Spawning Methods and Technology for Spawning

SRI LANKA EXPORT DEVELOPMENT BOARD

National Aquaculture Development Authority of Sri Lanka

Introduction

- Fish reproductive patterns fall into many categories spanning ovipary (egg producers), vivipary (live bearers)
- Fish also strategize behavior to minimize parental investment.
- This lecture discusses the various spawning methods and strategies of fish and the appropriate spawning methods to use

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REPRODUCTIVE STRATEGIES

Egg Development and Ovulation

- Egg development is an important part of reproduction.
- During this time egg yolk is laid down - stress and poor quality diets will effect this.
- Synchronous Development
  - All eggs are spawned and the fish dies e.g. Salmon
- Group Synchronous Development
  - Multiple spawning and seasonal spawners
- Asynchronous Development
  - Multiple and daily spawning
  - All oocyte development stages present
  - Most tropical species – will continue to develop eggs while conditions are favourable

Spawning

- The final phase of egg development is ovulation, when the eggs are released from the ovary in readiness for spawning.
- Environmental cues play major role in this (temperature, water quality, light, rainfall etc) and can be used to 'trick' fish into spawning when we want them to
- Spawning is the culmination of the reproductive process, and involves the release of gametes (eggs and sperm) and the fertilisation of the eggs.
- Traditionally, spawning of fish was done naturally, however, modern aquaculture often relies on artificially inducing spawning activity through use of hormones and environmental manipulation.
- Induced spawning is generally used only when the fish cannot spawn naturally in captivity

Reproductive Pattern of Aquarium Fish

- Fish display a wide variety of reproductive strategies and can be grouped according to several methods.
- Each group needs to be treated differently – it is important to know how the new fish you want to breed spawns to know how to treat it
- Realize also, that most of these strategies aren't there for the fry, but the parents!!

What is included in parental care?

- Construction/maintenance of nest
- Burying eggs once deposited
- Defending eggs from predators, aggressive behavior
- Fanning or splashing eggs (oxygen/cleaning)
- Removal of dead/diseased eggs
- Carrying eggs and fry (mouth, brood pouch, head)
- Defending fry, herding them away from danger
- Providing first food (mucus) or teaching feeding techniques

- **Artificial incubation and hatching of eggs and fry endeavour to simulate and optimise these natural processes.**

Reproductive Guilds

- There are many different Reproductive Guilds, the ones relevant to ornamental fish are:

I. Non-guarders
II. Guarders
III. Bearers

Reproductive Guilds

Non-guarders - Open substrate spawners
1. Pelagic spawners
2. Benthic spawners
Coarse-bottom spawners (rocks gravel)
Pelagic free-embryo and larvae
Benthic free-embryo and larvae
b) Plant spawners
c) Sand spawners

- Most Brabs, tetras, Rasboras etc fit into this group
- Many species eat their eggs so a method to hide and/or collect the eggs is needed

Reproductive Guilds -

Non-guarders - Brood hiders
1. Benthic Spawners
2. Cave Spawners
3. Spawners on/in invertebrates (shells)
4. Beach Spawners
5. Annual Fish

- Not common in species we produce

Reproductive Guilds

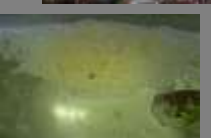
Guarders – substrate choosers
1. Rock spawners
2. Plant spawners

- This group will deposit eggs on a substrate, does not create a nest but may clean the surface
- Examples include Angelfish and many other cichlid species

Reproductive Guilds

Guarders - Nest Spawners
1. Rock and gravel nesters
2. Sand nesters
3. Plant material nesters
4. Bubble nesters
5. Burrowing nesters
6. Miscellaneous material nesters
7. Anemone nesters

- This groups specifically 'builds' a nest to spawn and or incubate eggs/larvae



Reproductive Guilds

External bearers

1. Transfer brooders
2. Forehead brooders
3. Mouth Brooders
4. Gill chamber brooders
5. Skin brooders
6. Pouch brooders

- This group hold, their young after they are spawned/hatched for protection.
- Examples include seahorses and mouthbrooding cichlids

Reproductive Guilds

Internal bearers

1. Ovi-ovoviviparous
2. Ovoviviparous
3. Viviparous

- This is the so-called livebearer group where females give 'birth' to functional fry
- Includes the livebearers Guppies etc
- Sharks and rays

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BROODSTOCK CONDITIONING

Brood stock Conditioning

- In order to prepare brood stock for spawning, they must be conditioned.
- This involves changing feeding strategies and the culture environment to allow eggs and sperm to develop and prepare the brood stock for spawning.

Brood stock Conditioning

- Brood stock should be kept in an environment that is not stressful and reflects conditions in their natural environment
- Stocking density should be lower than that usually used for growing fish on the farm – this will help reduce stress leading and will promote gonad maturation
- Breeders must be fed with good quality diet at optimal levels. High quality feeds will help promote gonad maturation while poor feeding inhibits or delays maturation and can even lead to gonad regression
- Quality of diet has a direct effect on the quality and quantity of eggs produced. Generally need good levels of unsaturated fatty acid omega3 HUFA. Also carotenoids (red/yellow pigments) – it is suggested to use more than 1 type of feed to ensure adequate nutrition

Brood stock Conditioning

- Quantity of diet – when feeding 'rich' maturation diets, fish can lay down fats around the gonads – this is not conducive to good spawning.
- Conditioning diets often consist of fortified artificial feeds (higher value proteins and fatty acids) or live feeds.
- Need to have good source of vitamins, fatty acids such as omega 3 and 6
- Live feeds (ie. Zooplankton, worms, beef heart) are often more favoured for ornamental fish.

Brood stock Conditioning

- Typical conditioning feeds:
  - Beef heart or Liver
  - Prawn/shrimp or other shellfish
  - Spirulina
  - Wheatgerm
  - Fish oils
  - All generally have high fatty acid content and carotenes
  - Combination of foods is best
- Can also add:
  - 1 gram Vitamin C to food per kg
  - 1 gram Vitamin B complex per kg
  - Bind with cod liver oil

Broodstock Conditioning

- In order to properly condition your fish for spawning you should know:
- Natural conditions for breeding
  - Water quality
    - pH, temperature, general hardness most important
  - What feeds they eat
    - Ie plant material, other fish, insects etc
    - This will guide you on best
  - Time of year
    - What is the climate like when they spawn? (Dry season, Wet season, Winter, Summer etc)
    - Do they spawn during wet season = flooding?
    - Photoperiod or day length (this can be an important trigger for maturation and spawning for many species

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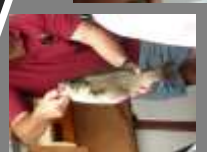
MONITORING MATURATION OF STOCK

Egg Development and Ovulation

- Egg development is an important part of reproduction. During this time egg yolk is laid down - stress and poor quality diets will effect this.
- Poor management and nutrition can lead to poor quality eggs being produced. This will result in poor quality larvae with poor survival and growth.
- The final phase of egg development is ovulation, when the eggs are released from the ovary in readiness for spawning.

Visual Signs of Maturation

- The female becomes heavier in the abdominal area from developing eggs, spawning may be imminent after.
- More swelling may be evident at the front (throat area) or the rear (anal) area when ovulation takes place.
- The vent (urogenital pore) may become swollen, protruded, or blood shot as a sign of ovulation or spawning.
- However, these methods are subjective and can be unreliable.

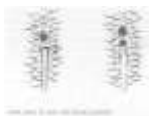


Visual Signs of Maturation

- Many species undergo specific colour and behavioural changes during spawning.
  - Some have elaborate courtship behaviour and may begin forming a pair several days before spawning.
- Male fish often become highly aggressive during spawning and fiercely defend their mates.
- Males often have the most pronounced colour and or morphological changes during spawning

Visual Signs of Maturation

- Behavioural interactions between male and female fish prior to spawning – courtship behaviour
- This may be a 'social' stimuli for gonad maturation (particularly in final stages)
  - Many cichlid species will build a 'nest' site together and interact in courtship behaviour such as nudging, jaw locking etc



Visual Signs of Maturation

- Again for new species it is important to watch your fish while conditioning to check for signs of maturation
- We need to look for the following:
  - Changes in bodyshape and colour of fish
  - Changes in behaviour

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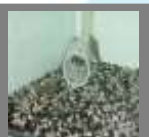
SPAWNING

Spawning Behaviour

- Spawning is an annual event for most temperate and larger fish species, or with ornamental species, most are partial spawners occurs over a set period of time during the year.
- Maturation and spawning occurs when environmental conditions are most favourable for survival of eggs and larvae:
  - Ample water supplies with good quality
  - Ample supplies of food.
- Fish exhibit a range of behaviours associated with spawning including:
  - migration, colour and morphological changes, nest building, elaborate courtship behaviour, parental behaviour.
- This behaviour depends on what reproductive strategy the fish has, this defines how we need to breed the fish in captivity

Natural Spawning

- Majority of commercially produced species are spawned using natural spawning methods
- Many are 'asynchronous' and will continually spawn if provided correct conditions
- Easier and more convenient using natural spawning
  - Fish can be fed maturation diets (livefeeds, formulated feeds) and kept in specific spawning culture units.
  - Gonad maturation is controlled by ambient temperatures and photoperiod



Natural Spawning

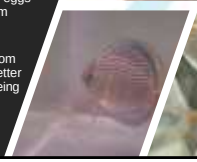
- Many tropical species can be 'tricked' into spawning by manipulating water quality – these may be useful for difficult to breed species
- Some of these methods are:
  - Water change with cold water at least 2 to 4 degrees celcius lower than the tank water
  - water change when a low pressure front is passing can be even more effective – this simulates incoming rainwater = more food
  - A cycle over some weeks of reducing water levels and increasing poor water quality followed by a rapid water change with clean freshwater – this simulates a dry and wet season cycle
  - Spraying water with a pump or similar onto the water surface of the tank – this stimulates rainfall
- **These all depend on the species, again it is important to understand the natural spawning conditions of the species you work with – this will guide you as to what you need to do**

Spawning Substrates

- There are many spawning substrates used, depending on the requirements of the species:
  - pipes, hollow logs, hides (ie caves),
  - spawning mops (ie floating plants),
  - tiles, plates etc (ie flat surfaces or broad leaves).
  - spawning mats (ie. Benthic plants)
- The type of spawning substrate needed depends on the reproductive strategy of the fish

Spawning Substrates

- The substrate may play a role in spawning (ie the sensation of swimming through plants stimulates many species to release eggs and sperm), or may serve as a substrate for eggs to adhere to.
- Species that utilise a substrate can be easily separated from their eggs by removing the substrate from tanks after spawning.
- In general, separating eggs from broodstock quickly ensures better results, prevents eggs from being eaten



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SPAWNING METHODS FOR DIFFERENT REPRODUCTIVE GUILDS

Spawning Methods for Different Reproductive Guilds

- To summarise what we have discussed so far:
  - Different species of fish have different requirements for maturation and spawning
  - Different spawning substrates and strategies are needed for different species
  - We need to understand how fish reproduce in nature so we can optimise spawning on the farm
- The following section highlights how we approach natural spawning for the different groups

Open Substrate Spawners

- This is the most common spawning method in most cichlids
- Example: Cichlids, Angles, Discus, Jack Dempseys, Oscars, Sunfish, Gobies, Damsels, Clownfish Flowerhorn and Red Parrot
- Adults form permanent pair bonds – generally best kept as a pair in an aquarium
  - 50 litre to 100litre aquarium suitable for most species depending on their size
  - Aeration / filtration / water changes needed to maintain water quality
- The female lays the eggs on a flat surface, such as a rock, male fertilizes.
- Often aggressive protective behavior – will kill other fish if present in breeding tank which is why we generally keep as pairs

Open Substrate Spawners

- Often the key to success is finding a compatible pair
  - Not unusual for cichlids to kill each other
  - Try to pair fish at similar size
  - May need to provide a hiding area for fish to get away from aggressive partner
  - Provide plenty of food
  - Remove/separate fish if become too aggressive
  - Try adding Vitamin B complex to the water – this can reduce aggressive behaviour
- This is best done by raising groups to maturity and picking out the pairs as they form. Set them up in their own tank, condition them, watch & wait.
- If the pairs become regular egg-eaters or fry devourers, you can remove the eggs to be hatched away from their parents.

Open Substrate Spawners

- Although not technically egg hiders, some will often bury them and move them from place to place in the tank.
- In addition, although this group are not considered Mouthbrooders some will pick the fry up in their mouths and move them to a safer territory, especially at night time. Don't think they are eating the fry until many are actually missing!
- However, they can eat fry if startled. For best results remove eggs and incubate artificially

Egg Hiders

- Permanent pair bonds possible with many species, particularly cichlids.
- Both sexes may provide parental care.
- Eggs are usually laid in a hidden area such as a cave, flower pot or shell.
- Spawning is difficult to observed.
- Included in this group are many Dwarf cichlids, *Apistogramma, Nanacara, Namachromis, Pelvicachromis, Julidochromis, Lamprologous, Loricaria, Farlowella & Ancistrus*.

Egg Hiders

- Set up a pair with several spawning choices = places to hide
- The female will lay the eggs within a cave or under a rock and the male will fertilize the eggs in unison. (Unlike, open substrate spawners, egg movement is rare.)
- Female will be very aggressive toward male during this time. (May need to remove the male.)
- When the fry are free-swimming, she will bring them out and parade them around the tank. Pay attention to feeding whatever the fry require.
- Spawning frequency can be increased by removing the substrate with the eggs BUT checking for eggs may disturb breeding activity

Egg Hiders

- Absence of female from general view for extended periods (1 to 2 wks) indicates spawning has occurred.
- Female can be very aggressive toward male during this time. (May need to remove the male.)
- When the fry are free-swimming, she will bring them out and parade them around the tank. Pay attention to feeding whatever the fry require.
- It is often good to remove the male at this point. In another 3-4 weeks, the female can also be removed.

Mouth Brooders

- Set up a colony with rocks, gravel and caves.
- 1male to 3 to 4 females – this will help reduce aggression
- Male have a territory, may include a 'nesting' site.
- The female, when ripe, will begin the circular "spanning dance" around the pit with the male.
- Eggs are laid, fertilized, then scooped up into the female's mouth.
- In some African Cichlids the female tries to " scoop up" the egg spots on the male's anal fin, thereby ensuring that the sperm has reached the eggs in her mouth (sperm drinking).

Mouth Brooders

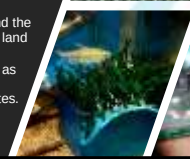
- Female incubates eggs for 3 wks.
- She will not eat at all in this time, unless the eggs have been lost or swallowed.
- When the fry are old enough, the female will release them and guard them.
- Often, she can be seen chewing up and spitting out food for them.
- When danger approaches the fry fly at lightning speed to hide in the mother's mouth.
- When the young have been free swimming for about three to four weeks it is OK to remove the female. Cannibalism possible in active females.

Mouthbrooders

- To increase productivity periodically (weekly or fortnightly) remove eggs/fry and incubate artificially
- Gently force the mouth open and 'milk' the eggs/fry – they will fall out of the females mouth if you hold her up head down

Egg Scatterers

- Mostly schooling types: Barbs, Danios, Characins, Tetras & Rainbows.
- They spawn as they school, scattering eggs all over the tank.
- Females release the eggs haphazardly; the males follow close behind, releasing sperm at the same time.
- Amazingly, the two meet and the eggs stick to whatever they land on.
- The eggs are usually eaten as fast as they are laid by the spawners and their tankmates.



Egg Scatterers

- Best to keep and condition males and females separately
- Fish are spawned as pairs or groups in smaller tanks then removed and out back to separate tanks
- Some species like rainbowfish are kept as colonies and spawning mops removed

Egg Scatterers

- "Set up another tank!"
- High substrate density: plants (plastic or real) or mops.
- Add pair late in afternoon, cover to reduce light levels
- The next morning they should spawn at sunrise. After a few hours, remove the pair.
- The fry will hatch in three to four days.

Egg Scatterers

- Many species have very small fry – this is a challenge to get
- "Eyelash fry" feed on infusoria (plankton), then live baby brine shrimp, vinegar eels, microworms, etc.
- After two weeks they can take powdered flake foods.

Mop Spawners

- *Killifish Aphyosemion, Aplocheilus, Epiplatys, Rivukus, Simposonichthys Rainbowfish*
- Lay their eggs in mops or in plants, generally in the upper part of the tank
- What makes these fish different from the egg lay scatterers is that their eggs are harder and larger, and they only lay about 20 -30 a day.
- Incubate 2-3 wks for killies, 7-10 days for rainbows.


Mop Spawners

- Hang several mops, add a sponge filter and a heater if needed. Add a pair of fish.
- Female will lay the eggs deep in the mop or the plant, male fertilizes them.
- Remove mops daily or 2 to 3 times per week





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COMMERCIALISING SPAWNING

Commercialising Spawning

- Need to reach commercial levels of spawning
- What is commercial spawning = Mass spawning
- mating multiple pairs daily/weekly (10, 20….1,000 pairs)
  - Keep males and females separate
  - Spawn in small containers
  - Combine spawn and incubate together
  - Great for barbs, tetras, gouramis
- Keeping mutliple colonies of species
  - Cichlids, rainbows
- Keeping multiple pairs of fish
  - Eg
  - Maybe 100 or 200 pairs on Angelfish


Commercialising Spawning

- Need to specialise in a small number of species to get productivity scale
- Keep new batches of broodstock at all times, need to ensure turnover of breeders on regular basis






Spawning




Commercialising Spawning

Thankyou….

The end….

Any questions?????