INTRODUCTION OF AQUATIC ALIEN SPECIES IN MEXICO

INSTITUTO NACIONAL DE LA PESCA

CULTURED SPECIES

TILAPIA*
CARP*
CATFISH*
RAINBOW TROUT*
FRESHWATER PRAWN*
JAPANESE OYSTER*
MUSSEL*
SHRIMP
AMERICAN OYSTER

* EXOTIC SPECIES

POTENCIAL NATIVE SPECIES

ABALONE
CALIFORNIA MUSSEL
SCALLOP
UAHOG
PEARL OYSTER
RUGOSE PEN SHELL
MARINE FISH:
SPOTTED SAND BASS, BARRED SNAPPER,
SNOOK, POMPANO,
SEA URCHIN, SEA CUCUMBER,
ARTEMIA,
SHRIMP OF THE GULF OF MEXICO
FRESHWATER FISH, etc.

INTRODUCTION OF

CARPS

CARP INTRODUCTIONS

Cyprinus carpio communis	*1872*
Cyprinus carpio specularis	*1956*
Cyprinus carpio rubrofuscus	*1960*
Ctenopharhygodon idellus	*1965*
Hypophthalmichthys molitrix	*1965*
Aristhychthys nobillis	*1979*
Mylopharyngodon piceus	*1979*
Megalobrama amblycephala	*1979*

REASONS

- AS FOOD FISH
- LOW COST TO PRODUCE THEM
- FOR ROOTED AQUATIC WEED CONTROL
- FOR MOLLUSKS CONTROL
- AQUARIUM TRADE & AS PETS IN GARDEN PONDS
- PREY OF SPORT FISH
- BAITS

CHARACTERISTICS

- OMNIVOROUS
- EARLY SEXUALLY MATURE
- HIGH FECUNDITY
- RAPID GROWTH
- ADAPTABLE TO DIFFERENT ENVIRONMENTAL CONDITIONS

IMPACTS

- COMPETITION FOR FOOD WITH INVERTEBRATES AND FISH LARVAE
- REMOVAL OF VEGETATION
  - ELIMINATION OF FOOD SOURCES
  - SHELTER
  - SPAWNING SUBSTRATES
  - INCREASE WATER TURBIDITY
- EUTROPHICATION
- PRAY ON EGGS AND LARVAE OF OTHER CYPRINIDS
- REPRODUCING IN THE WILD
- HYBRIDIZE WITH OTHER CYPRINIDS
- CARRIERS OF SEVERAL PARASITES
- RESPONSIBLE FOR THE DECREASE OF NATIVE FISH POPULATIONS
  - *Chirostoma estor* IN MEXICO

Present Distribution

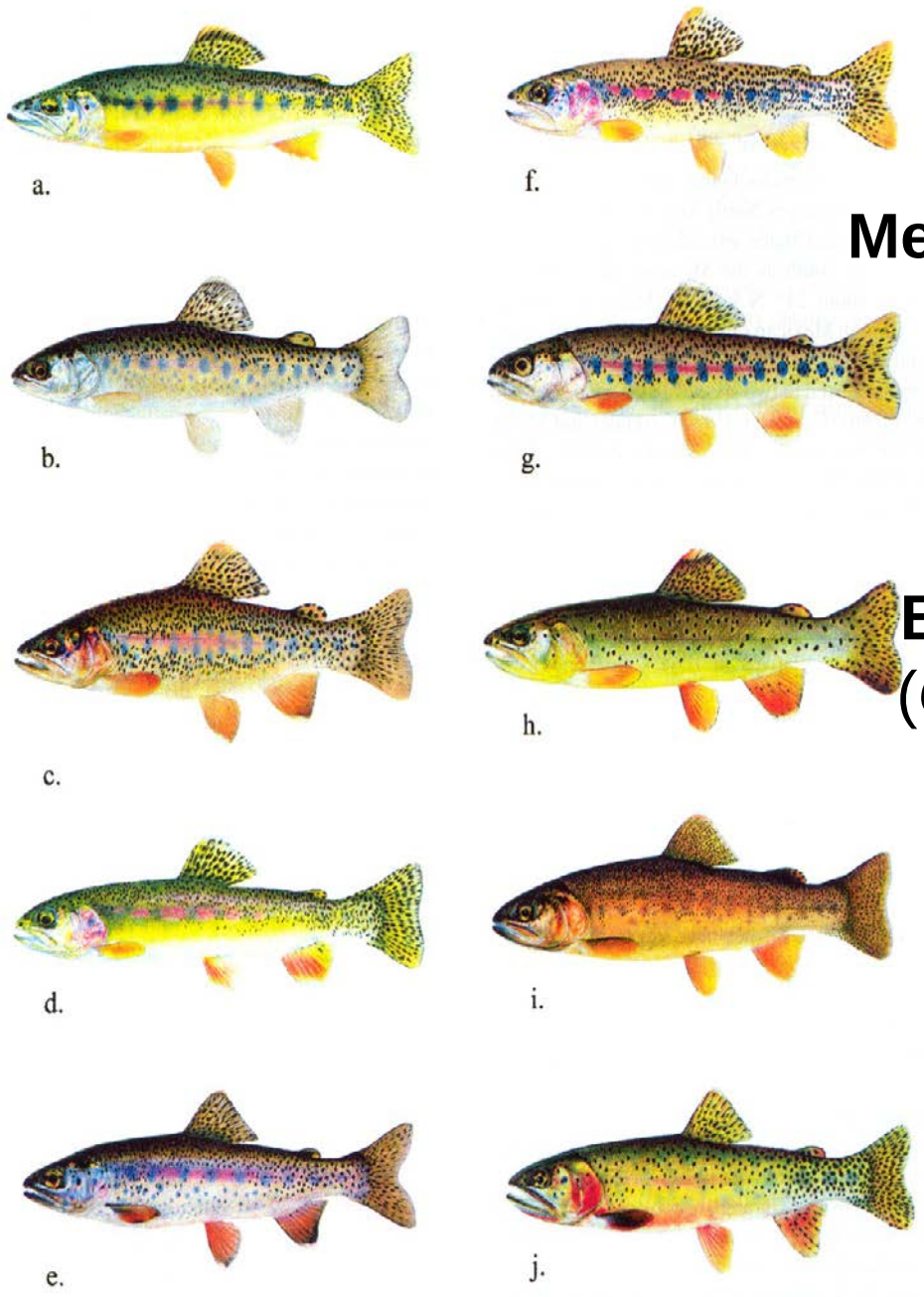
INTRODUCTION OF TROUTS

IMPACT

DISPLACEMENT OF NATIVE SPECIES

- EATING THEIR LARVAE
- CROSSBREEDING WITH OTHER NATIVE OR NOT NATIVE TROUT
- DISPLACE OTHER FISH FROM THEIR NATURAL REFUGES

Native Mexican Trout



Mexican golden trout
(*O. chrysogaster*)

and

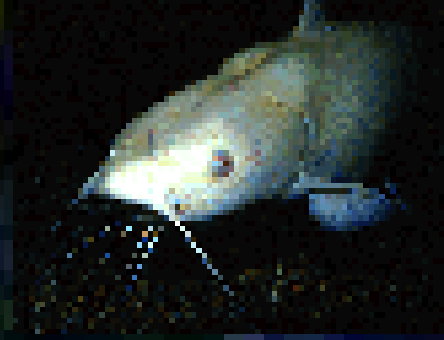
B.C. rainbow trout
(*O. mykiss nelsoni*)

ENLISTED
(CITES, AFS)

DISEASES

- **VHS** Viral Haemorrhagic Septicemia
- **IHN** Infectious Haematopoietic Necrosis
- **VEN** Viral Eritrocitic Necrosis
- **HVSD** Herpes Viral Salmon Disease
- **Ceratomixosis** *Ceratomyxa shasta*
- **BKD** Bacterial Kidney Disease
- **EHN** Epizootic Haematopoietic Necrosis
- **IPNV** Infectious pancreatic necrosis virus
- **Whirling disease** *Myxobolus cerebralis*

Present Distribution

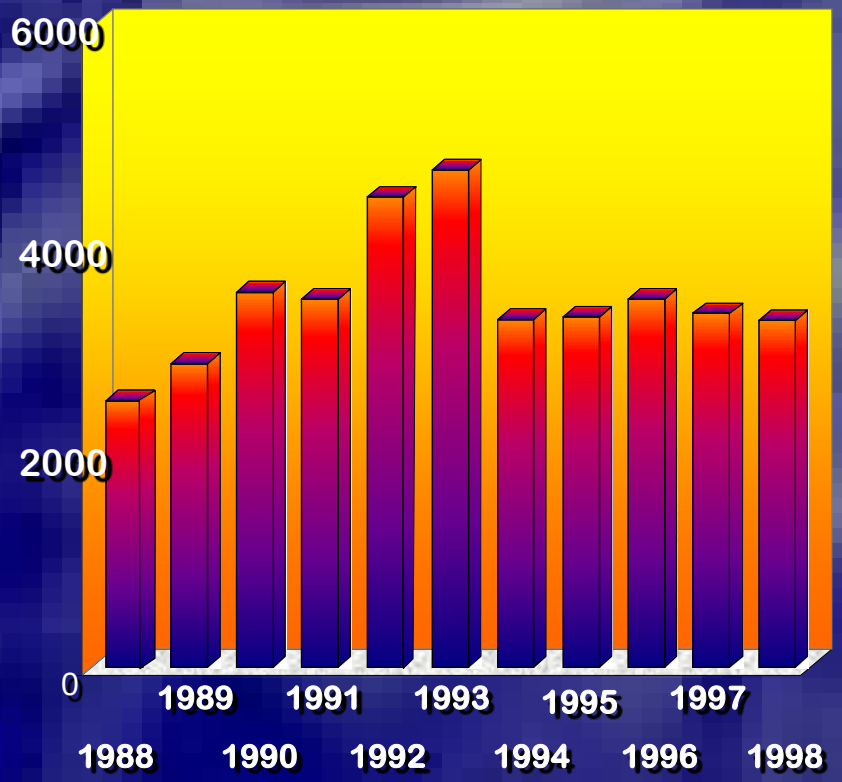


INTRODUCTION OF

INTRODUCTION OF

CATFISH

- **1972 AND 1973 *Ictalurus punctatus* INTRODUCED FOR AQUACULTURE IN NUEVO LEON AND SINALOA**
- **CULTURED SUCCESSFULLY FROM 1983 TO 1993,**
- **DISPLACEMENT OF *Ictalurus pricei* BY COMPETITION AND HYBRIDIZATION**
  - **RISK FOR OTHER NATIVE SPECIES**
    - **(*Ictalurus melas, I. furcatus, I. ochoterenai*)**



Present Distribution

INTRODUCTION OF TILAPIA

Introduction

In the early 60's

- Commercial Aquaculture 70's
- Several species are raised
- Among the most popular
  - *Oreochromis mossambicus*
  - *O. niloticus*
  - *O. aureus*
  - Various hybrids among these and even other species

REASONS

- PRODUCTION OF FOOD FOR LOCAL CONSUMPTION
- DIVERSIFICATION OF RURAL ACTIVITIES RELATED TO AGRICULTURE AND ANIMAL HUSBANDRY
- AQUATIC PLANT CONTROL
- 90's ALTERNATIVE TO SHRIMP CULTURE

Grows well in most production systems

- Simple hatchery technology
- Disease resistant
- Grow well at high densities

CHARACTERISTICS

- HARDY FISH
- RESISTANT TO VARIOUS ENVIRONMENTAL STRESSORS
  - TEMPERATURE
  - SALINITY
  - EUTROPHIC WATERS, etc.
- PRECOCIOUS REPRODUCTION
  - HIGHLY AGRESSIVE DURING THE BREEDING SEASON

CONSEQUENCES

- **IMPACT ON NATIVES CICHLIDS**
  - (e.g. *Cichlasoma istlanum, C. bartoni, C. labridens*)
  - **DIRECTLY COMPETING FOR NESTING AREAS**
- **OPPORTUNISTICALLY FEED ON A NUMBER OF DIFFERENT FOOD ITEMS**
  - **POTENTIAL TO COMPETE WITH A BROAD ARRAY OF NATIVE TAXA**
- **NO GENETIC CONTROL IN THE PRODUCTION CENTERS**
  - **RISK OF ENDOGAMY AND HYBRIDIZATION**
- **INTRODUCTIONS AND CULTURE TRIALS HAVE EXTENDED TO BRAKISH AND MARINE WATER**

PRODUCTION

MEXICO 80,000 mt

- Main cultured species
- Intensive in the North, lake ranching in South
- First place in freshwater fisheries
- More than 10,000 direct employments

THE REALITY

- Tilapia are one of the most important domesticated fish today
- Tilapia will be the single most important aquaculture product in the 21st Century
  - The "*Aquatic chicken*"
  - The "*Perfect fish*"
  - The "*Fish of the year*"

Why tilapia will surpass other species in importance?

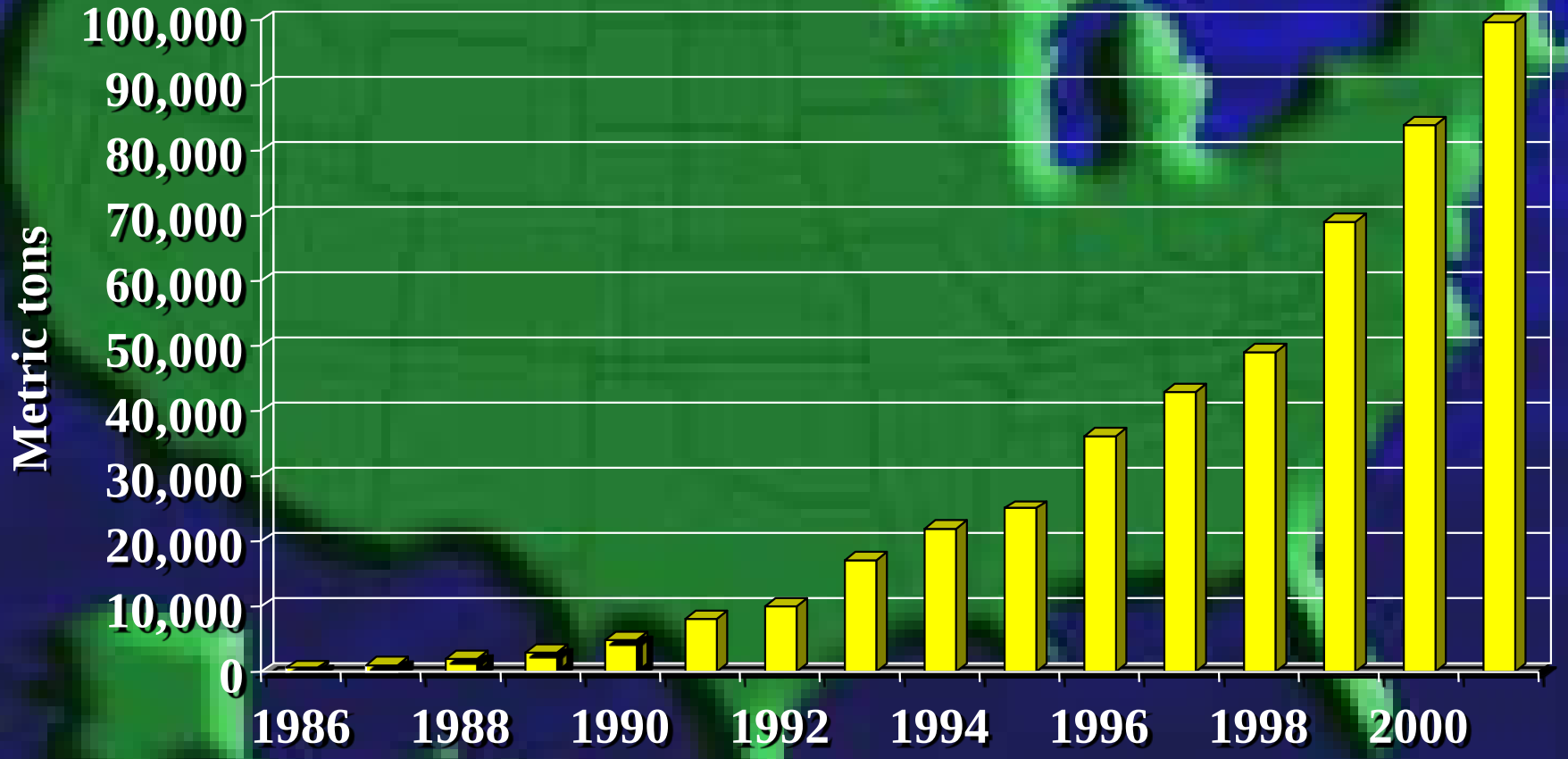
- Carp: markets are limited
- Salmonids and shrimps need high levels of fish meal, limited ingredients for diets
- Most other species need higher water quality, competition for sites

New product forms - Push and Pull

Smoked tilapia

Sashimi grade tilapia

US Tilapia consumption (mt)




MISS TILAPIA

Present Distribution

Sucker Mouth Catfish

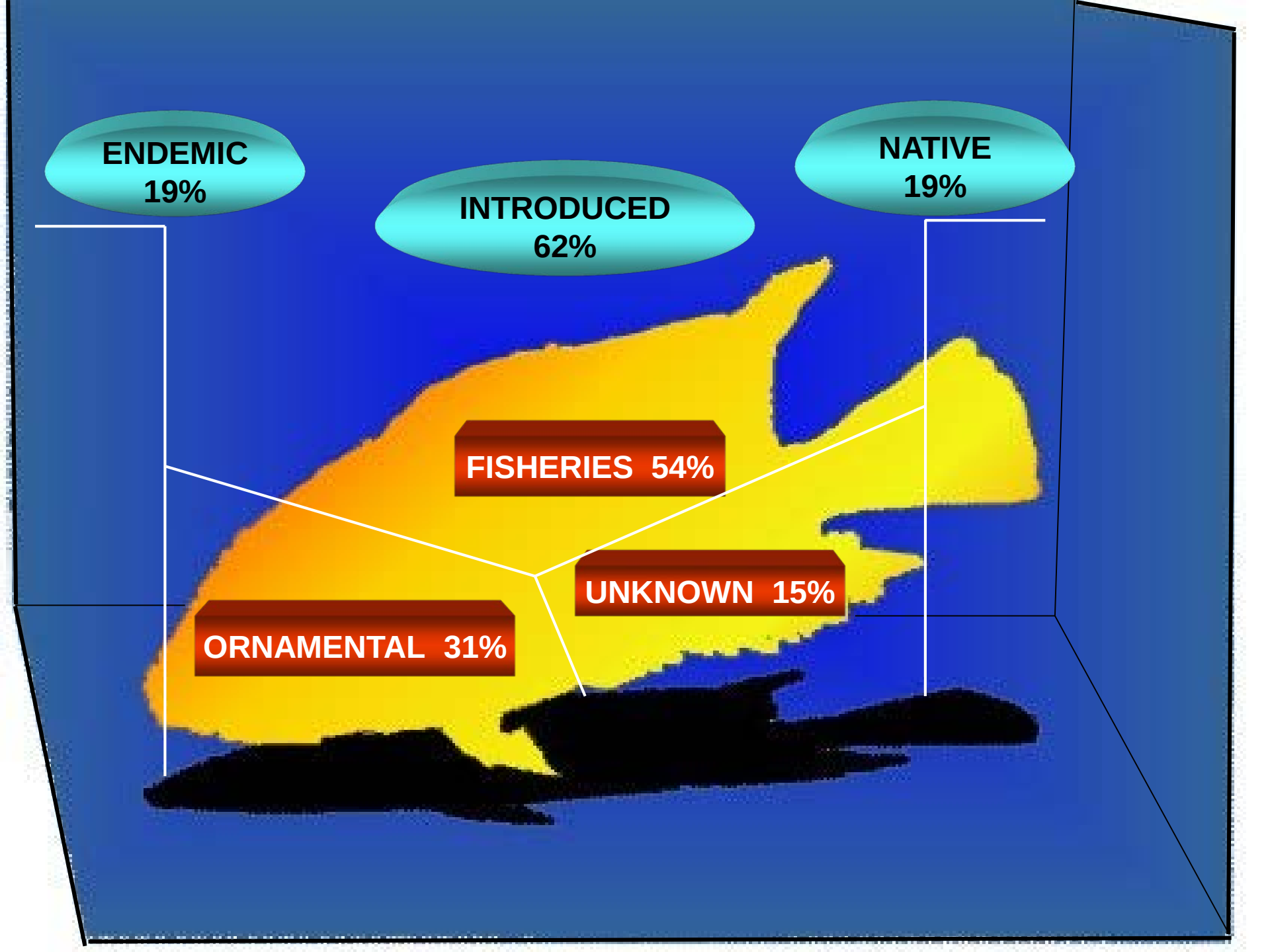
Hypostomus plecostomus

- The body is protected by heavy, bandlike armour
- Feed at dusk and are fiercely territorial.
- The downturned mouth is full of tiny rasping teeth
  - Can rasp the sides of slower moving fishes
  - Severe damage may result
- Life span: Unknown, maybe 10-30 years

PLECOSTOMUS

- THE HERVIVOROUS VACUUM
  - Will devour or destroy virtually any plant
  - May eat FW snails
- Manage to survive out of water much longer than other fish
  - They can utilize atmospheric oxygen somewhat
  - Spend dry season above the water line, in mud holes in the bank

Present Distribution


ENDEMIC
19%
INTRODUCED
62%
NATIVE
19%
FISHERIES 54%
UNKNOWN 15%
ORNAMENTAL 31%

CONVICT CICHLID

Archocentrus (Cichlasoma) nigrofasciatum

- Central America
  - Guatemala, Honduras, Nicaragua, Costa Rica and Panama
- Omnivorous
- Extremely hardy
- Among the easiest bred fish in captivity
  - Precocious: can breed when they're even only 1" long
- One of the most aggressive fish
  - Especially aggressive while breeding
- Impact on *Cichlasoma istlanum* populations


Rio Amacuzac
Rio Atoyac
Rio
Balsas

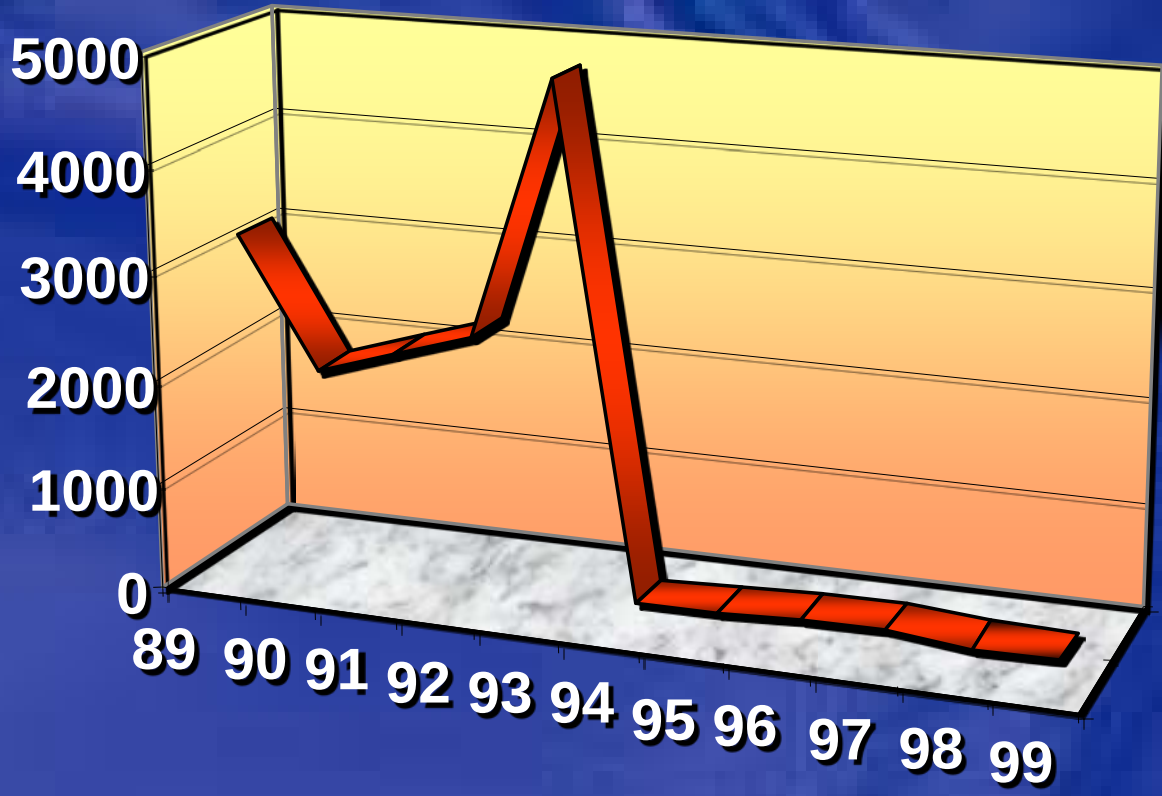
INTRODUCCION OF

Macrobrachium rosenbergii

Macrobrachium SPECIES in MEXICO

- *M. acanthurus*
- *M. carcinus*
- *M. heterochirus*
- *M. tenellum*
- *M. americanum*
- *M. olferesi*
- *M. acherontium*
- *M. occidentale*
- *M. digueti*
- *M. villalobosi*
- *M. acanthochirus*

- **INTRODUCED (1970)**
  - RAPID GROWTH
  - ADAPTABILITY TO DIFFERENT ENVIRONMENTAL CONDITIONS



PRODUCTION

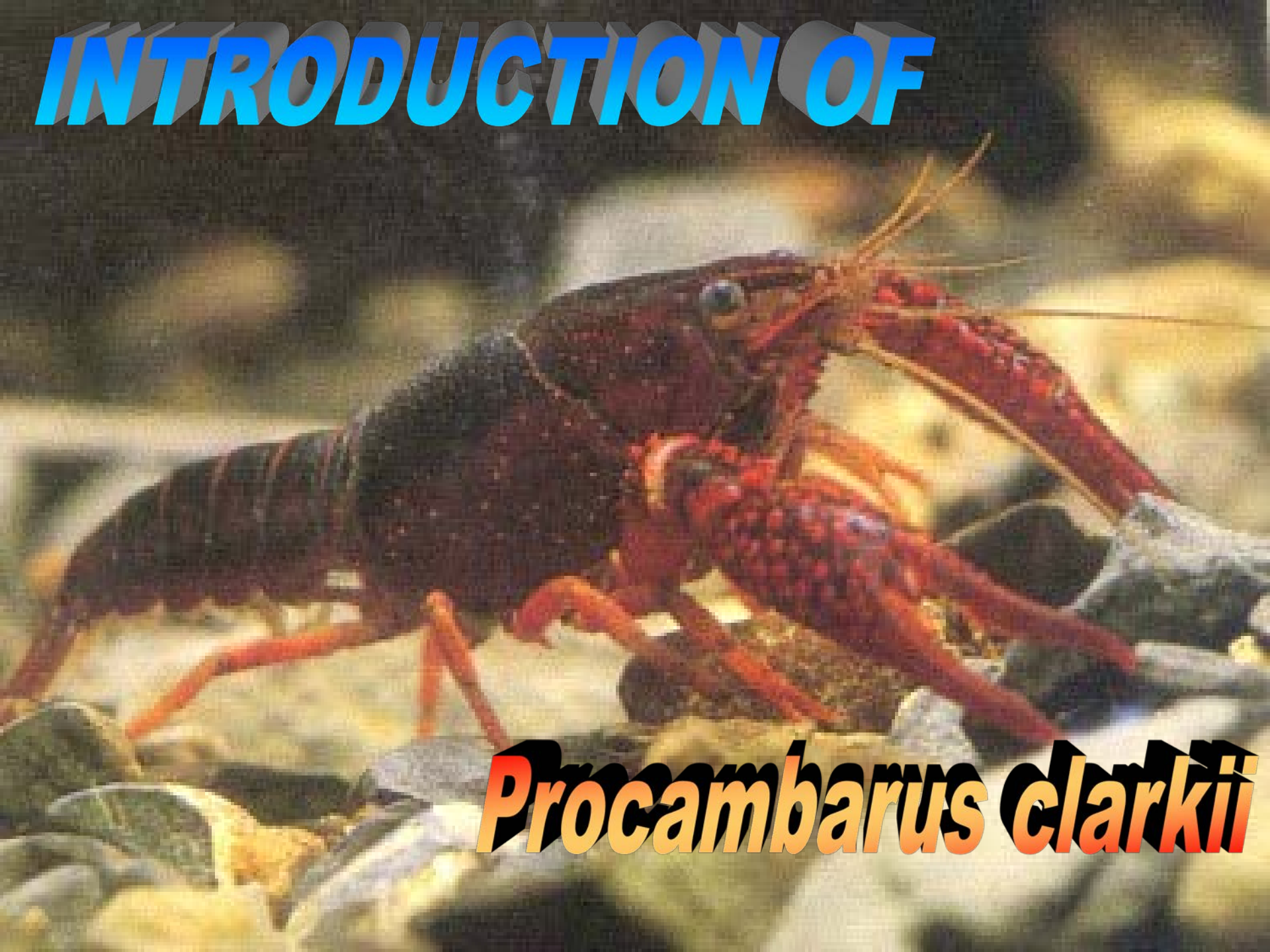
- ONLY 51 METRIC TONS IN 1999
- LACK OF ADEQUATE TECHNOLOGY
- IRREGULAR LARVAL SUPPLY
- ONLY ONE HATCHERY PRODUCING LARVAE

Present Distribution

CRAYFISH OF MEXICO

- **49 species of crayfish in Mexico**
  - (40 *Procambarus* and 9 *Cambarellus*)
- **3 exotic species have been introduced**
  - ***Procambarus clarkii***
  - ***Cherax quadricarinatus***
  - ***Orconectes virilis***

INTRODUCTION OF



Procambarus clarkii


P. clarkii WAS INTRODUCED INTO MEXICO WITH THE FALSE ASSUMPTION THAT A LARGE COMMERCIAL BUSSINESS WOULD RESULT

EXTREMELY HARDY, HAVING ADAPTED TO DIFFERENT ENVIRONMENTS IN :

- AMERICA
- EUROPE
- ASIA
- AFRICA

REPRODUCTION

- REACH MATURITY BETWEEN 2 AND 6 MONTHS AFTER HATCHING
- MATURE CRAWFISH MATE IN OPEN WATERS ALL YEAR
- SPERM IS VIABLE FOR 8 MONTHS
- EGGS FROM 100 - 700

⇨ THEY MULTIPLY AND COMPETE AGAINST NATIVE CRAYFISH FOR FOOD SOURCES

- **1985** 3 FEMALES AND 1 MALE OF

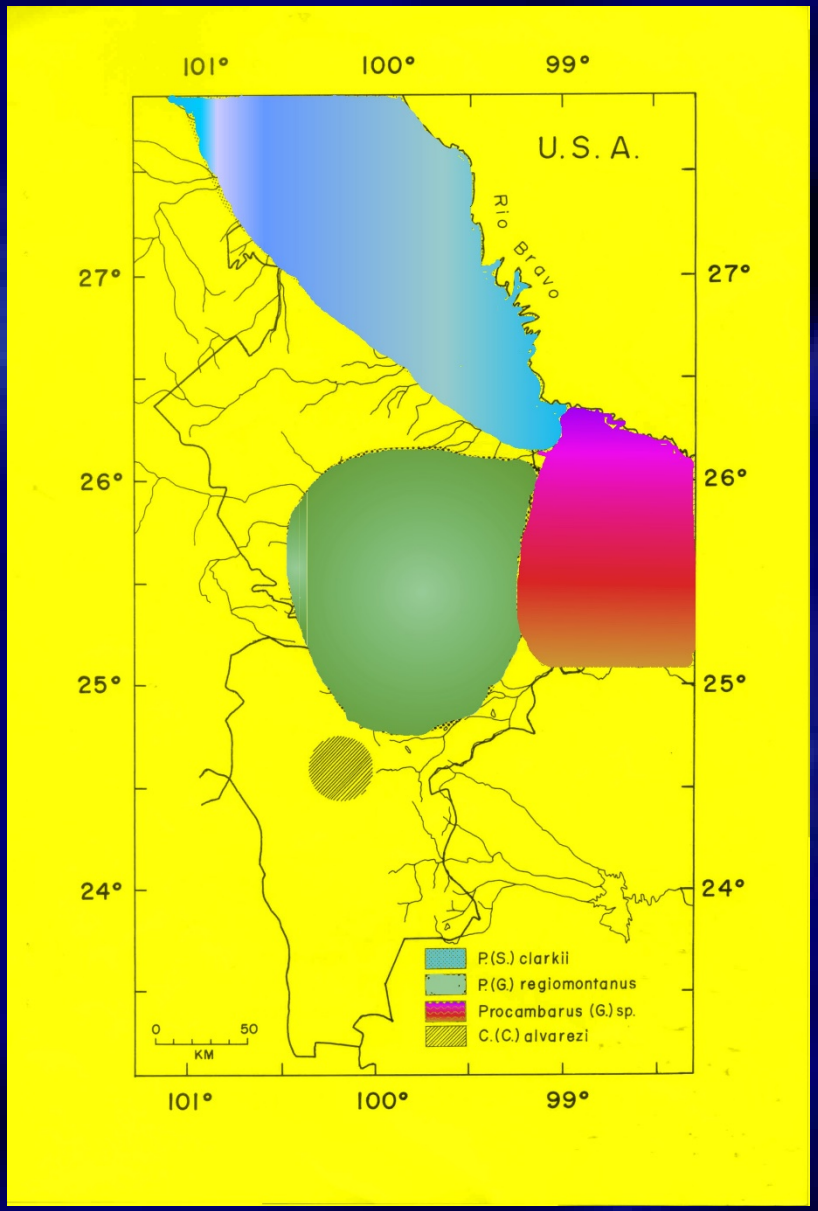
  P. clarkii

- ***P. regiomontanus*** WAS NUMERICALLY DOMINANT

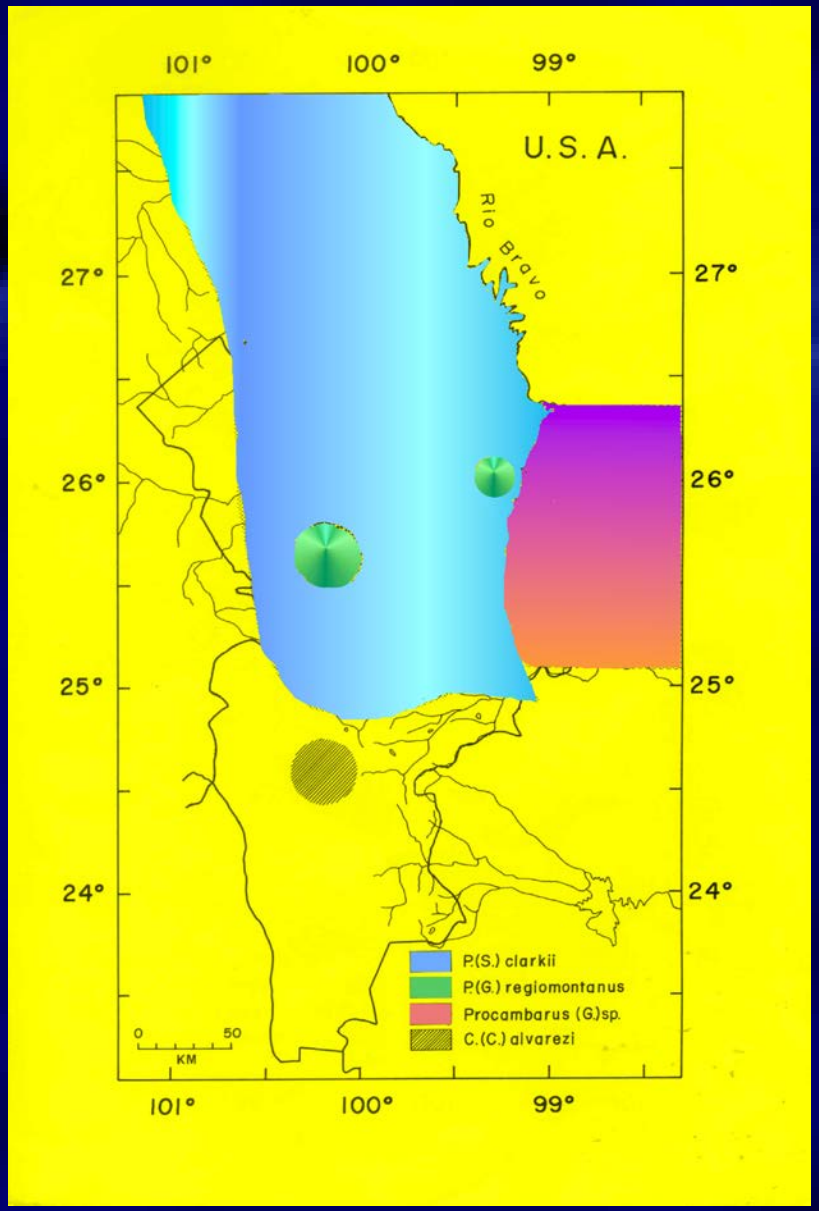
- **1987** ***P. clarkii*** POPULATIONS INCREASED SPECTACULARLY
- SIGNIFICANT COLLAPSE OF THE POPULATIONS OF ***P. regiomontanus***

- **1992** ***P.clarkii*** REPRESENTED FROM 95 - 100% OF CRAYFISH POPULATIONS

1985


101°
100°
99°
U.S.A.
Rio Bravo
27°
26°
25°
24°
P.(S.) clarkii
P.(G.) regiomontanus
Procambarus (G.) sp.
C.(C.) alvarezi
0
50
KM

1992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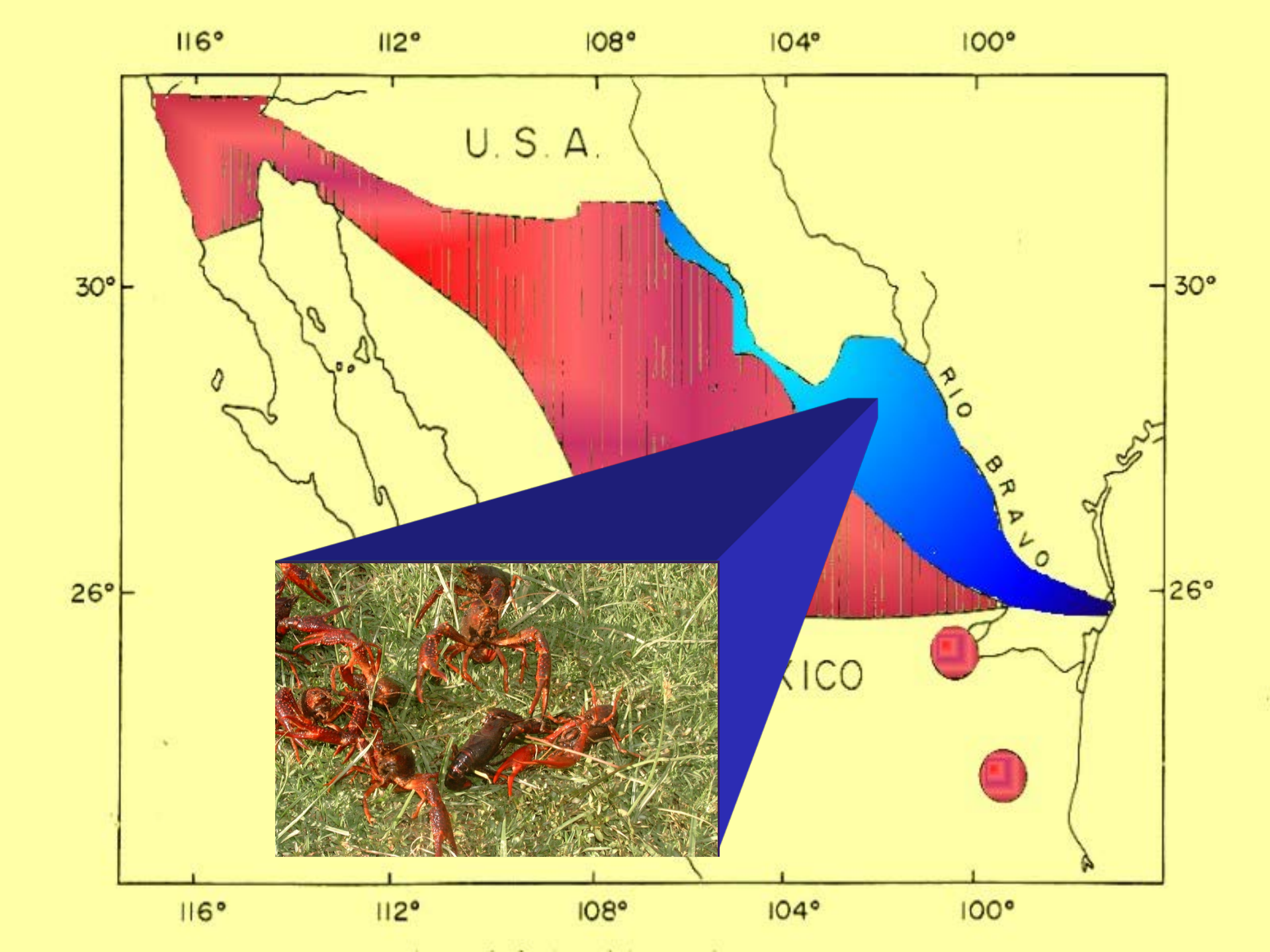

116°
112°
108°
104°
100°
U. S. A.
30°
26°
RIO BRAVO
XICO

RESULTS

- THE PRESENCE OF A VERY AGGRESSIVE SPECIES
  - CANNIBALISTIC BEHAVIOUR
- PRESENTS INTENSIVE BURROWING ACTIVITY
  - CAN SURVIVE UP TO 5 MONTHS IN THE BURROW
  - MAY CAUSE DAMAGE IN LEVEES , DAMS, OR WATER CONTROL STRUCTURES
- CONTRIBUTES TO PUBLIC OR VETERINARY HEALTH PROBLEMS
  - AS AN INTERMEDIATE HOST OF SEVERAL PARASITIC HELMINTHS OF VERTEBRATES AND CARRIER OF *Aphanomyces astaci*

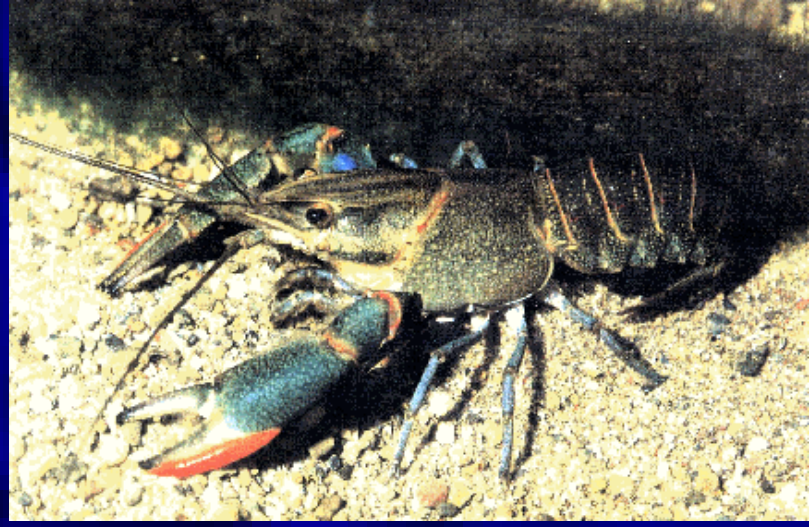
...AND THERE IS NO COMMERCIAL CULTURE OF THE SPECIES


INTRODUCTION OF
Cherax quadricarinatus

INTRODUCED IN 1990

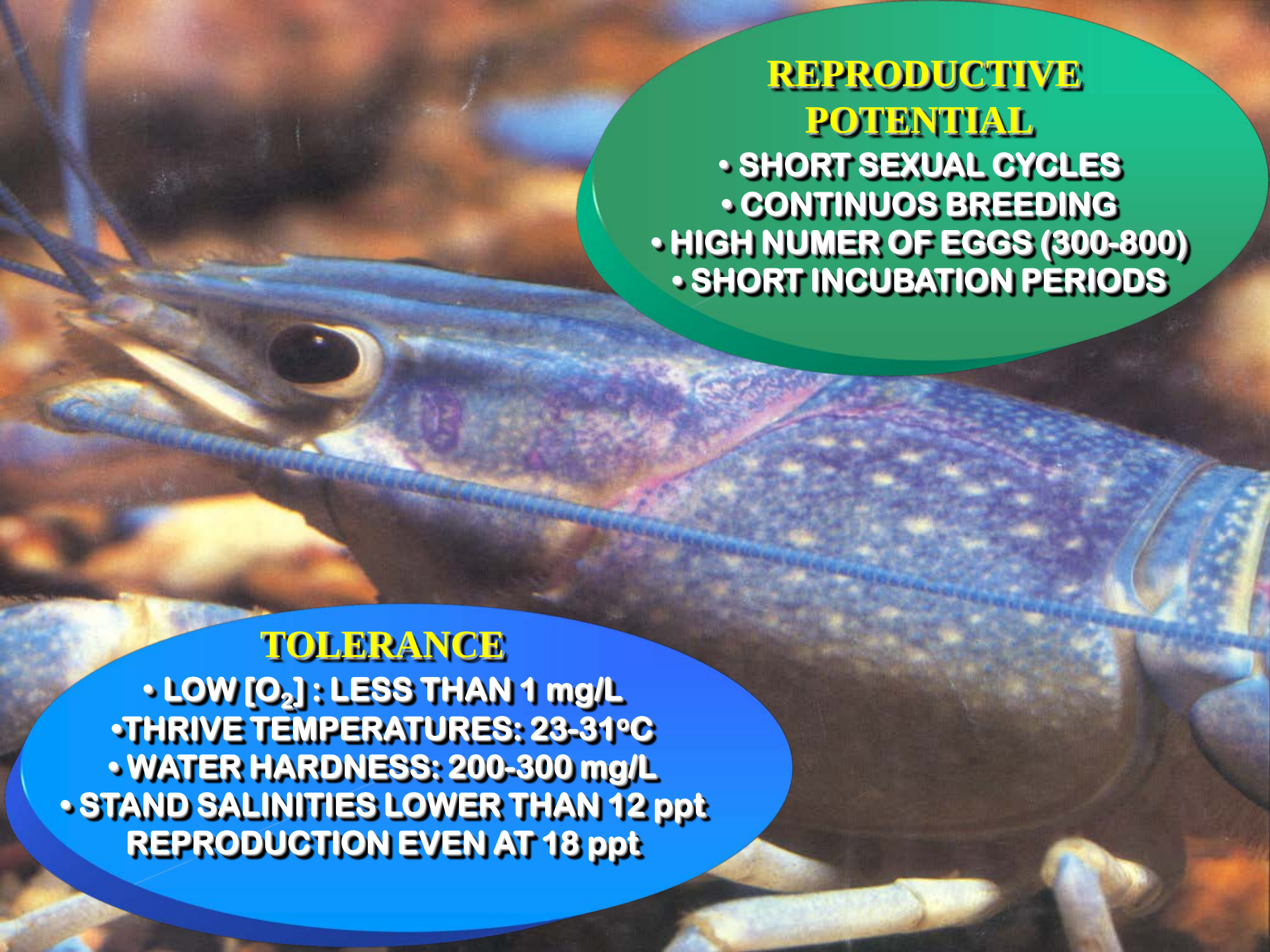
REASON: : TO ALLEVIATE PROBLEMS IN THE SHRIMP CULTURE INDUSTRY

- **PROMOTED AS A ROBUST SPECIES WITH SEVERAL SUITABLE CHARACTERISTICS FOR AQUACULTURE**



- **RAPID GROWTH: (400-800 g/year) ONE OF THE LARGER FRESHWATER CRAYFISH IN THE WORLD**
- **ATTRACTIVE PRICE (U.S.$9.90-12.10/kg)**

- JUVENILES ARE ACTIVE PREDATORS
  - CANNIBALISM EVEN WHEN OTHER SOURCES OF FOOD ARE PRESENT
- ADULTS VERY AGGRESSIVE IN CROWDED CONDITIONS
- STRONG RESPONSE TO WATER CURRENT AND MOVE UPSTREAM IN A FLOW OF WATER



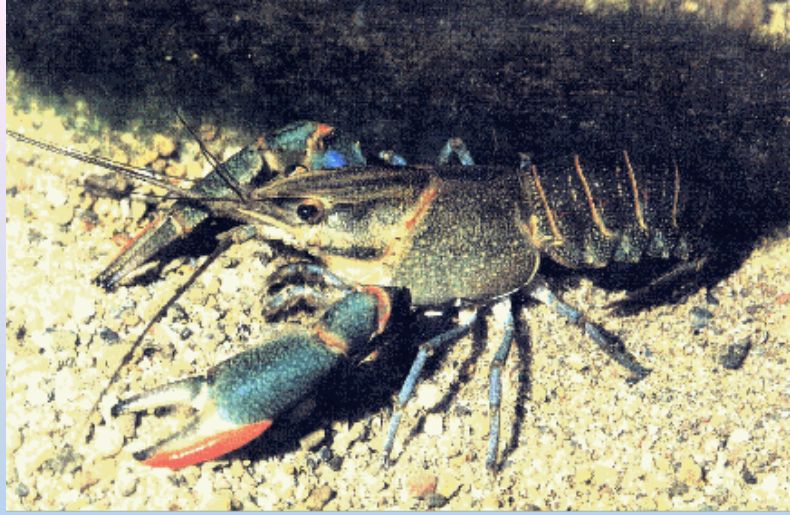
REPRODUCTIVE POTENTIAL

- SHORT SEXUAL CYCLES
- CONTINUOS BREEDING
- HIGH NUMER OF EGGS (300-800)
- SHORT INCUBATION PERIODS

TOLERANCE

- LOW [O_2] : LESS THAN 1 mg/L
- THRIVE TEMPERATURES: 23-31°C
- WATER HARDNESS: 200-300 mg/L
- STAND SALINITIES LOWER THAN 12 ppt
  REPRODUCTION EVEN AT 18 ppt

DISEASES



- **PROMOTED AS BEING DISEASE-FREE !!**

VIRUSES
CqBV
CGV
CdSPV

BACTERIA
Eye necrosis syndrome
Filamentous bacteria on gills
Chitinoclastic bacteria

RICKETTSIA

FUNGUS
Aphanomyces astaci

ENDOPARASITIC CILIATES
Tetrahymena pyriformis

MICROSPORIDIANS
Thelohania

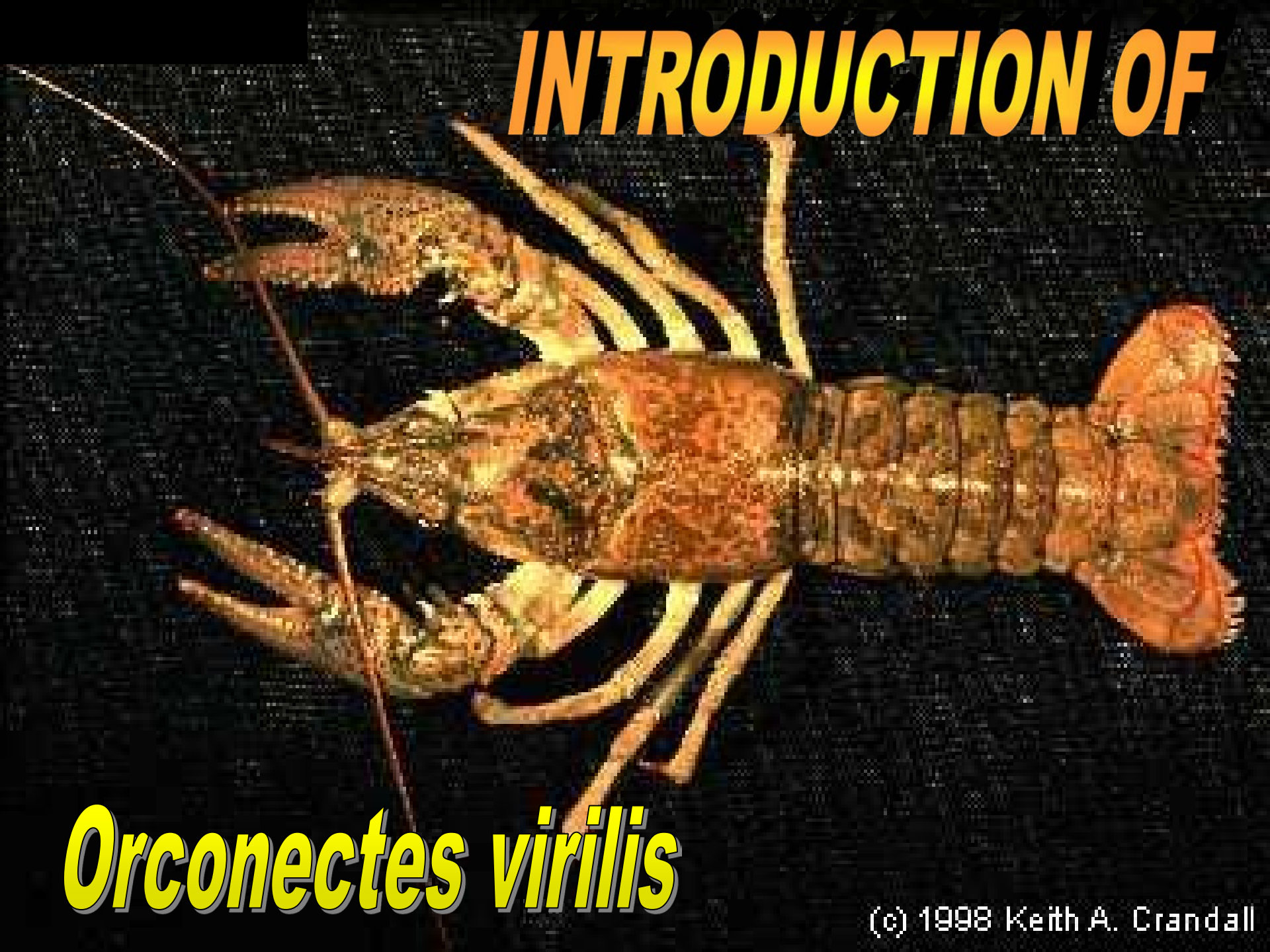
EXOPARASITIC CILIATES
Zoothamnium
Epistylis

NEMATODES

PLATHELMINTHS

Transplantations includes: USA, Mexico, Caribbean Islands, Ecuador, China, Southern Africa (Swaziland, Zambia), Italy, and Israel

Present Distribution


INTRODUCTION OF
Orconectes virilis
(c) 1998 Keith A. Crandall

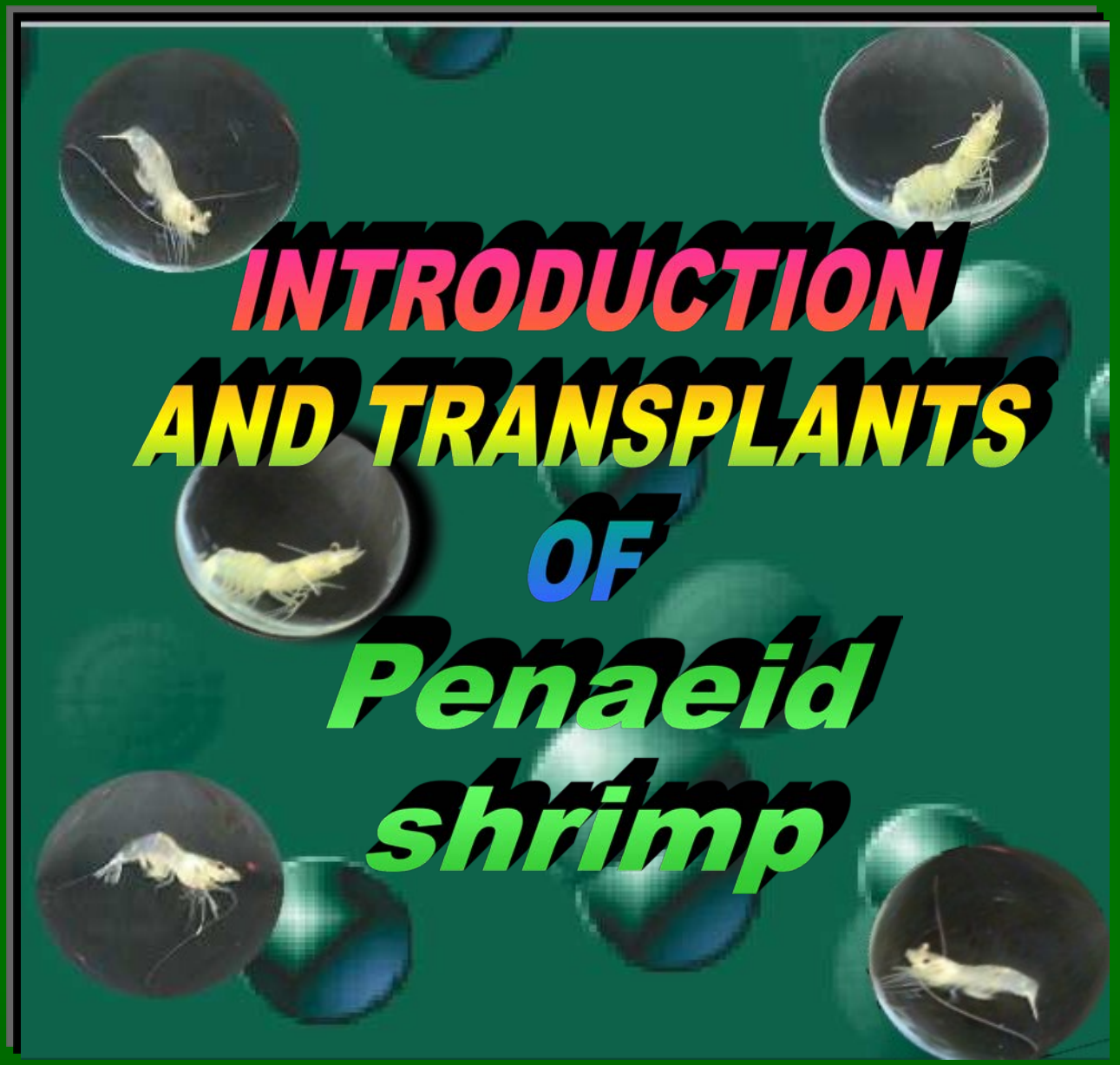
CHARACTERISTICS

- LOW METABOLIC REQUIREMENTS
- LOW O_2 CONSUMPTION RATE
- USE LESS FOOD THAN OTHER SPECIES
- DEVELOPS WELL ABOVE 10°C

- CO-EXISTS AND COMPETES WITH

P. clarkii

EXOTIC *vs* EXOTIC


INTRODUCTION
AND TRANSPLANTS
OF
Penaeid
shrimp


L. setiferus
F. duorarum
F. aztecus
L. schmitii
L. vannamei
L. stylirostris
F. californiensis
L. occidentalis
F. brevirostris


INTRODUCTION OF
Penaeus monodon

PRESENCE OF *P. monodon* IN NORTHAMERICA

USA

- 1988 imported postlarvae (HDA) released by accident from Blufton, S.C. into a stream that terminates in coastal waters
- Animals captured by commercial shrimpers along the East Coast
  - As far south as Cape Canaveral, Florida

MEXICO

- 1990 first reported occurrence (Sinaloa)
- 1994 nutritional experiments in Baja California

POTENTIAL CARRIER OF:

- MBV (Monodon baculovirus)
- YHV (Yellow head virus)
- IHHNV (Hypodermal and hematopoietic necrosis virus)
- HPV (hepatopancreatic parvo-like virus)
- BMNV (baculoviral midgut gland necrosis virus)
- LPV lymphoidal parvo-like virus)
- RLV (Reo-like virus)

TRANSPLANTS

L. vannamei

L. stylirostris

WHY PACIFIC SHRIMP?

- Larger body size
  - Increased body weight increases production which increases profits
- Pacific species seem to be "more forgiving" to the grower
  - They are hardier and survivals are generally better

Hybridization

The following crosses (genetically verified) have been attempted:

- ***L. setiferus x L. schmittii***
- ***L. setiferus x L. stylirostris***

But the crosses did not reproduce

(University of California and Texas A&M University)

WSSV has been experimentally induced or detected in:

- VIRUS DILUTIONS 10^{-7}/ml
- VERTICAL TRANSMISION
- INADVERTENT CARRIERS
- INSECTS

- *Trachypenaeus curvirostris*
- *Exopalaemon orientalis*
- *Macrobrachium* sp
- *Procambarus clarkii*
- *Scylla serrata*
- *Charybdis feriatus*
- *Portunus pelagicus*
- *Portunus sanguinolentus*
- *Thalamita* sp
- *Cherax quadricarinatus*
- *Calappa philarigus*
- *Charybdis natator*
- *Helice tridens*
- *Acetes spp*
- *Artemia salina (cysts)*

(Lan et al., 1996; Lightner, In Press; Royo, et al (1999 Chang et al, 2001; Chen et al, 2000)

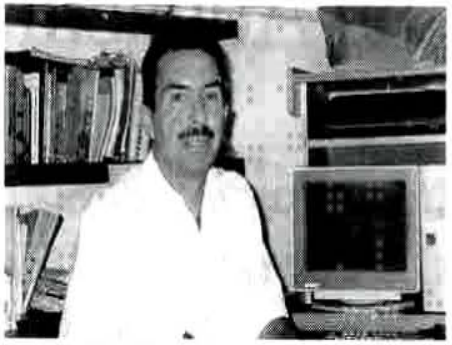
Alternativas

Camaronicultura en Agua Dulce
Una alternativa comprobada

El cultivo de camarón P. vannamei en el Estado de Colima, México, fue iniciado hace menos de dos años por la Empresa Aquagranjas, debido a circunstancias particulares las primeras siembras se efectuaron en estanques de agua dulce antes dedicados al cultivo del langostino (Macrobrachium rosembergii), los excelentes resultados obtenidos inicialmente y la posterior afinación de aspectos operativos, han propiciado en México y posiblemente en otros países, la camaronicultura estrictamente dulceacuícola. Además ha sido relevante la no aparición de los patógenos asociados a la engorda del camarón blanco bajo estas circunstancias.

*B.P. Miguel Avila Tamayo**

La tolerancia y adaptabilidad de *P. vannamei* a amplios rangos de parámetros del agua, es ampliamente conocida y reportada en numerosas publicaciones, pero pareciera ciencia ficción o fantasía la existencia de una granja camaronera a 400 mts. sobre el nivel del mar, ¡Un verdadero camarón de altura!, y a 40 km. distante de la costa. Lógicamanete el primer cuestionamiento en surgir es ¿Que tipo de toma de agua tiene?, de hecho posee un par de pozos profundos de agua a 0 ppm salinidad, con estas condiciones se han logrado rendimientos de 1.47 Ton./Ha. en 105 días, 14.7 grs. peso promedio a la cosecha y sobrevivencia de 69% con



B.P. Miguel Ávila Tamayo, Director de Aquagranjas.

ANTECEDENTES

Hace menos de 2 años Aquagranjas, laboratorio dedicado anteriormente al larvicultivo de langostino Malayo *Macrobrachium rosembergii* ubicado en el Municipio de Tecomán, Colima, produjo el primer lote de postlarvas de camarón blanco *P. vannamei*, las

estanques de agua salada o salobre para el cultivo de camarón, tres granjas anteriormente dedicadas al cultivo del langostino tomaron la alternativa de sembrar estas postlarvas, una de ellas, la mencionada al inicio de este documento, (Acuícola Montegrande) y otras dos (Acuícola Los Desmontes y Acuícola La Parotita ubicadas en la zona costera del Municipio de Tecomán), la sorpresa no se hizo esperar, obteniéndose simultáneamente en las tres granjas, resultados similares a los antes descritos.

La topografía de la cuenca oceánica adyacente a la costa colimense se caracteriza por la ausencia de plataforma continental que sustente en su fondo poblaciones masivas de recur-

donde generalmente se ha promovido el cultivo de especies como tilapia u otro tipo de peces, el cultivo de camarón balnco en agua dulce ha sorprendido a las personas que lo han iniciado o que han substituido las especies antes cultivadas por éste.

Históricamente en Colima y otras entidades de la región se han ejercido recursos económicos de manera consistente en especies que no han alcanzado rentabilidad, éstos podrían ser aplicados para promover y apoyar directamente el cultivo de camarón. A continuación se exponen los principales costos de producción e ingreso de venta del camarón cultivado en estanquería en el estado:

SPECIAL STRAINS

WSSV

- **SPF (Hawaii)**
  - *L. vannamei* resistant to IHHN
  - SUCCEPTIBLE TO TSV
- **SPR-43 (New Caledonia)**
  - *L.* stylirostris resistant to IHHN
  - SUCCEPTIBLE TO "Syndrome 93" (mortalities caused by *Vibrio penaeicida*)
- **SUPER SHRIMP (Aruba)**
  - IHHNV and Taura resistant *L.* stylirostris

...As they grow and disperse, species unavoidably carry their parasites and diseases with them, but not their predators, competitors and prey…

Minns and Cooley, 1999

Marisa

Corbicula

Pomacea

Melanoides

INTRODUCTION OF

Thiara (Melanoides) tuberculata

SCREW SNAIL

THE TRAVELING SNAIL

- INTRODUCED AROUND 1960
- AQUARIUM TRADE "the Philippine horn of plenty"
  - CARELESS WASHING OF TANKS
  - DISPOSAL OF WATER AND DETRITUS INTO PUBLIC SEWAGE SYSTEMS
- FOR ITS CAPACITY FOR PREDATING, COMPETING OR REDUCING POPULATIONS OF *Biomphalaria*
  - INTERMEDIATE HOST OF BILHARZIOSIS

Biological Characteristics

- Support a wide range of environmental conditions
  - Found in good numbers in waters up to 30ppt
  - Tolerate pollution from different sources
  - Stay buried during daylight, while at night climb to the air/water interface (operculate)
- May reproduce both sexually and by parthenogenesis
  - Individuals as small as 10mm may begin to reproduce
  - Viviparous
  - Number of young within the brood pouch ranges from 62 to 88
- Life span 5 years
- Found in high densities
  - 2,500/m^2 (Durango, Mexico), 37,500/m^2 (Florida, USA), 51,650/m^2 (Texas, USA)
- Spread of screw snails correlated with the decline of native snail populations

Biodiversity losses in the Freshwater Snail Fauna at La Presa Rodrigo Gómez, NL. México

NATIVE	1985[2]	1987-1991[3]	1992[4]	1996
Pyrogophorus spinosus	XXXX	XXX	X	X
Cochliopina riograndensis	X	-	-	-
Physa mexicana	XXXX	XXX	X	XX
Pseudosuccinea columella	XX	-	-	-
Biomphalaria havanensis	XXX	XX	XX	XX
Planorbella trivolis	XXXX	XXX	XX	XX
Gundlachia radiata	XXX	XX	X	-
Sphaerium sp.	XX	-	-	-
Anodonta imbecilis	XXXX	XXX	XX	X
EXOTIC				
Thiara tuberculata	X	XXX	XXXX	XXXX
Corbicula manilensis	XXX	XX	X	XX
SPECIES RATIO	9/2	6/2	6/2	5/2
SPECIES LOSS (%)	0	40	40	50

X=rare, XX=scarce, XXX=common, XXXX= abundant

Present Distribution

IMPACT

- *Melanoides* and *Thiara* dominate most sites
- Infective cercaria drifted downstream
  - *Centrocestus formosanus*
  - *Haplorchis pumilio*

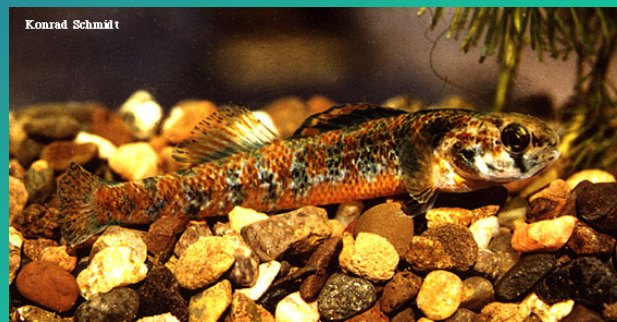
  } Fish fluke
  - *Philophtalmus gralli* (avian eye fluke)
  - *Paragonimus westermani* (lung fluke)
  - *Opisthorchis sinensis* (liver fluke)

COMAL RIVER (TX)

2,279 snails 6% infected

- **Fountain darter** (*Etheostoma fonticola*)
- **Rio Grande darter** (*Etheostoma grahami*)
- **Devils River minnow** (*Dionda diaboli*)
- **Prosepine shiner** (*Cyprinella prosepina*)
- **Pecos gambusia** (*Gambusia mobilis*)
  - Darters severe damage gills
    - Encysted trematode damage gill filaments large parasite loads, lethal to fish

➔ Displace *Elimia* sp

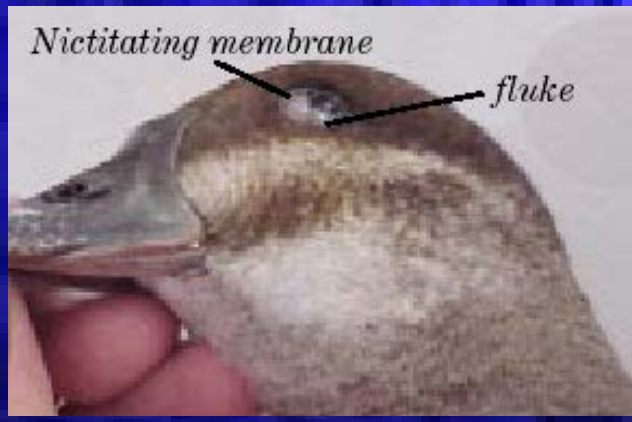


IMPACT ON BIRDS

Yellow crown night heron
(*Nyctanassa violacea*)

…Possibly…

- Whooping crane
- Black necked stork
- Grackle
- Magpie goose
- Wattled crane
- Doubled wattled cassoway

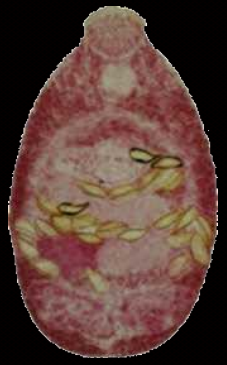


INVASION OF THIARID SNAILS

Area of origin (occupied before 1950)

Invaded area after 1950

FAUCON et al. *in press*



Centrocestus formosanus

found in 39 species of fish in Mexico

- ATHERINIDAE
- CICHLIDAE
- CYPRINIDAE
- ELEOTRIDAE
- ICTALURIDAE
- GOBIIDAE
- GOODEIDAE
- MUGILIDAE
- POECIILIDAE
- CHARACIDAE

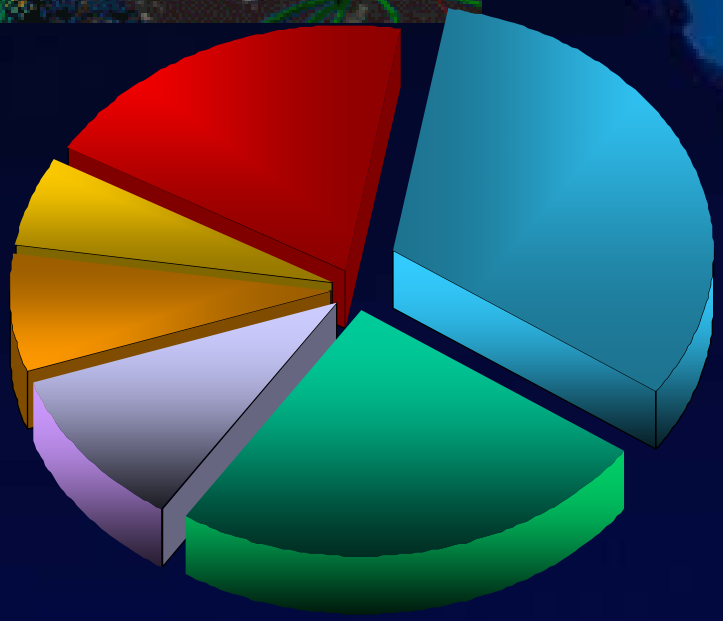
The Cichlid Room Companion http://cichlidae.com © Juan Miguel Artigas Azas

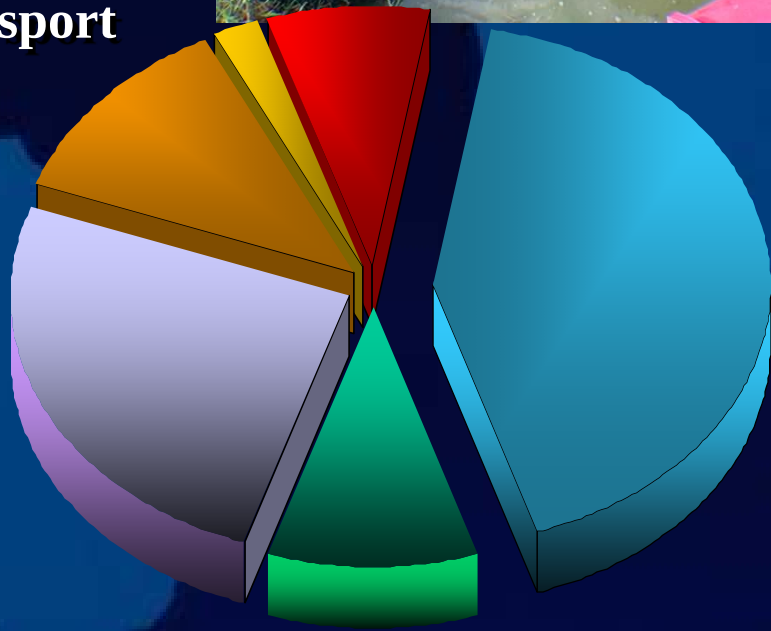
Herichthys minckleyi piscívoro emboscando

Herichthys minckleyi oligomelánico, Poza la Becerra

Herichthys minckleyi en coloración normal

Numbers of Non-indigenous aquatic Species Internationally and in Mexico by Pathway of Introduction





Source: Welcomme 1988

Source: Contreras 1997

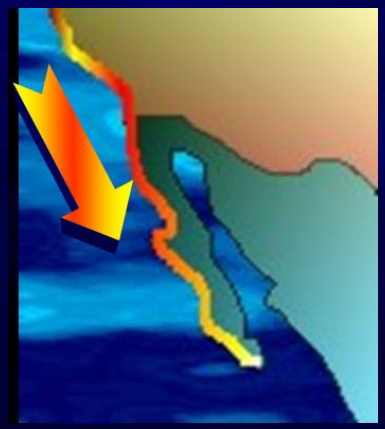
WEEDS

- *Water Hyacinth*

- *Hydrilla*

SEAWEEDS

Sargassum muticum

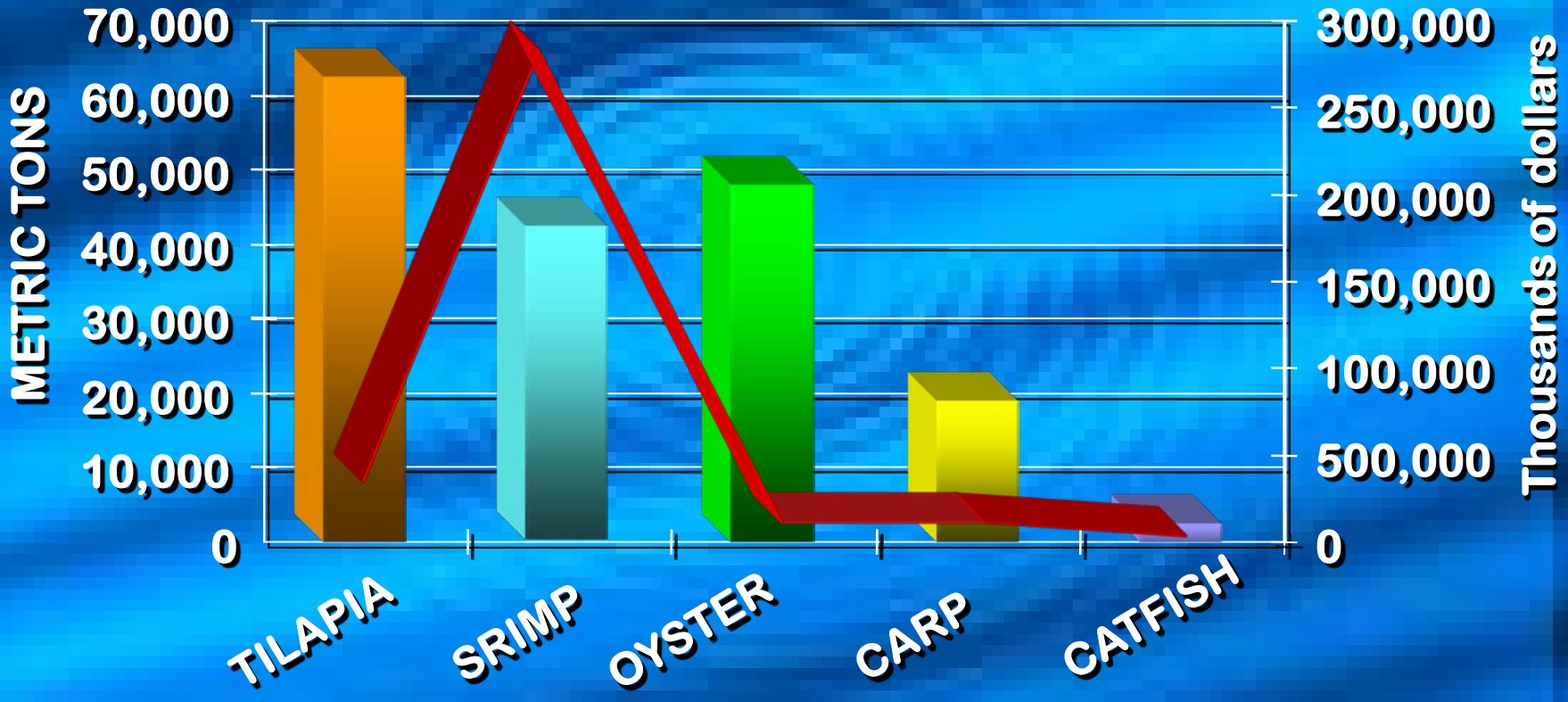


Caulerpa taxifolia

CONCLUSION

- AQUACULTURE IN MEXICO IS CHARACTERIZED BY THE CULTURE OF EXOTIC SPECIES
- AS A CONSEQUENCE OF:
  - LACK OF KNOWLEDGE OF NATIVE SPECIES
  - PRICE OF EXOTIC SPECIES IN THE INTERNATIONAL MARKET
  - AVAILABILITY OF TECHNOLOGY FOR THEIR CULTURE

AQUACULTURE PRODUCTION -MEXICO



STRATEGIES

- IMPACT OF AQUACULTURE ON NATIVE RESOURCES CAN AND MUST BE MINIMIZED
- AQUACULTURE IS A BILLIONAIRE INDUSTRY
  - EVERY INTRODUCTION OF A NEW SPECIES SHOULD COST AT LEAT A SMALL FRACTION TO THE INDUSTRY
  - INCLUDING THE COST OF RESEARCH TO DETERMINE WHETHER THAT SPECIES HAS A POTENTIAL TO BE INVASIVE

CRITERIA FOR INTRODUCING EXOTIC SPECIES

- Justify the need
- Before any species is introduced, methods for controlling its abundance and expansion must be available
- Species with close relatives should not be introduced so as to avoid hybridization with native species
- Ecological studies

LAW

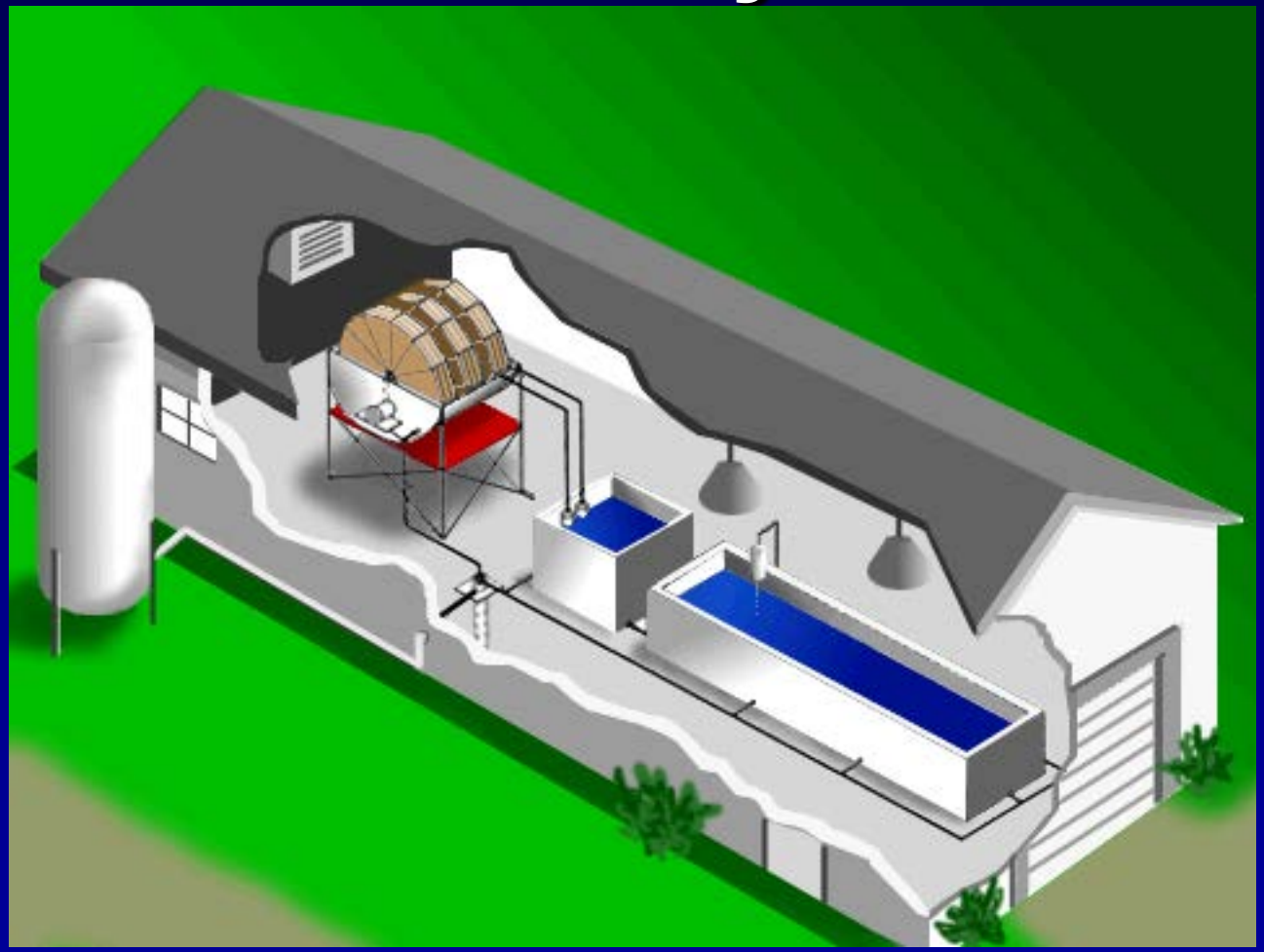
- Demonstrate to the Authority the legal origin of products of aquatic flora and fauna

- Demonstrate that the species or biological material pretended to be introduced in federal waters jurisdiction will not harm, alter or put at risk fisheries resources

WAYS TO PREVENT OR MINIMIZE IMPACTS

- DIKING PONDS
- SAND AND GRAVEL FILTRATION OF ALL EFFLUENTS
- KEEP OUT OF FLOOD PRONE AREAS
- ASSURE TRIPLOIDY
- STERILIZATION
- CULTURE OF MONOSEX POPULATIONS
- AVOID TRANSPLANTING
- LOCAL PRODUCTION OF RESISTANT STRAINS
- HACCP FOR AQUACULTURE OPERATIONS

RAS Layout



AQUARIUM TRADE

- Identify the producers, importers, retail pet stores
- Adopt OATA international guidelines
- Promote the exchange of unwanted organisms
- Control mesures in Farms and Public Aquaria (U.V., ozonification…etc.)
- Monitoring near Production Centers
- Reproduction of native species


NATIVE SPECIES
CULTURING THE FUTURE

WHY NATIVE SPECIES?

➔ ECONOMICAL

- COMMERCIAL VALUE OF DIFFERENT SPECIES (CARP $ 1.00 USD/Kg v.*s.* *Chirostoma estor* $25.00 USD/Kg)
- WITH A WELL ESTABLISHED NATIONAL MARKET

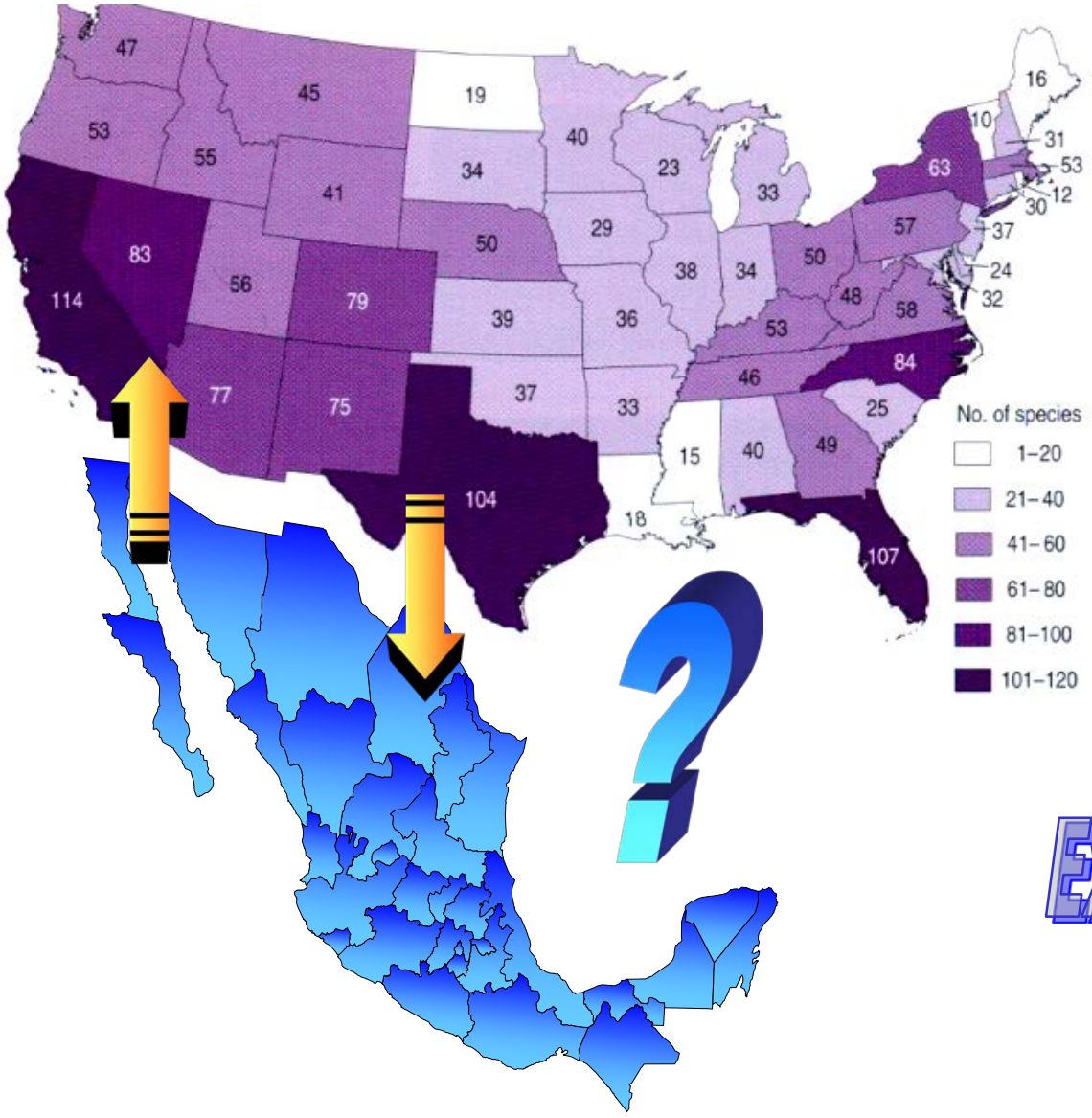
➔ SOCIOCULTURAL

- SUPPORT TRADICIONAL FISHERIES

➔ ECOLOGICAL

- SEVERAL NATIVE SPECIES ARE OVER-EXPLOITED OR ENDANGERED SPECIES

…Overall introductions have produced a biological pollution around the world, degrading the fruits of evolution…



Exotic fish introduced into inland waters

...THE INTERNATIONAL CONTEXT...

- ONCE AN INVASIVE SPECIES BECOME ESTABLISHED WITHIN ONE COUNTRY, THEY POSE A THREAT TO AN ENTIRE REGION
- NEIGHBORING COUNTRIES ARE OFTEN UNAWARE OF EACH OTHER' S POLICIES AND PRACTICES
- THE ABILITY TO PREVENT INVASIVE SPECIES FROM ENTERING THE U.S. DEPENDS GREATLY UPON THE CAPABILITY OF OTHER COUNTRIES TO EFFECTIVELY MANAGE INVASIVE SPECIES AND INVASION PATHWAYS DOMESTICALLY

COOPERATION

- **Identify Invasive Species of Common Concern**
- **Increase taxonomic capacity**
  - Share database on Aquatic Invasive Species
- **Identify North American Priorities for Vectors and Pathways**
- **Awareness of invasive species**
  - Workshops
  - Translation of Educational materials & video/book accessible to a wide public
  - Consumer awareness Aquaria
- **Strengthen networks of stakeholders**
- **Develop Aquaculture and Aquarium HACCP**

OPPORTUNITIES

- Research
- Monitoring
- Early detection and rapid response to new invaders
  - Co-ordinate responses to new invasions and pathways


THE END