Hatchery Management

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Contents of this lecture

- Aquatic organisms (fact sheet)
- Modes of fish reproduction
- Naturally collected fry/broodstock
- Sexual maturation and broodstock management
- Fish hatcheries and hatchery technologies
- Nursing
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Aquatic organisms (fish)
Introductory fact Sheet

- Cold Blooded Animals Except a known species (Great white shark)
- Highly fecund animals (regardless?)
- Highly diversified group (finfish, crustaceans, molluscs, …)
- Vary significantly in regard to the mode of their reproduction
- Living environments determine types of fish inhabiting and reproducing in such waters (cold water, warm water, freshwater, marine water)

Modes of fish reproduction

Egg layers - examples

Substrate spawners

Prawn carrying eggs

Oviparous

Majority of fish

Mouth brooders

Egg retainers

Ovoviviparous

Each embryo develops in its own egg in female's body until hatch. Embryos depend on their yolks

Live bearers (when male gives birth)

mother retains the eggs and nourishes the embryos till they are born

Egg layers and parental care

No parental care: fish freely lay their eggs and sperm and then abandon the eggs (e.g. Atlantic herring, tilapia zillii)

Modes of parental care:

- Nesting and guarding: (e.g. Nile tilapia, channel catfish)
- Fanning egg masses (e.g. channel catfish males)
- Mouth incubation: (e.g. Nile tilapia females)
- Guard young after hatching (e.g. bowfins males)
- Internal holding of hatchling before giving birth

Passive care & special arrangements: (depending on species):

- Hiding eggs
- Eggs have oil droplets that help them float
- Some bottom-dwelling fishes produce eggs that sink
- Laying sticky eggs to attach to various objects

Parental care

Spawning nest (tilapia)

Copa female holding fry

Fanning egg mass
(channel catfish male)

Protomelas sp.
(taking fry in)

Organism and spawning runs & last stops

Eels
Sargasso Sea (last stop)
catadromous

Salmon
Rivers (last stop)
anadromous

Mullet
(no last stop)
catadromous

Mother Nature
Fry/gravid female collection

Milkfish

Black tiger shrimp

Mullet fry

Mullet

Collection of broodstock/fry from nature is done in case of:

Naturally Abundant

No hatcheries

Reproductive cycle is not closed

Economic reasons

Disturbing mother nature

Human activities (over fishing)

Pollution (mass/selective effects)

Political conflicts (sturgeon & shared stocks)

Construction of dams (block migration)

Fish ladder?

The establishment of hatcheries became necessary for aquaculture development

Hatchery Management

ONE SHOULD REMEMBER

- The collection of wild fry could be more economical **BUT** has its limitation.
- Advanced technology can only be applied through artificial spawning in hatcheries.
- The role of the hatchery is very different from farm (Numbers of appropriate size).
- Water temperature and light are very important in hatchery practices (fish are cold blooded animals).
- Therefore, optimum range for reproduction falls **within** survival range.

Hatchery Broodstock

- Sources (wild – farm or hatchery)
- Domesticated versus wild

To be covered in the lecture on genetics

- Efficiency under different environments (GxE)
- Not passing through genetic bottlenecks
- From maximum number of spawns
- Good understanding of effective breeding number N_e

Broodstock from the wild

Why? and when?

For First time ever

For stock enhancement programs **(release)** (**Fish for natural systems are not the same for aquaculture)**

Does not mature in captivity **(until now)**

Hatchery facilities cannot handle the full operations

Economic reasons

BUT: Less Reliable & not economical anymore (shrimp – Iran - Thailand)

Cannot perform breeding programs

Broodstock **(<u>From other hatcheries or farms)</u>**

More reliable

More domesticated (for aquaculture)

Possible application of breeding programs

Possible conditioning for extended spawning seasons

Better understanding of broodstock history (depending on the quality of book keeping system)

Replacing hatchery broodstock

Facts:

Young broodstock produce more eggs/g, with shorter spawning interval & much easier to handle. Replacing old broodstock by younger ones is often recommended

No Fixed Rule

Replacing oldest age group

OR

Annually change 33%

OR

All-in & all-out

Compensating the missing sex to correct for the skewed sex ratio (in fish changing sex – e.g. gilthead seabream when males change into females)

Broodstock Maintenance

Overwintering

Tilapia (Egypt)

Whiteleg shrimp (Peru)

Photo credit: Victor Hugo

Seabream – seabass (Italy)

Feeding

Overfeeding with carbohydrate rich or fatty diet **to be avoided**

Cases showed that visceral fat in Indian carps and grass carp affected ovaries development and hence no response to hormonal injection

Placing fish in weedy habitats helped in shedding visceral fat and fish spawned

Mixing squids to the artificial feed of marine broodstock is believed needed

Broodstock – ponds/tanks

Ponds

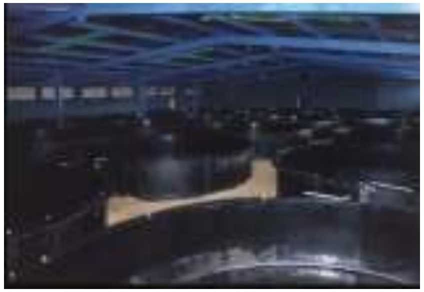
Sufficient number will help avoid too many fishing and so reduce stress and possible decline in the potency of fish

Good match between outdoor ponds and indoor facility should be secured

A recovery pond for spent females is a must

Depending on hatchery plan, a pond for common carp may be considered (donor to pituitary gland)

Tanks



Neither material nor paint should carry any harm to broodfish

Water flow should be adequate to fish biomass **(not excessive)**

Design should allow self-cleaning

Tanks are either covered or enough free board should be secured

Air supply from oil-free air pumps

Hatchery Management – Water

Quantity

For freshwater hatchery

Ponds of 5-ha require 40-50 l/second of water

For marine hatchery

Pumping capacity/h 50% of water volume

Quality

Hatchery water should be:

- Low in turbidity
- **H**igh in DO
- Low in CO_2
- **Extremely low** in hydrogen sulfide **(if any)**
- **N**ot super-saturated with nitrogen other gases
- **Salinity (level & range)**: close to optimum
- **Temperature**: close to optimum with minimum fluctuation
- **Heavy metals**: case by case

Water Quality

Turbidity

Sand filter – oyster hatchery Morocco

Suction pump – backyard prawn hatchery – Thailand

Sterilization

UV system – oyster hatchery Morocco

We need to consider:

What could be accepted in a farm may not be tolerated in a hatchery

Copper and Zinc are damaging elements (no copper pipes, no zinc containers)

Hatchery management
Started complex (Egypt case)

1980 – Abbassa (common carp)

1982 – Sète/France
(seabass, seabream)

Hatchery management
Turned easier- more towards natural systems

Open spawning system
Marine hatchery - Cyprus

Egg collection system
Marine hatchery - Kuwait

Hapa system
Tilapia hatchery - Egypt

Management concept

Usually apply to large hatcheries

Abbassa

Aswan

Management concept

Should also apply to small hatcheries

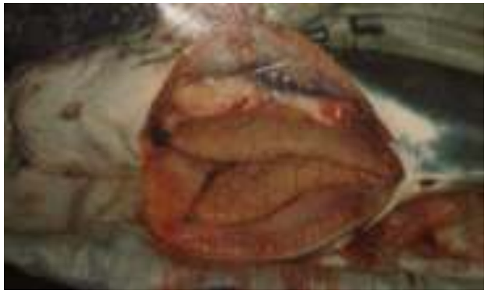
8 million tilapia fry

2 million tilapia fry

Broodstock
Gonad Development

- Gonads develop to a certain stage and remain dormant
- Further development will be triggered as suitable conditions exist producing ready to spawn
- Favored light & temperature, salinity, flood conditions, presence of opposite sex are all triggering factors
- Dormant stage continues if environmental changes are not too strong
- If environmental conditions gets worse, absorption of eggs takes place

Ovary



Testes

Broodstock sorting

Sorting (based on gonad development)

Females:

- Ripest (ready to spawn)
- Promising
- Not different from males (discard)

Males:

- Ready
- Unready (discard)

Sexing and sexual Maturation

Roughness of the dorsal surface of pectoral fins for the male of grass carp

Can be easy

Sexing and sexual maturation

May not be possible or requires additional work

Sea urchin – sex is only known after they shed their gametes

Fish in the spawning run/grounds must be sexually mature

Laparoscopy is used to determine the sex and stage of maturation in sturgeon

Egg sampling
a common practice with many fish species

Hatchery technologies

Chosen reproduction mechanisms is determined based on:

- Specific to species & requirements and available facilities
- Economics

Fish spawning could be classified as:

Natural: Tilapia, common carp, African catfish

Some artificial: Tilapia, some marine species, shrimp, others

Artificial: Chinese carps, common carp, some marine species, African catfish, others

Why there is no artificial spawning for tilapia on commercial scale?

Natural Systems

Sticky eggs of common carp

Our responsibility:

Choose the ready broodstock

Furnish the required facilities & environments

Watch for the spawning

Fish responsibility:

Get the work done

Seabass

Channel catfish

Tilapia

Artificial Spawning

Biological parameters still controls

A broodstock must be ready in order to respond to induction practices

Artificial Spawning
(related to hormonal/other substances injection/)

Hormones used for induced spawning **do not produce** eggs or sperm (gametes)

Hormones only trigger the release of fully developed gametes

Fish must not only be sexually mature but also in the advanced stage of sexual development before induced spawning will be successful

Sources of hormones could be the pituitary gland or other hormones (e.g. HCG, LHRH)

Spawning induction in sea urchin is done using potassium chloride

Pituitary gland

First used in 1934 in Brazil

Should be taken from sexually mature male or female

Will be more effective when taken just prior to the spawning season

One kg of common carp has a pituitary weighs 3 mg dry weight (usually used by count)

Administration of hormones & fish

IF:

Fish are selected properly **and**

Hormones are administered at the right timing and dose

↓

Ovulation is expected

Full Spawners or Batch Spawners?

Inserting other substances

Potassium chloride injection and/or

Acetylcholine injection

Has been used successfully to induce sea urchin spawning

♀

♂

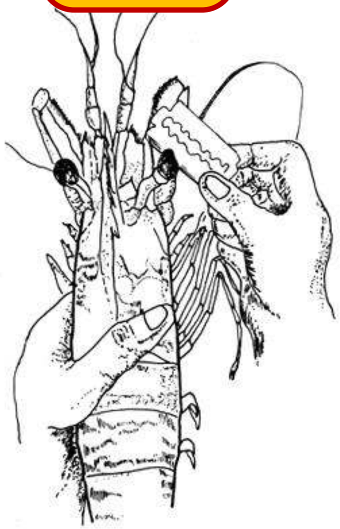
Sea urchin, Loxechinus albus

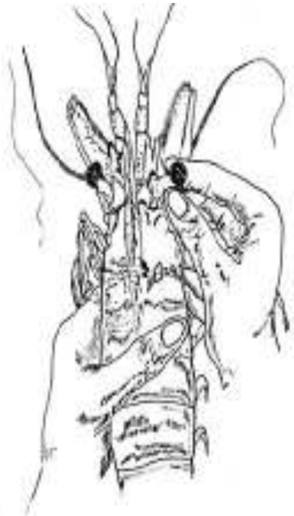
Photo credit: Rodrigo Rivera González (Chile)

Specific hormonal induction & eyestalk ablation

X organ

GIH
MIH





Commercially adopted in the early 1970s

Eye stalk ablation removes x organ along with "Gonad Inhibiting Hormones" and hence stimulate the final gonad development

Hopefully one eye stalk only

Incision

Source of diagrams: FAO, shrimp hatchery, design, operation and management

Press

Ripening – (fish are cold blooded)

Ripening period (time between final hormonal dose and ovulation/stripping): e.g. Common carp:

Temperature (c)	Ripening time (hour)
15-16	24-26
18-19	15-16
22-23	12-15
25	10
28	08

Ovulation

- Time of ovulation need to be watched
- Indicator fish may tell
- If eggs were not stripped at the appropriate time it turns overripe
- Over-ripe eggs do not fertilize
- Time between final injection and ovulation is ripening time (hour-grade)

Ovulation & stripping

African catfish

Colossoma sp.

Mekong Giant Catfish

Credit: Wanna Thawinwan (Thailand)

Fertilization

After the completion of fertilization, (dry or wet method), fertilized eggs (embryos) should be incubated till hatching

Good quality milt
=
High rate of fertilization

One male or more?

Preserving milt

Incubation – duration & facilities

Affected by:

Species

Type of eggs

Environmental conditions

Key environmental factors are temperature and light

In general, incubation period could be as short as few days for some species or as long as several months for other species

Incubation period (examples)

Selective warm water species

Source: FAO

Species	Incubation temperature (C)	
	Optimum	Days/hours
Common carp	20 - 22	3.5 - 4 d
Grass carp	22 - 25	1 – 1.5 d
Catla	24 - 30	14 – 20 h
Asian catfish Pangasius sutchi	28 - 29	23 – 25 h
Nile tilapia	28	4 d
Clarias macrocephalus	26 - 30	18 – 20 h
Cachama Colossoma oculus	25 - 26	18 – 19 h

Incubation & temperature

Source: Earl Leitritz, trout & salmon culture

Temp C	Incubation period (days)		
	Rainbow trout	Brown trout	Nile tilapia
1.7		156	
4.4	80	100	
7.2	48	64	
10.0	31	41	
12.8	24		
15.6	19		
24.0			5-6
28.0			4
30.0			3

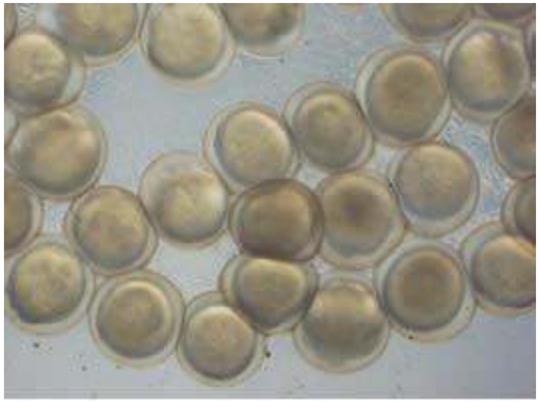
Types of fish eggs in relation to:
incubation or treatment

Mass (Channel catfish)

Large Eggs (salmon)

Loose Eggs (tilapia)

Sticky eggs (carps) Tannin is used to dissolve the adhesive material



Incubators in relation to types of eggs

Tilapia

African catfish

Has been found simple and efficient

Credit: Grace Charway

Channel catfish

Black catfish

Large size incubator for highly fecund fish

Photo credit: Claudia Gravina (Uruguay)

Chinese-system incubators

For grass carp

Photo credit: Jorge Valdiviezo (Mexico)

Incubating tanks are circular with outer and inner chambers. The inner chamber is adequately screened to allow only water to pass through. These tanks have outlets through which hatchling pass through into the larval tanks. Water speed and direction assures favorable circulation and protection of incubated.

For Indian carps

Photo credit: G.V. Raju (India)

Stimulating the spawning (Common carp) – Dubish pond

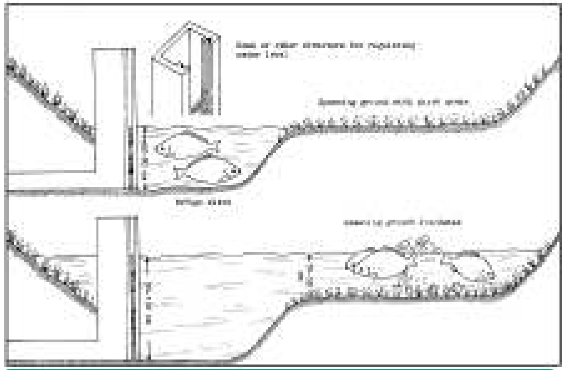
The Dubish Pond has a raised center area that is still covered by water.

This area is covered with a spawning medium such as trimmed grass(eggs stick to).

Selected pairs of broodstock spawn on the raised section.

Immediately after, water is drained down to allow taking breeders out from deep water

The pond is filled again. The eggs hatch as they grow to adequate size, they are collected for further nursing



Source of the sketch: FAO

Dubish ponds are typically 120 to 300 m^2 in surface and have an average depth of 30 – 60 cm

The relative shallowness and small area of the pond allow the water to warm quickly after filling

The shallow depth ensures the emergent nature of the chosen substrate (grasses).

Embryonic Developments

Never mix different ages during incubation

Tilapia

Advanced stage

Green eggs

Freshwater prawn

Good or Bad Eggs

If eggs are heavily infected with fungus and other batches could be obtained:

Discard the bad batch

Embryonic Development

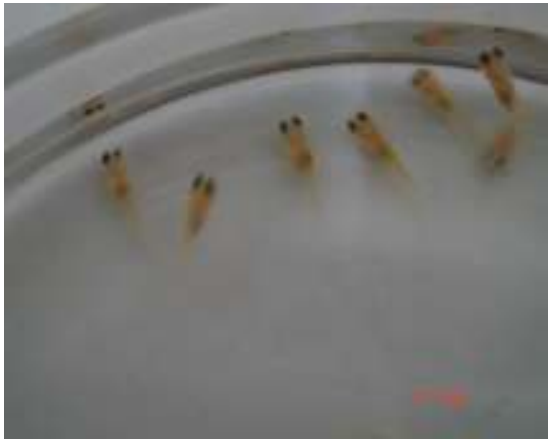
- Stable temperature is very important during incubation
- Proper hygienic condition of the system is influenced by the quality of fertilized eggs

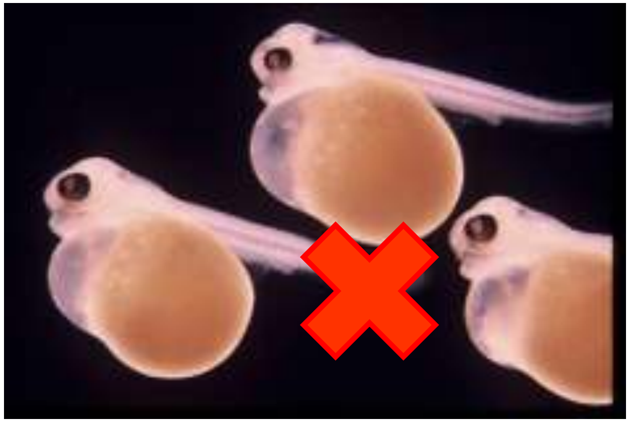
Incubation/Temperature

It is much safer to incubate at highest safe temperature

(refer to an earlier table)

Hatchery Products (good <u>or</u> bad)





Early nursing

Water temperature is the most important single factor

Temperature range is acceptable; severe fluctuation should be avoided. (some species cannot tolerate temperature fluctuation that exceeds **0.5**° C/day (seabass, seabream)

Light regime is critical for some species

Nursing (the right of young)

No matter where a larvae stays or moves
Its food should be there

Feeding ratios do not apply during early nursing – instead, Food concentration

The onset of the first larval feeding is a crucial step in the young fish life as starvation is a major cause of larval mortality

Management & species

While management may apply to almost all species

Because in biology nothing is exact

Modification in hatchery operations may take place according to species

Some steps may be omitted, others may be added

In brief, study your species

FERTILIZATION OF EGGS

- the stripped eggs should be quantified in 200-300 grams in each bowl and separated from each female
- for fertilization of eggs, use sperms from 2-3 males in volume of 2-3 ml
- the fertilization occurs during 3-5 minutes after mixing eggs and sperms together

Sacrifice the male

Source: your colleagues

PROCESO DE REPRODUCCION INDUCIDA

Manejo de Reproductores

→

Inducción

Desove y Fecundación

Source: your colleagues

Incubación

Cosecha y cría de larvas

Extending the spawning season

Chilling, heating and light manipulation are used in marine hatcheries (Italy)

Green houses helped to produce tilapia at the time suitable to farms (Egypt)

- Manipulating of photoperiod and temperature are the key factors for extending the spawning season outside the natural season
- The technique is successfully has been successfully applied to both several fish species and is now a current practice.
- This could allow seed production year round according to marketing and/or farming needs.

Enhancing Hatchery Efficiency

Multi-species – multi-sizes - quality

Sea Bass

Sea bream

Soles

Shrimp

The same concept applies to:

Freshwater hatchers

Production of different sizes of the same species if economically visible

Screening for disease causing agents

Vaccination

Conclusion

- Hatcheries will remain a main component of aquaculture development.
- Hatcheries are not farms
- Results of hatchery products appear on the farms
- Screening for new candidates is the responsibility of national research systems.
- Hatcheries are the place of genetics applications
- Competition, economics, quality control are issues to be considered in order for the activity to remain sustainable.