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The Comparative Study Of Climatic Changes on the Breeding Performances of an Indian Catfish Heteropneustes Fossilis (Bloch)

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ABSTRACT

In the Indian catfish, or stinging catfish, Heteropneustes fossilis (Bloch), also referred to as shingi locally, is a widely cultivated commercial species. Because of its distinct flavor, high nutritional content, low fat level, high iron content, and therapeutic qualities, the species is regarded in Bengali tradition as a nutritional supplement for recovering patients. India has seen a sharp rise in the demand for stinging catfish cultivation; however the needs of commercial aquaculture farms cannot be met by natural or wild sources of fry. Furthermore, fish farmers have a poor opinion of the quality of stinging catfish fingerlings and fry raised in hatcheries. Climate change related effects include changes in physico-chemical proprieties of sea and freshwater, such as variations in water temperature, salinity, pH/pCO_2 and oxygen content, which can impact fish critical physiological functions including reproduction. In this context, the main aim of the present review is to discuss how climate change related effects (variation in water temperature and salinity, increases in duration and frequency of hypoxia events, water acidification) would impact reproduction by affecting the neuroendocrine axis (brain-pituitary-gonad axis).

Keywords: - Climate change, Breeding Performance, Indian Catfish, Shingi ,Heteropneustes Fossilis (Bloch), & Climatic adaptation.

INTRODUCTION

Climate change affects communities and livelihoods in fisheries and aquaculture. Climatic adaptation strategies must emphasize the need for poverty eradication and food security.

Particularly susceptible to the effects of climate change are small-scale aqua culturists and fishermen. Both their physical location and their state of poverty contribute to their vulnerability. Communities that depend on fishing and fish farming are vulnerable to extreme weather events linked to climate change as well as natural hazards including hurricanes, cyclones, sea level rise, ocean acidification, floods, and coastal erosion because of their waterfront locations. Regular flooding is inevitability for millions of people who live in lowland coastal and floodplain regions. The effects of climate change are damaging human and environmental systems,

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including infrastructure, upsetting fisheries, depleting natural resources, and putting species and ecosystems in jeopardy, as has been documented throughout this volume. Resilience is also lowered by these effects. Thus, human health, welfare, and livelihoods are threatened by climate change. By 2050, total maximum catch potential globally has been projected to decrease under climate change by 2.8% to 5.3% under representative concentration pathway (RCP) 2.6 and by 7.0% to 12.1 % under RCP8.5 from present yields, but with substantial variability across national exclusive economic zones. Predictions of the future impact of climate change on the poverty and vulnerability of fisheries and aquaculture stem from models of climate change, which show, for example, increased fish productivity at high latitudes and decreased productivity at low- and mid-latitudes, with significant regional variations.

• Shifts in fish distribution and migration behavior.

• Disrupted traditional fishing patterns which will have to change, at least over a period of time, depending on how fast these shifts occur.

• Change in policies and regulatory systems to deal with climate change effects that will impact on fishing practices. These policies will affect poverty, food security, and equity within and among fisheries communities.

• Mobile, large-scale fleets will be able to better adapt to the shifts in fish distribution than small-scale, community-based fleets.

• Communities at lower latitudes will see their fish landings go down, while communities at higher latitudes will see them go up.

• Poor communities in the tropical south will suffer losses while communities in the north experience higher fishing pressure as fleets move there. Shifting species distributions may cause fishers and fish-workers to migrate in search of livelihood opportunities elsewhere, where existing tenure systems and rights will be challenged. Fish farmers have this opportunity to a lesser degree because they are less mobile.

After talking about how poverty and climate change interact with fisheries and aquaculture, the following two sections use this background information to investigate how well the international climate change regime addresses the relationship between poverty and climate change in these two industries. Prior to moving on to the national level, it analyzes the international level first.

The fisheries and aquaculture sector faces a governance challenge when it comes to climate change adaptation. To address this, various government agencies, civil society organizations, academic institutions, and community organizations must collaborate to define and implement policies and pathways (Bavinck et al., eds, 2011; FAO, 2018; Kooimanet al., 2005). It stands to reason that the debate over climate change policies and initiatives will be just as heated here as it has been in other sectors pertaining to environmental policy and change, such as fisheries and aquaculture management. In order to promote collaboration, coordination, and policy coherence, partnerships must be established given the complexity of the problems related to poverty and climate change. Additionally, institutions that define shared and differential obligations need to be strengthened and built.

In some fish species, sex differentiation as well as the timing and phenology of the spawning period are known to be significantly impacted by changes in temperature and photoperiod regimes. Temperature mostly affects gonad function by interfering with gametogenesis and steroidogenesis (especially gonadal aromatase activity). The growth of embryos and the quality of released gametes are both directly impacted by temperature. Reduced sperm quality and reproductive production are particularly linked to changes in salinity or acidity of the water. Hypoxia events can affect the quality of gametes and reproductive success by acting on the

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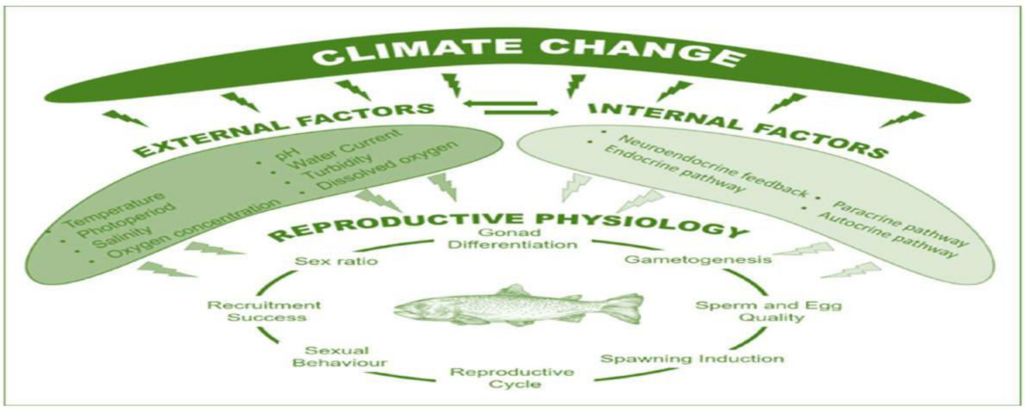
availability of the steroid precursor cholesterol or directly on aromatase activity, which can interact with gonad steroidogenesis.

REVIEW OF LITRATURE

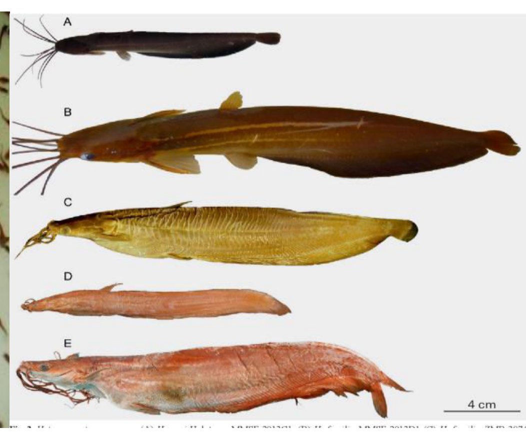
Indian Catfish is renowned for its excellent market value and palatability. The Heteropneustes fossilis (Bloch,1794), sometimes referred to as Singhi or Shing, is a well-liked catfish in Bangladesh. It thrives best in natural habitats such as ditches, floodplains, beels, haor, and baor. Its ability to breathe air, or an accessory respiratory system, allows it to survive for hours in situations where it would otherwise perish in damp muck or water with little oxygen content. The fish can survive in shallow and abandoned waterways since it is not only incredibly resilient to various environmental factors but also thrives well in low-oxygen conditions. Comparative analysis of HCG and PG in different combinations for induced breeding of shing, Heteropneustes fossilis (Bloch) (PDF).



CLIMATIC CHANGE ON BREEDING PERFORMANCE

Breading season of cat fish

Hatchery production of stinging catfish (*Heteropneustes fossilis*) seed is increasing as it is a good fish species favoured by consumers due to its high protein and lower fat content. Stinging catfish naturally breeds in the monsoon season, and is found gravid in the wild during July-September. In captivity it can be successfully produced using either induced or natural breeding techniques. This article summarises what is known about stinging catfish biology, and methods for its captive breeding, rearing of larvae and fry, feeding strategies and health concerns, to aid production of seed of this valuable catfish.

Figures 1&2 Shown Seasonal Breading Performance

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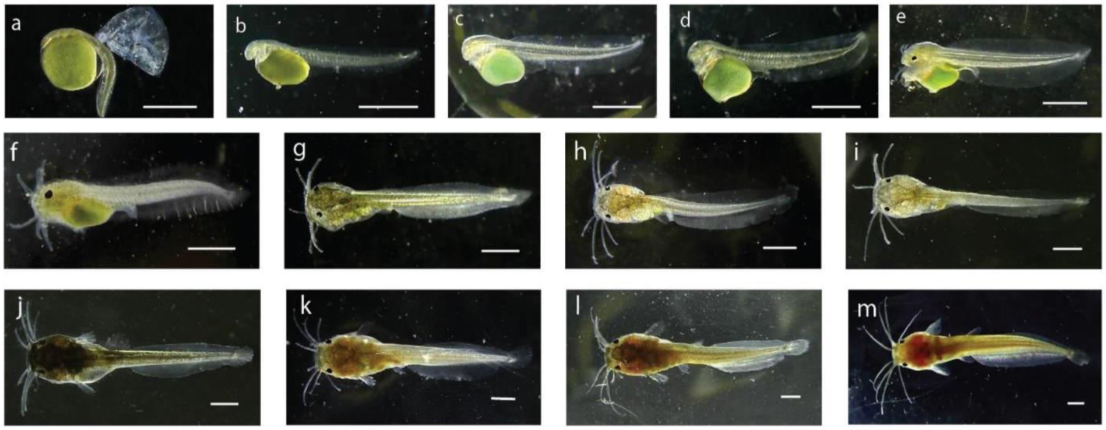
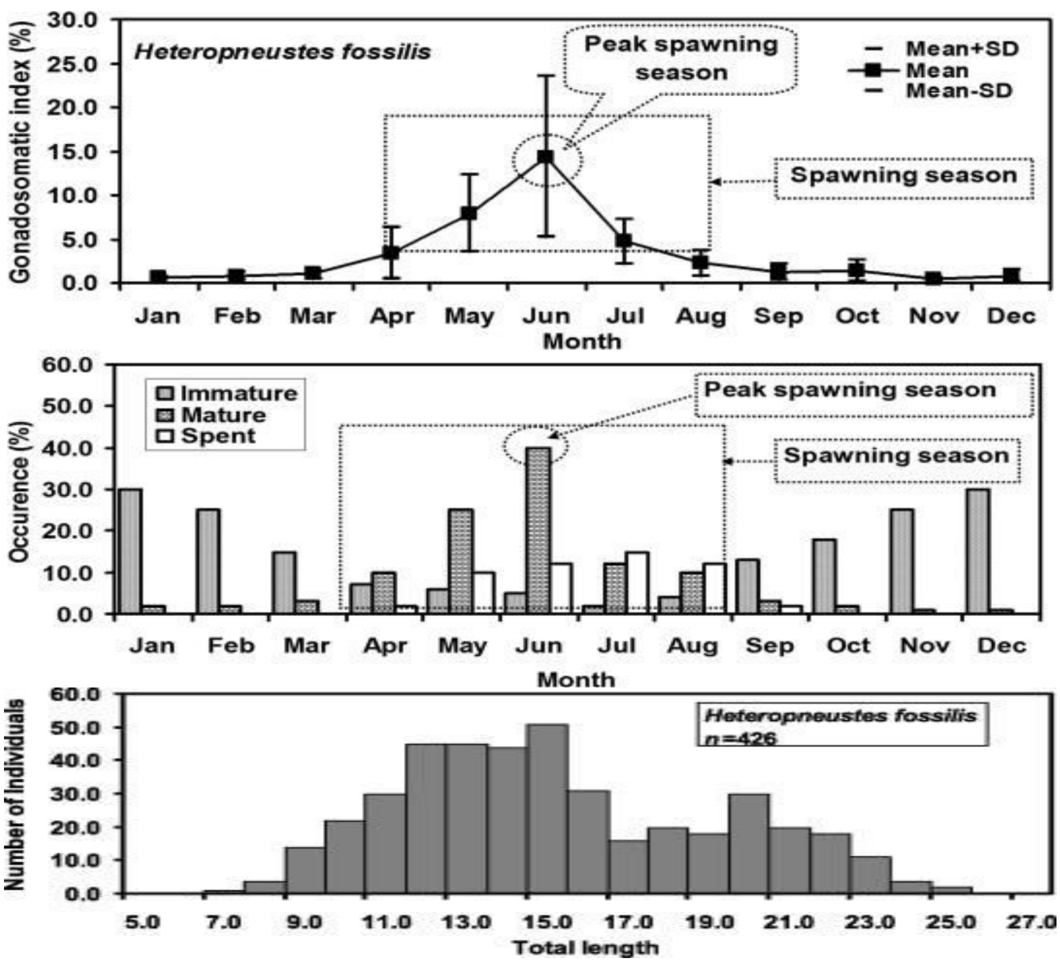


Figure:- 3Growth and Development of H.Fossilis During Breading Season

<u>COMPARATIVE STUDY OF BREEDING PERFORMANCE DUE TO CLIMATIC CHANGE</u>



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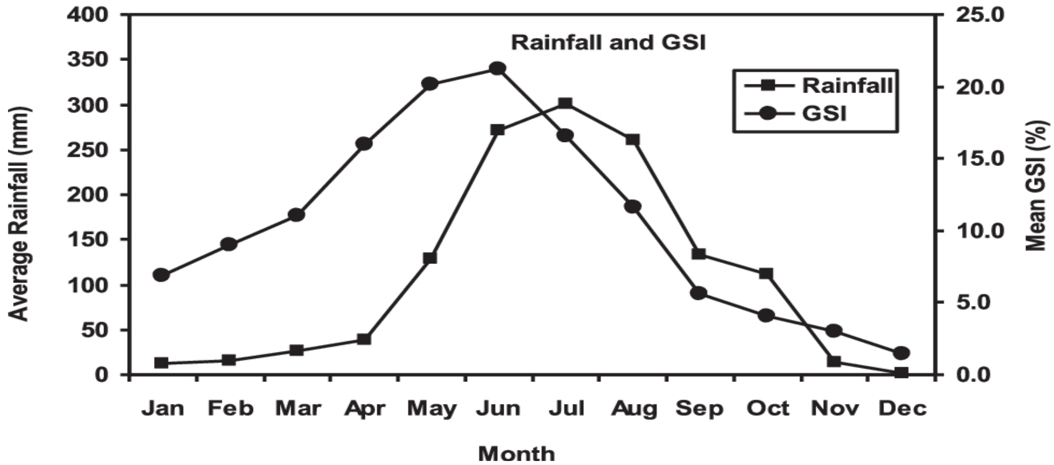
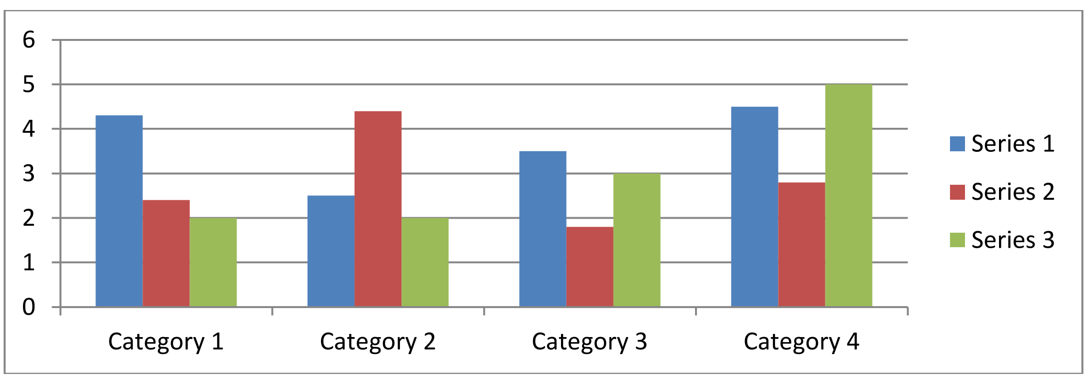


Table 1. Impact of water quality on breeding Performance

Parameter	Highest	Lowest	Average ± SE
Air temperature (°C)	31.37	26.60	28.87 ± 0.23
Surface pressure (kPa)	100.62	99.97	100.36 ± 0.03
Relative humidity (%)	93.44	71.19	81.87 ± 1.17
Water temperature (°C)	31.00	27.00	30.46 ± 0.18
pH	8.60	7.40	8.05 ± 0.05
DO (mg/L)	11.81	4.90	9.85 ± 0.53
TDS	178.00	148.00	161.53 ± 1.41
Ammonia (mg/L)	0.13	0.13	0.13



OBSERVATION:- 1

Breeding performance

H. fossilis is a breeder of monsoon. In the wild, the species can be found from July to September. During the breeding season, the sexes exhibit distinct physical differences.A protruding belly with a spherical genital papilla on the female and a slim abdomen with a pointed papilla on the

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male, respectively, identify suitable individuals. The homogeneous size of intraovarian eggs harvested via catheterization also signifies the maturity of females. By injecting pituitary extract, commercially available synthetic hormone (Ovaprim/Ovatide/Wova-FH), LHRHa, and pimozide, researchers have successfully bred the fi sh. 17α-hydroxy-progesterone and 17α, 20β-dihydroprogesterone. Hatchery owners try to use a synthetic hormone easily available on the market as inducing agent. An injection of up to 1 ml/kg body weight is suffi cient to induce ovulation and the female is ready for stripping 10-11 hours post-injection. The male of this species does not ooze milt freely. Hence, sperm suspension is prepared by the maceration of dissected testes with normal saline solution. The ovulated eggs with sperm suspension are mixed with the addition of a little freshwater for fertilisation. Sperm suspension from one male is suffi cient to fertilise the eggs produced by two females similar in weight to the male.

H. fossilis is an extremely fertile fish that yields 10–15 thousand eggs from 100–150 g fish. The eggs are between 1.4 and 1.6 mm in size and have a vivid green color. Incubation of eggs takes place in receptacles with slowly flowing or stagnant water. It is possible to add a shower to containers holding stagnant water to prevent oxygen depletion during incubation. After around two hours of incubation, the fertilized eggs reach the morula stage, and after 14 to 15 hours, periodic twitching, or movement of the embryo, is seen. After 16–17 hours, when the water temperature reaches 27–28˚C, hatching begins. The size of the freshly hatched larvae is 2.5–3.0 mm.

Natural Breeding

Both induced breeding through stripping and natural breeding under hatchery conditions are feasible in this fish farm. One advantage of this procedure is that it does not require the males to be sacrificed in order to fertilize the stripped eggs. Good brood stock is chosen in the manner previously mentioned for both sexes. During pairing, males and females of comparable weight are typically selected and maintained in a 1:1 ratio. The use of more men might not be very beneficial in increasing the fertilization or ovulation rate during peak breeding season. The same male can be used for breeding again after 15-20 days.

Sustainability and observation.

Temperature affects metabolic rates and biochemical processes, which in turn affects the quantity of energy available for development, feeding, and reproduction. Therefore, it is crucial to comprehend the physiological and molecular reactions that fish adopt to adapt to ocean warming. Within the subject of eco-physiology, many measures, including oxidative stress and the ensuing physiological response, have been used to track the health of both wild and cultivated fish. Fish's usage of antioxidants to combat oxidative stress brought on by rising temperatures influences a number of physiological reactions. Consequently, measures of antioxidative biomarkers may provide an early assessment of the damage by more quickly and specifically detecting the presence of various environmental stressors. Climate vulnerability assessments should be conducted as part of a future fisheries management framework, according to studies in recent years. Adaptation planning on the cusp of climate change can provide a rapid appraisal approach to understanding vulnerabilities. In recent years, some new approaches have gained enormous importance as a participatory framework for carrying out climate profiling and

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data-limited assessments that adapt to changes in stock status, to increase the number of fisheries that can implement multispecies management to improve their performance.

Table 2 Different stages of embryonic development on the breading performance of stinging catfish in different time period.

Figure No.	Development Stages	Size in Diameter (µm)	Development Time Range in Both System (Hour: Minutes)	Characteristics
A	Fertilized egg	1355.06 ± 17.15	00:00	Round, transparent and adhesive in nature.
B	Blastodisc formation	1364.88 ± 28.43	00:20–00:25	Cytoplasm accumulated at the anterior part to form animal pole or blastodisc where cell divisions occur. Reddish blastodisc on the pole of fertilized eggs were easily identified with the naked eye.
C	2-cell	1438.09 ± 25.29	00:30–00:35	Two cells over the yolk sphere were clearly visible at the first cleavage stage.
D	4-cell	1440.59 ± 47.69	00:40–00:50	Four cells at the animal pole produced by second cleavage.
E	8-cell	1457.19 ± 9.92	1:00–1:10	Third cleavage produced eight cells arranged in two rows of four cells where little overlapping of blastomeres was observed.
F	16-cell	1472.02 ± 13.17	1:20–1:30	Sixteen cells were produced in fourth cleavage. At this stage cell counting becomes difficult and cell size becomes reduced due to successive cell division.
G	32-cell	1472.16 ± 23.46	2:00–2:20	Fifth cleavage where the blastomeres were visible in 2-3 layers producing 32 cells.
H	64-cell	1475.81 ± 19.64	2:30–2:40	Sixth cleavage where overlapping of blastomeres was observed producing 64 cells and were placed in 2–3 layers.
I	Morula	1480.44 ± 30.88	2:50–3:00	Repeated cell divisions leading to the formation of multicellular blastodisc where the cells were very small and gave a flowery look at the animal pole.
J	Blastula	1486.01 ± 1.22	4:00–4:15	Epiboly formed as embryonic shield on the animal pole and blastoderm was compressed occupying more than half of the area over the yolk sphere.
K	Gastrula	1491.03 ± 30.56	6:35–6:40	Germinal ring was formed with two somites where thick layer of blastoderm occupied 3/4 area over the yolk sphere. The broader end became the future cephalic part of the embryo.
L	Somatic formation	1509.26 ± 40.58	9:00–18:00	Antero-posterior axis become distinguishable, cephalic portion become broader, and embryonic rudiment became distinct with two somites. Further development of somites reached 22–25, and the yolk became completely encircled by kidney shaped embryo with clear distinction of head and tail.
M	Yolk plug	1523.80 ± 31.66	19:00–19:30	Yolk plugs are the remaining patch of endodermal cells formed and exposed on the vegetal surface of the blastula.

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Figure No.	Development Stages	Size in Diameter (µm)	Development Time Range in Both System (Hour: Minutes)	Characteristics
N	Twisting movement	1551.90 ± 23.59	20:00–21:00	Tail became free from yolk sphere and frequent embryonic twitching movements occurred as the embryo tried to rupture the perivitelline membrane.
O	Pre-hatching	1647.44 ± 40.61	21:00–22:00	Wriggling movement increased as chorion wall still enclosed the embryo, heartbeat increased to 68 times per minute.
P	Newly hatched larvae	2780.08 ± 43.67	22:30–23:00	The egg membrane was broken down and the embryo tail first emerged, followed by the trunk and head region. It took around 2 h for completion of the hatching from twisting movement of the embryo.

Reproduction with assistance

Under the scenario of climate change, the strategy of in-situ conservation which protects diminishing fish populations is given top importance? Therefore, ex situ conservation has been suggested by scientists as a successful way to extract functional gametes in order to preserve and spread these priceless gremlins via captive breeding. One of the most promising techniques for ex situ conservation is the creation of surrogate brood stock using germ cell transplantation, which creates millions of fish gametes with desired traits including growth, illness resistance, and fecundity by using a single donor.

OBSERVATION

Evaluation of Stinging Catfish Breeding Performance.

100 eggs were randomly selected from each replicate and put in a Petri plate to measure the fertilization rate. The number of fertilized eggs that had a green or black tint was determined. Then, 100 fertilized eggs were divided into three hatching bowls that had water and oxygen flowing from the three hapas in order to monitor the hatching rates. After hatching, the total number of hatchlings was tallied. The following formula was utilized to determine the rates of fertilization and hatching:

I The fertilisation rate (%) is calculated as (fertilized eggs/total eggs) times 100.

(ii) Hatching rate (%) = (total number of fertilized eggs / hatched eggs) × 100

Evaluation and comparative observation of Climatic change and Water Quality Parameters

Surface pressure, humidity, and air temperature were among the climate variables that were gathered. Every day, the main indicators of water quality were noted. Throughout the study period, a SMART sensor temperature meter (SMART Sensor AR 867), a DO meter (Lutron DO-5509), a pocket-sized pH meter (pH-107), a TDS meter (TDS-3 Pen portable TDS meter), and an ammonia test kit were used to measure various water quality parameters on a daily basis.

Discussion

Climate change water quality

There were no critical values for any of the measured meteorological factors, including air temperature, relative humidity, air pressure, and water quality metrics including pH, DO, TDS,

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and ammonia. In the hapas, there was a 27–31 °C variance in water temperature (Table 1). The DO ranged from 4.9 to 11.81 ppm, whereas the pH values varied from 7.4 to 8.6.

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Table 3 water quality parameters by climate change

Parameter	Highest	Lowest	Average ± SE
Air temperature (°C)	31.37	26.60	28.87 ± 0.23
Surface pressure (kPa)	100.62	99.97	100.36 ± 0.03
Relative humidity (%)	93.44	71.19	81.87 ± 1.17
Water temperature (°C)	31.00	27.00	30.46 ± 0.18
pH	8.60	7.40	8.05 ± 0.05
DO (mg/L)	11.81	4.90	9.85 ± 0.53
TDS	178.00	148.00	161.53 ± 1.41
Ammonia (mg/L)	0.13	0.13	0.13

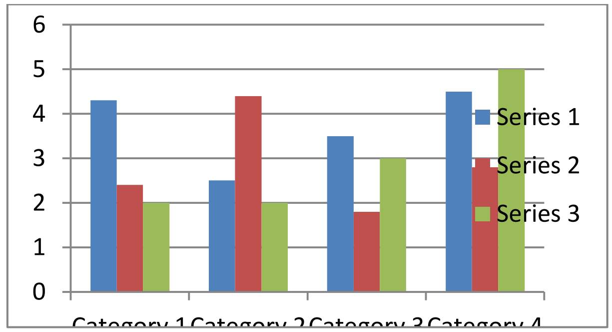
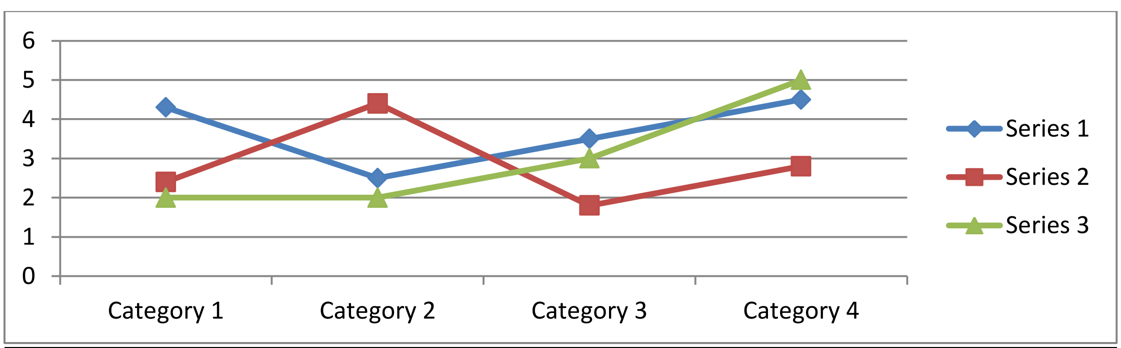


Table 4 Relative impact of water quality parameters by climate change

	Air Temperature	Surface Pressure	Humidity	Water Temperature	DO	pH	TDS
Air Temperature	**1**						
Surface Pressure	**−0.123**	**1**					
Humidity	**−0.918 ****	**0.005**	**1**				
Water Temperature	**0.697 ****	**−0.264**	**−0.511 ****	**1**			
DO	**−0.401 ***	**0.283**	**0.595 ****	**−0.045**	**1**		
pH	**−0.268**	**0.139**	**0.398 ***	**−0.102**	**0.642 ****	**1**	**−0.233**
TDS	0.453 *	−0.203	−0.585 **	0.116	−0.605 **	−0.233	1



A freshwater fish (H. Fossilis) species with extensive cultivation potential is the stinging catfish. It takes a thorough understanding of embryonic and larval development to enhance stinging catfish farming. Few researches have been done in this area, and our understanding of this fish's embryonic and larval development is still incomplete. This study was carried out to look into and gather comprehensive data on this commercially significant fish's embryonic and larval development in connection to water quality and climate parameters.

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Larval Development and Water Quality and Climate Parameters Correlation
Canonical correlation analysis revealed that the first function accounted for a moderate correlation (43%) between growth parameters and climatic variables, whereas the second function explained a substantial correlation (79%) between water quality parameters and growth parameters. Alongside the overall loading percentage of variance, the contributions of each parameter under the categories of growth, water quality, and climate are displayed as separate percentages of variance. As a result of the considerable loading variance associated with the first canonical correlation, pH, DO, and weight all exhibited positive correlations. This suggests that pH and DO play a major role in larval development.

During Breeding Seasons

The broods were discovered to be completely grown and prepared for spawning throughout the breeding season. The male's body color was very noticeable, whereas the female's color was more subdued. The female had a soft, bulging abdomen. The female's vaginal opening was spherical and protruded, but the male's was slightly enlarged. The brood fishes were chosen for induced breeding based on the aforementioned characteristics.

Breeding behavior of Heteropneustes fossilis (bloch).

After the injection, the shing fish were placed into the breeding tank, and the breeding behavior was regularly monitored. The male fish's movements and activities increased four hours after treatment. The male began to follow the female, circling her. It began nudging the female fish's ventral region with its nose. This was an ongoing activity for quite some time. Additionally, women's activities rose. It began to move and remained in the center of the water column. After that, the male approached the female abruptly and gave her a short nuzzle with its snout in the ventral area.

CONCLUSION

The current work comparative breeding performanc due to climatic change advances our understanding of the morphological developmental stages and their characteristics in stinging catfish larvae, which is crucial for creating hatchery management guides that hatchery operators may use. This research will simplify hatchery administration and boost hatchery productivity by providing microphotographic images that succinctly illustrate the many phases of embryonic development. The developmental phases of larvae and post-larvals are quite well defined and characterized. In order to present comprehensive information regarding the relationship between water quality and climatic conditions and larval growth, canonical correlation analysis was utilized.

The information gathered from this research on the different phases of stinging catfish embryonic and larval development using photo micrographic techniques, image analysis, and the relationship between water quality and climate parameters and larval growth will be crucial to hatchery operations.

Future Prospective

Given how crucial temperature is in aquatic ecosystems, there has been a significant surge in interest in thermal eco-physiology, a branch of biology that examines how an organism's physiology responds to its surroundings. Fish cannot control their body temperature because they are poikilothermic. Fish sexual reproduction is highly dependent on particular environmental cues that control and initiate sexual maturation, breeding, and the survival of offspring. Fish in fisheries and aquaculture may experience adverse effects on reproduction and risk their ability to successfully reproduce and survive when environmental unpredictability and perturbations of their breeding sites are coupled.

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