the permittee shall immediately place the entire facility under quarantine.

(i) A private facility quarantined under subsections (d), (g) or (h) of this section shall remain under quarantine condition until the department removes the quarantine in writing or authorizes in writing other actions deemed appropriate by the department based on the required analyses.

(j) If the results of inspections or testing performed under subsection (f) of this section indicate the absence of any manifestations of disease, the permittee may begin discharging from the facility.

§57.115. Transportation of Live Exotic Species.

(a) Transport of live harmful or potentially harmful exotic species is prohibited except by:
  (1) a licensed fish farmer in immediate possession of a valid Exotic Species Permit and Exotic Species Transport Invoice;
  (2) a commercial shipper acting for the permit holder in possession of an Exotic Species Transport Invoice;
  (3) persons holding exotic species pursuant to limitation of §57.113(a) through (e).

(b) A fish farmer transporting live triploid grass carp must have sales invoices which account, collectively, for all triploid grass carp being transported and a copy of the United States Fish and Wildlife Service certification declaring that the grass carp being transported have been certified as being triploid grass carp in addition to meeting requirements in Chapter 134 of the Agriculture Code.

§57.116. Exotic Species Transport Invoice.

(a) An Exotic Species Transport Invoice shall contain all the following information correctly stated and legibly written: invoice number; date of shipment; name, address, and phone number of the shipper; name, address and phone number of the receiver; Texas Fish Farmers License number and exotic species permit number, if applicable; number and total weight of each harmful or potentially harmful exotic species; a check mark indicating interstate import, interstate export, or intrastate type of shipment. A completed invoice shall accompany each shipment of harmful or potentially harmful exotic species sold or transferred, and shall be sequentially numbered during the permit period; no invoice number shall be used more than once during any one permit period by the permittee.

(b) The Exotic Species Transport Invoice shall be provided by the permittee; one copy shall be retained by the permittee for a period of at least one year following shipping date.

(c) The permittee is responsible for supplying copies of the exotic species transport invoice to out-of-state dealers from which the permittee has ordered harmful or potentially harmful exotic species, or to whom harmful or potentially harmful exotic species are transferred, so that shipment will be properly marked and numbered upon delivery to the permittee in Texas.

(d) Owners, or their agents, of private ponds stocked with Mozambique tilapia or triploid grass carp by an Exotic Species Permit holder shall retain a copy of the Exotic Species Transport Invoice for a period of one (1) year after the stocking date or as long as the tilapia are in the water, whichever is longer.

§57.117. Exotic Species Permit: Fee and Application Requirements.

(a) The department shall charge a nonrefundable exotic species permit application fee as follows:
  (1) application for new, renewed, or amended exotic species permit which requires facility inspection - $250;
  (2) application for renewed or amended exotic species permit requiring no facility inspection - $25;

(3) renewal applications received more than one year after the renewal date will require an additional inspection and cost $250.

(b) To be considered for an Exotic Species Permit, the applicant shall:

(1) meet one or more of the following criteria:

(A) possess a valid Texas Fish Farmer's License;

(B) possess a valid permit from the Texas Natural Resource Conservation Commission authorizing operation of a wastewater treatment facility;

(C) possess a department approved research proposal involving use of harmful or potentially harmful exotic fish, shellfish, or aquatic plants;

(D) operate a public aquarium approved for display of harmful or potentially harmful exotic fish, shellfish or aquatic plants;

(2) complete and submit an exotic species permit application on a form provided by the department;

(3) submit an accurate-to-scale plat of the facility specifically including, but not limited to, location of:

(A) all private facilities and owner's name and physical address including a designation of the plat of all private facilities which will be used for possession of harmful or potentially harmful exotic species;

(B) all structures which drain private facilities;

(C) all points at which private facility effluent is discharged from the private facilities or the fish farm;

(D) all structures designed to prevent escapement of harmful or potentially harmful species from the fish farm;

(E) any vats, raceways, or other structures to be used in holding harmful or potentially harmful exotic species;

(4) demonstrate to the department that an existing fish farm, private facility, or wastewater treatment facility meets requirements of §57.129 of this title (relating to Exotic Species Permit: Private Facility Criteria);

(5) remit to the department all applicable fees.

(c) Applicants for an exotic species permit for culture of harmful or potentially harmful exotic shellfish must meet all exotic species permit application requirements and requirements for disease free certification as listed in §57.114 of this title (relating to Health Certification of Exotic Shellfish).

(d) An applicant for an exotic species permit shall provide upon request from the department documentation necessary to identify any harmful or potentially harmful exotic species and confirm the source of origin of the species for which a permit is sought.

(e) An applicant for an Exotic Species Permit whose facility is located within the harmful or potentially harmful exotic species exclusion zone as defined in §57.111 of this title (relating to Definitions) must submit an emergency plan to the department for review and approval. The plan shall include measures sufficient to prevent release or escapement of permitted harmful or potentially harmful exotic species into public water during a natural catastrophe (such as a hurricane or flood).

§57.118. Exotic Species Permit Issuance.

(a) The department may issue an Exotic Species Permit only to:

(1) a licensed Fish Farmer and only for species listed in §57.113(c)-(e) of this title (relating to Exceptions);

(2) a wastewater treatment facility operator only for possession and use of waterhyacinth;

(3) department approved research programs; or

(4) a public aquarium for display purposes only.

(b) The department may issue an exotic species permit upon finding by the department that:

(1) all application requirements set out in §57.117 of this title (relating to Exotic Species Permit: Fee and Application Requirements) have been met;

(2) the fish farm operated by the applicant and named in the permit meets or will meet the design criteria listed in §57.129 of this title (relating to Exotic Species Permit: Private Facility Criteria);

(3) the applicant has complied with all provisions of the Parks and Wildlife Code, §66.007, §66.015, and these rules during the one-year period preceding the date of application.

(c) Permits issued for fish farms, private facilities, or wastewater treatment facilities under construction shall not authorize possession of harmful or potentially harmful exotic fish, shellfish, or aquatic plants until such time as the department has certified that the fish farm, private facilities, or water treatment facility as-built meets the requirements in §57.129 of this title (relating to Exotic Species Permit: Private Facility Criteria).

§57.119. Exotic Species Permit: Requirements for Permittee.

(a) A copy of the Exotic Species Permit shall be:

(1) made available for inspection upon request of authorized department personnel; and

(2) prominently displayed on the premises of the fish farm, private facilities, or wastewater treatment facility named in the permit.

(b) A permittee must provide access to all facilities covered by the application to authorized department personnel during any hours in which operations pursuant to the exotic species permit are ongoing.

(c) If a permittee discontinues fish farming, research activities, or public aquarium displays involving harmful or potentially harmful exotic species or discontinues wastewater treatment utilizing water hyacinth, the permittee shall:

(1) immediately and lawfully sell, transfer, or destroy all remaining individuals of that species in possession; and

(2) notify the department aquaculture coordinator at least 14 days prior to cessation of operation.

(d) Upon a request, a permittee shall provide an adequate number of fish, shellfish, or aquatic plants to authorized department employees for identification and analyses.

(e) In the event that a fish farm, private facilities, or wastewater treatment facility of a permit holder appears in imminent danger of overflow, flooding, or release of harmful or potentially harmful exotic fish, shellfish, or aquatic plants into public water, the permittee shall:

(1) immediately notify the department aquaculture coordinator;

(2) immediately begin implementation of the department approved emergency plan.

(f) Except in case of an emergency, a holder of an exotic species permit authorizing possession of [Pacific white shrimp] *Penaeus Ivannamei* must notify the department at least 72 hours prior to, but not more than seven days prior to[,] any harvesting of permitted shellfish. In an emergency beyond the control of the permittee, notification of harvest must be made as early as practicable prior to beginning of harvest operations.

(g) A holder of an exotic species permit authorizing possession of harmful or potentially harmful exotic species may sell or transfer ownership of live individuals may sell only to the holder of a valid exotic species permit specifically authorizing possession of transferred species.

(h) Upon discovery of release or escapement of harmful or potentially harmful exotic fish or shellfish from any private facilities authorized in an exotic species permit, the permittee must immediately halt discharge of all private facility effluent from the fish farm. If the permittee's private facility is located within a fish farm complex, upon discovery of release or escapement of harmful or potentially harmful fish or shellfish, the permittee must immediately halt discharge of all private facility effluent.

(i) A holder of an exotic species permit must notify the department's aquaculture coordinator in the event of escapement or release of harmful or potentially harmful exotic fish or shellfish, within two hours of discovery.

(j) All devices required in the exotic species permit for prevention of discharge of harmful or potentially harmful exotic fish, shellfish, or aquatic plants must be in place and properly maintained prior to and at all times such species are in possession.

(k) All private facility effluent discharged from a fish farm holding exotic harmful or potentially harmful exotic species must be routed through all devices for prevention of discharge of exotic species as required in the permit.

(l) A permittee must notify the department's aquaculture coordinator in the event of change of ownership of the fish farm named in that permittee's exotic species permit. Notification must be made immediately.

(m) Permits are not transferable from site to site or from person to person.

§57.120. Exotic Species Permit; Expiration and Renewal.

(a) Exotic Species Permits required by these rules expire on December 31 of the year issued.

(b) The department may renew an Exotic Species Permit upon finding that:

(1) the applicant has met all the requirements of §57.117 of this title (relating to Exotic Species Permit; Fees and Application Requirements);

(2) the facility will meet all facility design criteria listed in §57.129 of this title (relating to Exotic Species Permit: Private Facility Criteria);

(3) the applicant has complied with all provisions of the Parks and Wildlife Code §66.007, §66.015, and these rules during the one-year period preceding the date of agency action on the application for renewal; and

(4) the applicant has submitted a renewal application and all required annual and quarterly reports to the department as required in §57.123(a) and (b).

§57.121. Exotic Species Permit: Amendment.

(a) Exotic species permits may be amended upon a finding by the department that:

(1) the applicant has complied with all provisions of the Parks and Wildlife Code §66.007, §66.015, all conditions in [the] permit, and these rules during the one-year period preceding the date of application.

(2) the applicant has met all applicable application requirements under §57.117 of this title (relating to Exotic Species Permit: Fee Application Requirements); and

(3) the facilities as altered will meet the private facility criteria in §57.129 of this title (relating to Exotic Species Permit [: Private Facility Criteria]).

(b) Exotic species permits must be amended to reflect any:

(1) addition or deletion of species of harmful or potentially harmful exotic fish, shellfish, or aquatic plants held pursuant to the permit;

(2) intended distribution of harmful or potentially harmful exotic fish, shellfish, and aquatic plants into private facilities is not authorized in the permit;

(3) change in methods of preventing discharge of harmful or potentially harmful exotic fish, shellfish, and aquatic plants;

(4) change in discharge of private facility effluent from fish farms or wastewater treatment facilities; and

(5) change in existing design criteria listed in §57.129 of this title (relating to Exotic Species Permit: Private Facility Criteria).

(c) Applicants seeking amendment of exotic species permits, including those issued prior to January 23, 1992, must meet all application requirements listed in §57.117 of this title (relating to Exotic Species Permit: Fee and Application Requirements) and facility design criteria listed in §57.129 of this title (relating to Exotic Species Permit: Private Facility

Criteria).

§57.122. Appeal.

An opportunity for hearing shall be provided to the applicant or permit holder for any denial of an exotic species permit or triploid grass carp permit or where terms of issuance are different from those requested by the applicant.

(1) Requirements for hearing shall be made in writing to the department no more than 30 days from receipt of the denial notification.

(2) All hearings shall be conducted in accordance with the rules of practice and procedure of the Texas Parks and Wildlife Department and the Administrative Procedure Act.

§57.123. Exotic Species Permit Reports.

(a) The Exotic Species Permit holder shall submit an annual report that accounts for importation, possession, transport, sale, or other disposition of any harmful or potentially harmful exotic species handled by the permittee. This report shall be submitted on forms provided by the department with the application and shall be due January 10 of each year.

(b) An Exotic Species Permit holder who has imported, possessed, transported, transferred, or sold triploid grass carp shall submit a quarterly report to the department on or before April 10, July 10, and October 10 of each year. This report shall be submitted on a form provided by the department and shall include:

(1) a copy of each exotic species transport invoice issued during the past quarterly period; and

(2) a copy of each triploid grass carp certification received by the permittee for triploid grass carp purchased during the past quarterly period.

§57.124. Triploid Grass Carp: Sale, Purchase.

(a) Triploid grass carp may be sold only by a holder of an exotic species permit authorizing possession of triploid grass carp, and only to:

(1) a person in possession of a valid exotic species permit authorizing possession of triploid grass carp; or

(2) a person in possession of a valid triploid grass carp permit, and only in an amount less than or equal to that number specified on the permit.

(b) A person who holds a valid triploid grass carp permit may purchase triploid grass carp only from a Texas fish farmer in possession of a valid exotic species permit authorizing possession of triploid grass carp, and only in an amount less than or equal to that number specified in the triploid grass carp permit.

(c) A holder of an exotic species permit may obtain triploid grass carp only from:

(1) the holder of a valid exotic species permit authorizing possession of triploid grass carp; or

(2) a lawful source outside the state.

(d) A fish farmer in possession of an exotic species permit must notify the department not less than 72 hours prior to taking possession of any and all shipments of triploid grass carp received from any source. Notification must include:

(1) number of triploid grass carp being purchased;

(2) source of triploid grass carp;

(3) final destination of triploid grass carp;

(4) name of certifying authority who conducted triploid grass carp certification; and

(5) name, address, and fish farmer's license number (if applicable) of both shipper and receiver.

§57.125. Triploid Grass Carp Permit: Application, Fee .

(a) The department may issue a triploid grass carp permit to private individuals for stocking of triploid grass carp in private waters.

(b) To be considered for a triploid grass carp permit, an applicant shall:

(1) complete an initial triploid grass carp application on a form provided by the department;

(2) submit the application to the department not less than 30 days prior to the proposed stocking date; and

(3) remit to the department the sum of the cost of the triploid grass carp permit application fee and the triploid grass carp user fee.

(c) The department shall charge a triploid grass carp permit application fee in the amount of the sum of a $15 application flat fee plus $2.00 for each triploid grass carp requested on the triploid grass carp permit application form. In the case of permit denial, the triploid grass carp permit application flat fee is not refundable. The $15 flat fee will be waived in the case of application to stock triploid grass carp in public water.

(d) An applicant for a triploid grass carp permit or a permittee shall allow inspection of their facilities and ponds or lakes by authorized employees of the department during normal business hours.

§57.126. Triploid Grass Carp Permit: Terms of Issuance.

(a) The department may issue a triploid grass carp permit upon a finding that:

(1) applicant has completed and submitted to the department a triploid grass carp permit application;

(2) applicant has remitted to the department all pertinent fees;

(3) all information provided in the triploid grass carp permit application is true and correct;

(4) applicant has not been finally convicted, within the last year, for violation of the Parks and Wildlife Code §66.007, §66.015, or these rules;

(5) issuance of a triploid grass carp permit is consistent with department fisheries and wildlife management activities;
(6) issuance of a triploid grass carp permit is consistent with the Parks and Wildlife Commission's environmental policy;
(7) issuance of a triploid grass carp permit and subsequent stocking does not conflict with specific management objectives of the department; and [sic]
(8) issuance of a triploid grass carp permit and subsequent stocking will not detrimentally affect threatened or endangered species population, or their habitat; and
(9) issuance of a triploid grass carp permit and subsequent stocking will not detrimentally affect coastal wetland and estuarine ecosystems.

(b) A permittee shall allow, upon request, the take of a reasonable number of grass carp from the permittee's body of water by department personnel for determination of triploid status.

(c) In determining the number of triploid grass carp authorized for possession under a triploid grass carp permit[,] the department shall consider the surface area of the pond or lake named in the permit application, [sic] and[,] as appropriate, the percentage of surface area infested by aquatic vegetation.

§57.127. Triploid Grass Carp: Denial.

The department may deny a triploid grass carp permit upon a finding that the applicant fails to satisfy any of the required criteria for issuance of a permit listed in §57.124 of this title (relating to Triploid Grass Carp; Sale, Purchase).

§57.128. Exotic Species Permits, Triploid Grass Carp Permits: Revocation.

The department may revoke an exotic species permit or triploid grass carp permit upon finding that the permittee has violated any provision of these rules or rules promulgated under the Parks and Wildlife Code §66.015, or any conditions during the valid permit period.

§57.129. Exotic Species Permits: Private Facility Criteria.

(a) The fish farm or wastewater treatment facility must be designed to prevent discharge of water containing adult or juvenile harmful or potentially harmful exotic species, their eggs, seeds, or other reproductive parts from the permittee's property.

(b) Fish farms holding harmful or potentially harmful fish and shellfish shall have at least three appropriately designed and constructed permanent screens placed between any point in the fish farm where harmful or potentially harmful fish or shellfish are intended to be in water on the fish farm and the point where private facility effluent first leaves the fish farm.
(1) Screen mesh shall be an appropriate size for each stage of exotic fish or shellfish growth and development.
(2) One screen must be permanently affixed in front of the final discharge pipe in the hardest structure and remain in place while the pond is in use. This screen and backing material must be of sufficient strength to withstand a water level differential of the height of the discharge area.
(3) At all those facilities which discharge into public waters, one screen must be secured over the terminal end of the discharge pipe at all times. This screen must be secured in such a fashion as to prevent escape of permitted species. A second, additional screen must be secured over the terminal end of the discharge pipe during all harvest activities.
(4) Screens must be designed and constructed such that screens can be maintained and cleaned without reducing the level of protection against release of harmful or potentially harmful exotic fish or shellfish. The department may approve alternate methods of preventing discharge of harmful and potentially harmful exotic fish or shellfish upon finding that those methods are at least as effective in preventing discharge of adult or juvenile harmful or potentially harmful exotic species, their eggs, or other reproductive parts from the permittee's property. The point of discharge of all mechanical harvesting devices must be double screened to prevent escapement of harmful or potentially harmful fish or shellfish.

(c) Fish farms which are to contain species or hybrids of species listed in §57.113(c)-(e) (relating to Exceptions) and wastewater treatment facilities containing waterhyacinth which are within the 100-year flood plain, referred to as Zone A on the National Flood Insurance Program Flood Insurance Rate Map, must be enclosed within an earthen or concrete dike or levee constructed in such a manner to exclude all flood waters and such that no section of the crest of the dike or levee is less than one foot above the 100-foot flood elevation. Dike design or construction must be approved by the department before issuance of a permit.

(d) Fish farms containing harmful or potentially harmful exotic shellfish shall be capable of segregating stocks of shellfish which have not been certified as free of disease from other stocks of shellfish on that farm.

(e) A fish farm containing harmful or potentially harmful exotic shellfish must have in place security measures designed to prevent unrestricted or uncontrolled access to any private facilities containing harmful or potentially harmful exotic shellfish. Security measures must prevent unauthorized removal of such species from the fish farm.

(f) For fish farms that are part of a fish farm complex, the following additional facility standards shall apply:
(1) Each permittee shall maintain in the common drainage at least one screen for preventing the movement of harmful or potentially harmful fish or shellfish between the point where private facility effluent from the permittee's fish farm enters the common drainage and each point where an adjacent fish farmer's private facility effluent enters the common drainage. The adequacy of design and construction of such screens or other structures shall be determined by the department as provided in subsection (a)(1) of this section.

(2) Each permittee within the complex must have authority to stop the discharge of private facility effluent from the complex in the event of escapement or release of such fish or shellfish from that permittee's fish farm.

§57.130. Exotic Species Interstate Transport Permit .

(a) Transport of live harmful or potentially harmful exotic species originating from a point of origin outside the state of Texas and being transported through Texas to a destination outside the state of Texas is prohibited except by the holder of an Exotic Species Interstate Transport Permit.

(b) Anyone transporting live harmful or potentially harmful exotic species must provide documentation accounting, collectively, for all exotic species being transported.

§57.131. Exotic Species Interstate Transport Permit: Application and Issuance.

(a) The department shall charge a nonrefundable Exotic Species Interstate Transport Permit application fee of either:
(1) $25 for individual permits; or
(2) $100 for an annual permit.

(b) To apply for an Exotic Species Interstate Transport Permit an applicant shall:
(1) complete and submit an Exotic Species Interstate Transport Permit Application on a form provided by the department; [and]
(2) remit to the department aquaculture coordinator all appropriate fees.

(c) An applicant for an Exotic Species Interstate Transport Permit shall provide documentation upon request from the department necessary to identify any harmful or potentially harmful exotic species and source of origin of the species for which the permit is sought.

(d) The department may issue an Exotic Species Interstate Transport Permit upon finding that all provisions of subsections (a) - (c) have been met.

§57.132. Exotic Species Interstate Transport Permit: Permittee Requirements.

(a) A copy of the Exotic Species Interstate Transport Permit shall be made available for inspection immediately upon request of authorized department personnel.

(b) Permittee must provide access to shipments of exotic species to authorized department personnel during the effective date of the permit.

(c) Permittee must notify the department's aquaculture coordinator in writing or by facsimile transmission at least 72 hours prior to transport of live harmful or potentially harmful exotic species including transport date, intended transportation route, and name and physical address of recipient.

(d) While transporting harmful or potentially harmful exotic species within the state of Texas, a holder of an Exotic Species Interstate Transport Permit must notify the department's aquaculture coordinator in the event of escapement or release of harmful or potentially harmful exotic species within two hours of release.

(e) Except as provided by the terms and conditions of the Exotic Species Interstate Transport Permit, offloading or transfer of shipments of harmful or potentially harmful exotic species in the state of Texas is prohibited.

§57.133. Exotic Species Interstate Transport Permit: Expiration and Renewal.

(a) Exotic Species Interstate Transport Permits expire as stated on the permit.

(b) A separate Exotic Species Interstate Transport Permit must be issued for each vehicle, trailer, or other such transporting unit when transporting live harmful or potentially harmful exotic species though the state.

§57.134. Wastewater Discharge Authority.

a. An applicant for an initial exotic species permit must provide the following:
1. written documentation demonstrating that the applicant possesses the appropriate valid wastewater discharge authorization or has received an exemption from the Texas Natural Resources Conservation Commission if the fish farm, fish farm complex, or private facility is designated such that a discharge of waste into or adjacent to water in the state will, or is likely to, occur; or
2. adequate documentation to demonstrate that the facility is designed and will be operated in a manner such that no discharge of waste into or adjacent to water in the state will, is likely to, occur.

b. An applicant for an amendment or renewal of an exotic species permit must provide the following:
1. written documentation demonstrating that the applicant possesses or has timely applied for and is diligently pursuing the appropriate wastewater discharge authorization or exemption from the Texas Natural Resources Conservation Commission in accordance with 30 TAC Chapter 321, Subchapter O, if the fish farm, fish farm complex, or private facility is designed such that a discharge of waste into or adjacent to water in the state will, or is likely to, occur; or
2. adequate documentation to demonstrate that the facility is designed and will be operated in a manner such that no discharge of water into or adjacent to water in the state will, or is likely to, occur.

c. An exotic species permittee whose wastewater discharge authorization or exemption is revoked, suspended, or annulled by the Texas Natural Resources Conservation Commission will be treated as an applicant for an initial permit under subsection (a) of this section.

§57.135. Memorandum of Understanding between the Texas Parks and Wildlife Department and the Texas Natural Resources Conservation Commission.

The Texas Parks and Wildlife Department (TPWD) incorporates by reference the memorandum of understanding between the Texas Natural Resources Conservation Commission (TNRCC) and the TPWD as published in the January 3, 1997, edition of the Texas Register (22 TexReg 24) and as adopted by the TNRCC on July 22, 1997.

§57.136. Penalties.

The penalties for violation of this subchapter are prescribed by Parks and Wildlife Code, §66.012.