FISH PATHOLOGY

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CHAPTER 1

A COMPREHENSIVE OVERVIEW OFAQUATIC ENVIRONMENT

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ABSTRACT:

Many harmful substances from human activities end up in water, such as from factories, farms, cities, transportation, vacations, and our daily activities. However, bodies of water like rivers, lakes, and oceans offer various benefits that are essential for human health and happiness. Ensuring the protection of ecosystems and human health relies on properly evaluating the dangers related to the existence of harmful substances in the water. The goal of this book is to create tools that can assess environmental health better. It uses different methods and models to analyze how pollutants affect the environment. These tools are especially useful for understanding new pollutants and being concerned about old ones.Fresh water from lakes and rivers contains a variety of different organisms, including small living things that can only survive in water, as well as ones that come from land, animals, and plants. Fresh water, like other sources of water, can contain bacteria, protozoa, and viruses that come from feces. These harmful microorganisms can also make people sick.Fungi can also be found in water, both in the sea and in freshwater. However, they are not as significant when it comes to their connection with food compared to other types of microorganisms mentioned earlier. There are certain water fungi that can harm molluscs and fish. Aquatic fungi that are best suited to live in water can be found in all the main types of fungi found on land, such as Ascomycotina, Basidiomycotina, Deuteromycotina, and Zygomycotina. Some of these things could possibly make food spoil, like salad crops grown with water from rivers or lakes. The tiny organisms that live in water and make their own food, called cyanobacteria, and dinoflagellates, can build up in shellfish and make people sick, causing a serious illness called paralytic shellfish poisoning.

KEYWORDS:

Carbon Dioxide, Corrosive Rain, Fish, Ocene Water, Oxygen Nitrigen.

INTRODUCTION

Illness in fish is strongly connected to pressures in their surroundings. In nature, they usually have some freedom to change their surroundings. If there's a bad change in their environment like less oxygen or hotter temperatures, they can go somewhere else that's better for them. Sick fish will go to a warmer place to make their body temperature higher to help increase the speed of their inflammatory response. In simpler terms, when they live in certain situations, they don't get to choose the conditions outside of them. Therefore, it is crucial that the conditions in which they are kept provide the right environment for all the needs of the specific species. The water environment has many different parts that affect how fish grow and reproduce. It's important for fish to have a balanced internal state for these processes to happen. If changed too much, they can make you more likely to get sick, or even cause many different health problems. Some important things in the environment are temperature, light, water quality, space, food, and things that might scare animals like moving shadows. Another important thing for wild fish and those raised in extensive farming systems is how well the ecosystem where they live can provide them with food[1].

Fish have certain high and low temperature limits that they can tolerate, and they have ideal temperatures for things like growing, hatching eggs, converting food into energy, and fighting off certain diseases. These choices change depending on the type of organism and can also be different for various factors like the amount of oxygen and the pH level of water. Fresh waters can change in temperature by up to 40 degrees Celsius. This can happen because of where they are located, what time of year it is, how high up they are, what time of day it is, how deep they are, and other reasons. The temperature of the ocean doesn't change as much as land because the water moves around and there is a lot of it. Lots of fish illnesses are affected by temperature. The likelihood of getting sick depends on a certain temperature range. In some cases, when a host is infected by a pathogen, there is a delicate balance between the host's defenses and the pathogen's ability to invade the host. This balance can be changed by a change in temperature, particularly if it happens quickly. The temperature of the water also impacts other aspects of the water environment that are important for the health of fish. When the temperature goes up, gases that are dissolved in a liquid become less soluble. On the other hand, toxic substances that are not easily soluble in water, like crude oil and pesticides, become more soluble as the temperature increases. Some harmful substances like heavy metals become even more toxic when the temperature rises[2], [3].

Light is complicated factor in nature that has different parts, including color spectrum, intensity, and photoperiod. The underwater world has unique and always changing traits. Different types of fish react differently to light, and even fish of the same kind can react differently depending on their stage of growth. In bodies of water and large farming areas, the amount of light can be changed indirectly using techniques like making the water deeper and controlling algae, plants, and shade from trees. The presence of substances like clays, coal waste, and paper waste in the water makes it harder for light to pass through. This can make it difficult for algae to grow and may reduce the amount of food that fish have access to. In intensive systems, it is easier to control the amount of light, the duration of light, shaded areas, and how much light is absorbed by the background. All of these factors can affect how fish grow and mature. In these concentrated culture systems, it has been found that too much sunlight can cause sunburn on the back, head, or fins. Due to the thinning of the ozone layer caused by too many chlorinated compounds being released into the air, fish in the southern hemisphere are now facing a big issue of getting sunburned. Furthermore, in certain situations, even small amounts of ultraviolet radiation can cause sunburn. This condition is called photosensitization and it usually happens when a person eats chemicals that react to light. These chemicals can come from medication used for treatment or specific parts of food. In most living things, having the right amount of darkness and light at specific times is important for things like growing up and becoming sexually mature. Also, being healthy and balanced often relies on getting the right signals from the amount of daylight[4], [5].

Carbonate alkalinity and hardness The buffering capacity of new water is defi ned by the carbonate alkalinity and is ordinarily communicated as mg/litre of comparable calcium carbonate. Hardness could be a degree of calcium, magnesium and other metals in new water and is communicated so also as mg/litre of calcium carbonate. Delicate waters are classified as containing 60 mg/litre, modestly difficult as containing 60-120 mg/litre and difficult as surpassing 120 mg/litre. New waters with a signifi cant carbonate alkalinity are commonly of soluble pH and are characteristic of limestone regions or outcrops. Ocean water contains a tall carbonate alkalinity, in spite of the fact that borate particles moreover contribute to the buffering capacity of ocean water. This buffering capacity renders exceedingly acidic or antacid squanders, which are regularly profoundly poisonous in new water, but comparatively harmless after blending and weakening in ocean water. Corrosiveness In unpolluted new waters, corrosiveness is caused by carbonic corrosive and the natural acids determined from

soils, woodlands, swamps and lowlands. Mineral acids and their salts with powerless bases, both found in mechanical and mining squanders and in waters enduring from the impacts of ‘ corrosive rain, may con tribute to the corrosiveness of crude water supplies. Characteristic causticity, carbonate alkalinity and pH are important in defining the quality of the oceanic environment for fish wellbeing[6].

The extend of pH values found in new water is wide and can fluctuate, but fish commonly live within the extend of 5.0-9.5. Salmonids kept at pH values underneath 5 start to lose the capacity to direct plasma sodium and chloride concentrations. Dynamic bringing down of the pH underneath 5 comes about in such decreased sodium chloride plasma levels that coordinates body move ments are lost. Where developed salmon sear are likely to be uncovered to moo pH waters, steps are taken to extend the pH by augmentations of lime or by running the incubation center water through beds of chalk chips. Indeed within the pH run of 5.0-6.5, there are reports of decreased development rate in salmonids. Subsequently, in spite of the fact that fish may endure and even replicate in situations with a wide extend of pH values, their ideal execution, defi ned in terms of quick development rate or maximal regenerative capacity, would be limited to inside a much smaller extend of pH values[7], [8].

Few variables may cause water pH to drop or rise, but by and large in ocean water the pH is more stable due to ahigher buffer capacity. In new water, pH can be affected by disgraceful filtration frameworks and expanded carbon dioxide due to breath. pH is critical since fish got to keep up a consistent inside pH and an corrosive base adjust within the blood. Angle modify their pH by utilizing bicarbonate particles or acidic carbon dioxide. In the event that blood pH gets to be acidic, bicarbonate particles are discharged to buffer the pH back up to typical values. In differentiate, the expansion of carbon dioxide orthe expulsion of bicarbonate particles makes a difference to lower the blood pH. This instrument is controlled by the movement of the chemical carbonic anhydrase within the blood and gills. Most fish can adapt with inveterate changes in pH inside certain ranges; in any case, intense changes in pH can result in acidosis or alkalosis underneath. Sudden drops of pH lead to extreme trouble in a few species, and the fish may attempt to elude by bouncing out of the water, with the circumstance driving to passing on the off chance that untreated.

Sharpness bothers the gill and skin resulting in over the top bodily fluid generation and blushed zones especially on the ventral body. The transaction of pH and broken down metals, in specific aluminum, is additionally vital; for illustration, the ideal pH extend for salmon is 6.0 – 8.5 in new water and 7.0 – 8.5 in ocean water, but encounter appears that numerous new - water ranches can work palatably underneath pH 6 on the off chance that the pH is steady and aluminum levels are not tall. KEY Broken down Gasses Of the gasses broken down in water two are of specific intrigued: oxygen and nitrogen. The issues related with the event of carbon dioxide, smelling salts and hydrogen sulphide are extraordinary cases which are talked about independently in this segment. Hazard variables related with gas immersion contrast among generation frameworks and with life stages. Oxygen is frequently the first restricting figure in most generation frameworks, but in recycled frameworks where O2 is included artificially, carbon dioxide (CO2) can be the essential restricting calculate. Angle are especially powerless to super immersion of N2 and O2 amid the early life stages

DISCUSSION

Oxygen Temperature, saltiness, and the halfway weight of oxygen within the discuss that's in contact with the water all affect the sum of broken up oxygen within the water. With rising water temperature and saltiness, the sum of dissolvable oxygen (mg/L) required for 100% immersion (i.e., in balance with barometrical oxygen) diminishes. Since the relative contrast

in oxygen halfway weight causes the dissemination of oxygen over the gills and into the blood stream, the relative oxygen immersion in water (% immersion) is recognized as a vital parameter for the physiology of all angle. Salmonids, which are dynamic cold-water angle, require at slightest 40–60% oxygen immersion, or approximately 5 mg per liter, depending on the saltiness and temperature of the water. Hypoxia, or moo oxygen levels, can disturb physiological and regenerative forms, which can stretch out life forms and debilitate their resistant frameworks. Early stages of improvement may be influenced by diminished oxygen, which can result in early bring forth, anomalies in adolescent angle, and tall. Grown-up angle of most species will wheeze at the surface in unremitting conditions; this expanded breathing causes an increment in heart stroke volume, which eventually comes about in metabolic acidosis and mortality. Various tropical air-breathing angle may survive in nearly anoxic situations, in spite of changing particular rules for negligible oxygen levels for angle. To decrease the require for water amid strongly salmonid generation, flow-through tanks are as often as possible utilized for hyperoxygenation of O2. In any case, a few thinks about have appeared issues with diminished development, expanded push levels, and expanded defenselessness to viral illnesses as a result of utilizing hyperoxygenated water[8].

Be that as it may, a concurrent rise in CO2 and smelling salts within the water as a result of a decrease in a specific water stream may contribute to the antagonistic results. Be that as it may, advance investigate is required to affirm this. Greatly tall O2 levels may moreover be unsafe to salmon on their claim. Due to varieties in angle digestion system, algal generation and utilization of oxygen, and changeability in water trade such as in freshwater and saltwater cages, the O2 immersion in flow-through cultivating frameworks on waterway waters changes discernibly with the time of day and all through the season in cultivating units. The impacts of short-term O2 changeability are not well caught on, be that as it may a few inquire about propose that angle uncovered to changeability in O2 immersion had more regrettable development andnourish change proportions. Each gas in a blend of gases, such as air, dissolves in water in agreement with how solvent it is. The combined discuss weight as well as the gas's halfway weight within the discuss blend when it comes into contact with water. Nitrogen and oxygen have fractional weights of 0.78 and 0.21 in discuss, separately. When utilizing pumped water sources, discuss and water may be sucked into the pump together. This causes the pump to compress the discuss, which increments the sum of oxygen and nitrogen gasses within the arrangement.

Super-saturated for both gasses is the way it is characterized for the water coming out of the pump. Comparative to this, water and discuss may be pulled in combined at the admissions point of hydroelectric ventures, where they may at that point be compressed as they pass through the turbines, coming about in super-saturation. The affliction known as gas- bubble disease may show in angle kept in water that's greatly immersed with oxygen and nitrogen. When assessing the impacts of super-saturation, the proportion of oxygen to nitrogen as well as the entire broken down gas weight must be taken into thought. Normaly, 110% of the whole dissolvable gas is the most noteworthy secure level. Unless the water is discuss equilibrated, a rise in temperature from 5 °C to 10 °C in new water will result in levels of 112% and 113% for nitrogen and oxygen, individually, at the unused temperature. Typically since water at 5 °C is at 100% discuss immersion. In arrange to compensate for add up to gas weights of 110% immersion, a profundity of 1 m of water is adequate. At tall rises, when the values for oxygen solvency are found, there are weights less than one air. salt substance that has broken down. In common, oxygen and nitrogen are less solvent in water that has dissolved salts than are the lion's share of other gasses. the affect of rising seawater salt concentrations on oxygen solvency. The exemption is when the gas responds with water or another substance that's in arrangement[9], [10].

Underneath pH 7 the sum of undissociated alkali is considered insignificant at any concentration of alkali at risk to be experienced in fish incubation centers, but over pH 7.5 and particularly in ocean water (pH 7.8 – 8.2) its nearness is continuously a potential threat to fish wellbeing. Tall - protein diets encouraged to fish in seriously culture frameworks result in tall levels of smelling salts as the central nitrogen containing excretory item, so that where antacid or impartial water is reused without any treatment other than oxygenation, harmful alkali levels may construct up. The later move to distribution frameworks for generation ofhigh esteem species, such as salmon smolts, requires that alkali is evacuated by natural fi ltration at each cycle. The impacts of alkali poisonous quality on salmonids in new water, and the harmfulness of nitrogenous metabolic squanders in marine conditions. Alkali aggravates osmoregulation coming about in higher pee generation in new water and expanded drinking in salt water. In common, smelling salts harmfulness shows up to be generally comparative to that for new water salmon, but within the marine environment the harmfulness of ionized alkali ought to too be considered. The water quality standard for new water salmonids of 21 µ g is by and large con sidered to be satisfactory for most marine fish. Amid smelling salts exposures, whether inveterate or long winded, it is more youthful fish that are most at hazard particularly in the event that the pH esteem of the water is diminished[11].

The mineral substance of new waters is to a great extent decided by the composition of the soils and rocks through which they haverun. Chalk soils and limestones contribute calcium and magnesium carbonates and numerous other min erals in lesser amounts. Sands, sandstones, gneisses and stones contribute slightest in dissolvable mineral components. Rain water itself contains follows of numerous components determined from barometrical tidies. Ocean water is wealthy in broken down minerals. An abundance of a specific mineral or particle may imperil fish wellbeing. Such harmful circumstances are more commonly associated with man - made contamination than common water supplies, but ground waters may contain signifi cant amounts of broken up minerals such as ferrous press. The harmfulness of numerous overwhelming metals diminishes as the pH increments due to pH related impacts counting diminished solvency or expanded complexing with other compounds or particles. Corrosive rain causing fast diminishment in pH could be a specific marvel which can enormously influence fish survival in susceptible areas; it is examined in more noteworthy detail within the ‘ Corrosive rain ’ subsection of this chapter. It is well built up that emphatically charged aluminum in acidic waters is poisonous to fish due to amassing of Al in fish gills, causing ionoregulatory and respiratory disappointment.

Polychlorinated biphenyls (PCB) happen in common waters from a assortment of mechanical sources counting their utilize as plasticisers in paints and plastics. They are total poisons for fish. Another mechanical toxicant, broadly utilized within the marine environment until as of late, was tributyl tin oxide, a powerful antifoulant which was broadly utilized in fish culture to secure nets. It is poisonous to numerous molluscs and its utilize is presently prohibited in most nations. More as of late concerns have been communicated approximately levels of PCBs and dioxins display in cultivated and wild fish tissues and their conceivable hazard for people expending them. In all of these dialogs, the most weight of accentuation has been on the chemical evaluation and putative wellbeing hazard of utilization of wild and cultivated fish by people, but no thought was given to the dietary esteem of such fish utilization. The significance of fish, and in specific the greasy fishes such as herring, mackerel, fish and salmon, within the human count calories as a source of long chain n3 polyunsaturated greasy acids, is well perceived. Tragically it is additionally inside the lipid component of the fish that lipid soluble contaminants such as dioxins and PCBs gotten by means of the nourishment are put away.

Angle may be a nonexclusive term within the setting of human count calories, and there are wide contrasts in both wholesome esteem and potential contaminant levels, depending not as it were on the beginning and life organize of the fish species, but moreover on the tissue inspected, the season of collect and, for cultivated fish, the substance of the slim down. The eat less of wild fish is completely past human control, and it is as it were with the advancement of defined diets, for cultivated species such as salmon, catfishes and ocean bass, that the opportunity to specifically control tissue contaminant levels has ended up accessible. Such contemplations are fundamental in connection to any evaluate ment of comparative contaminant levels and their significance. Comparisons between cultivated and wild fish are especially diffi faction in this setting, and it is basic to compare like with like. EFSA, in a carefully approved peersurveyed reaction to such claims, concluded that there was small hazard of harmfulness from typical utilization of wild or cultivated species which the benefits to human wellbeing of such con sumption far exceeded any negligible chance from natural or inorganic buildups. Sewage Sewage releases may decrease water quality, depending on the degree of weakening accomplished, the degree of treatment of the initial fabric, its composition and the reaction of the environment. Oxygen consumption isthe foremost common result of such releases. It emerges from insufficientdilution, and microbial development on its particulate and solvent natural substance.

Sewage determined inorganic supplements, such as phosphates, alkali and nitrates, may fortify excessive sprouts of green growth or connected weed with specialist oxygen exhaustion and toxin generation. Sewage is additionally a potential source of overwhelming metals and poisonous natural squanders such as PCBs. In spite of the fact that its nearness is likely to be brief lived, the profoundly poisonous nitrite particle may too be display in sewage releases. Particulate materials All common waters contain a few suspended solids. Amid spates these can rise considerably, but wild fish can nor mally dodge them. Cultivated fish don't have this opportunity, and impacts such as gill surface hyperplasia and intemperate mucus generation on skin and gills are common. Angle eggs, both within the wild and beneath cultivate conditions, are exceptionally vulner able to residue deposits which hinder breath through the chorial layer and empower microbial development. Squanders related with certain businesses, such as quarrying, sand and rock extraction, mining, and paper and paint make, and surface unsettling influence from gracious building, can present expansive sums of particulate matter into waterways and their impacts on fish health may be watched numerous miles downstream from its source. As wellas an impact on the gills, which may eventually lead to tall mortalities in the event that such fish are oxygen pushed hence, tall levels of suspended solids moreover diminish light penetration into water, coming about in less vitality within the nourishment web supporting fish generation (European Inland Fisheries Admonitory Committee 1965).

Oil contamination Spills of unrefined and refined oils can have exceedingly poisonous impacts in lakes and other encased waters where weakening of the watersolvent components isn't quick. Rough oils are moderately less harmful, but utilize of oil dispersants and their solvents incredibly increments the poisonous quality for fish unless dilution is impressive. Oil spillage at ocean or downstream of refineries may make conditions outlandish for aquaculture. Indeed when oil levels are minimal and don't influence the fish per se, the coming about pollute within the fishflesh makes influenced fish completely unmarketable. Corrosive rain Angle murders related with the impacts of manmade acidification have been broadly perceived in Western Europe and North America for numerous a long time. The issues stem from inputs of inorganic acids and particulate metals into the air from businesses burning fossil fills. The acids are at that point transported over significant separations by pre vailing winds and kept in regions numerous miles from the source, leading to the wonder of

corrosive rain. The foremost helpless waters are those in regions with difficult, insoluble bedrocks where the natural buffering capacity of soils and waters is exceptionally moo, such as happen within the precipitous ranges of Europe and North America. The result is water of an unnaturally moo pH, commonly related with tall concentrations of aluminum and other metal particles filtered from the substrate of the catchment range by the unnatural causticity, especially amid snowmelt and when overwhelming rain takes after a dry spell.

The concentration of aluminum in these waters has been appeared to be especially signifi cant, as aluminum shows up to be most poisonous to fish at pH 5.0 – 6.0, which is over the typical poisonous limit for the coordinate impacts of expanded sharpness at moo pH on fish. The harmful limits for aluminum are not well set up and change impressively, depending upon the fish species, the arrange of the life cycle and other water quality characteristics, especially pH, calcium and the nearness of com plexing ligands. The neurotic picture related with aluminum and corrosive harming is by and large nondiagnostic, and expository and chronicled information are regularly moreover required for effective conclusion. The major shapes of marine fish culture include the utilize of floating net pens or cages, net enclosures on the shoreline, tidal ponds or lakes or pumped ocean water in shore based tanks. A few of the foremost signifi cant qualities of ocean water for fish wellbeing are influenced by the nearness of the shor.

Shallow ranges protected from water trade are hotter than the open ocean within the tropics and in mild locales in summer, in spite of the fact that in winter the inverse may apply, with ice arrangement happening in numerous calm locales. Water trade in all frameworks but shorebased tanks depends on common highlights. Upon this exchangedepends the thicknessat which fish may be kept in individual units and the by and large biomass which any particular region can bolster. Trade may be constrained in the event that tidal influences are unimportant, or whimsical on the off chance that the circulation is wind - driven. In case the common efficiency of such waters is tall the issues common in eutrophic lakes may happen, such as harmful algal sprouts and warm and oxygen stratification with occasional upset driving to surface waters moo in oxygen. Fresh water runoff may result in diminished and broadly fluctuating salinities, particularly within the beat 5 – 10 m. Long ocean gulfs with huge waterways rising into them are regions most inclined to this include. New water runoff may contain toxins poisonous for fish and may moreover be cooler or hotter than ocean water. The common occupants of ocean water, especially fish, will be a conceivable store of possibly pathogenic microorganisms. Great cultivation can frequently reduce on the off chance that not kill the impacts of such pathogens. A few shore based aquaculture offices and aquaria utilize sublittoral sandy sea bottoms as fi lters, putting their admissions channels a few meters underneath the sand surface to guarantee water of tall clarity and moo microbial and parasitic substance.

CONCLUSION

The water in our oceans, rivers, and lakes is very dirty because many different kinds of pollution end up there. This pollution is causing problems for the animals and plants that live in these water environments. For a very long time, people threw garbage and waste into rivers and oceans, thinking that because the oceans are so big, it wouldn't make much of a difference. This belief caused people to intentionally and constantly throw away industrial, household, agricultural, and radioactive waste into bodies of water. It is not surprising that medication waste is also being dumped into water without being treated. We have already talked about how harmful they are for the water ecosystem and people, even very small amounts of these chemicals can be considered a danger. Aquatic plant-based systems are a good option for cleaning dirty water because they are inexpensive, efficient, and easy to set

up and maintain. Water plants are important for cleaning dirty water and are being used a lot to fix problems with pollution in Water plants that can clean up water absorb drugs through their roots and only move a small amount of the drugs to their stems and leaves.

Usually, the amount of compounds is much higher in the roots compared to the shoot. However, there are a few cases where the movement of compounds is limited in both roots and shoots, like in the process of getting rid of diclofenac.

Certain types of medicinal substances can move to different parts of the plants and can also be found in specific parts of cells in certain water-based plants like penny grass, water spinach, rice, and purple perilla.

The movement of these compounds depends on different factors like how they dissolve in water, how they break apart in a solution, how well plants can change the compounds, and need other processes too.

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CHAPTER 2

ANATOMY AND PHYSIOLOGY OFBODY STRUCTURE AND FUNCTIONS OF FISH

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ABSTRACT:

Many types of fish in the ocean produce many tiny eggs that float in the water and eventually hatch into baby fish. Baby larvae that have just come out of their eggs are very small, usually between 1 to 5 millimeters long. They are fragile and not fully formed yet. They have many characteristics that are similar to how they were when they were still in their eggs, such as their underdeveloped mouth parts, digestive organs, fins, and eyes. Baby sea animals float and spread out in the ocean. Most, or over 99%, creatures do not survive to become juveniles. The first stage of a baby typically doesn't eat anything and gets its food from a yolk sac in the egg. Through the process of ontogeny and growth, a yolk-sac larva transforms into a larva that is actively able to feed. Eventually, it changes into a young form that looks like a small grown-up. In many cases, transformation happens after a few days to more than a year after hatching. It can be like a true change. Metamorphosis can bring about changes in appearance and functioning of the body, including bones, nerves, and behavior. Some species, like eels, flounders, and herring, have big changes in their body shape. But other species, like cods, basses, and sea breams, have smaller changes. Metamorphosis is usually considered finished when a young animal grows all its fin spines and rays, or when it develops its scales. Lengths during metamorphosis to the juvenile stage are typically less than 25 millimeters, but vary among species and can range from a few millimeters to several centimeters.

KEYWORDS:

Brain, Blood Vessesl, Cells, Spinal Cord, Teleost Fish.

INTRODUCTION

This chapter aims to provide a basic understanding of the structure and function of teleost fish's body, which is important in order to understand the diseases that can affect them and how they manifest. Teleosts have some similar basic functions as other vertebrates, so understanding mammals is not totally useless. But the teleosts are not the early ancestors of mammals. They are actually quite advanced, evolved recently, and spreading out to many different habitats. There are many types of fish called teleost, more than any other group of animals with backbones. Because of this, it is difficult to make accurate generalizations about all teleost fish. However, there are some specific types of teleost fish that are commonly used and studied, so we can still make some useful statements about them. This account will focus on the specific differences in the anatomy and physiology of non-mammalian creatures compared to those that are more familiar to us.

One important factor to think about is the water environment and how it affects fish. The fish needs to protect itself from the harmful effects of its environment and make sure it gets the right nutrients to survive. A main reason is that water holds heat well. This causes most fish to rely on outside sources, like the environment, to regulate their body temperature. The temperature of our body matches the temperature of the environment. There are no specific values that can be given for physiological constants, such as Temperature affects various

processes in teleosts, like heart rate, digestion rate, and growth rate. It is important to consider temperature when studying them. Sometimes, an animal can look very different depending on the temperature[1], [2].

Teleost fish have more variety in how they reproduce than any other animal group. Most species have males and females, but some can have both male and female characteristics, known as hermaphroditism or bisexuality. Parthenogenesis means when an egg develops without being fertilized. Gynogenesis means when an egg starts dividing because of a sperm's penetration, but the sperm doesn't contribute genes. These processes have been observed in nature and in the lab. Eggs and sperms can be released into the water for external fertilization. Alternatively, animals can have sexual intercourse, which can result in the release of fertilized eggs or the birth of live young fish. Young fish can be born in nests and taken care of by either the male or female fish. They can also be born from eggs that are laid in reeds, released into the water as floating eggs, or even held in the mouth of a parent fish. It is important to know about the reproductive body parts and how they work in fish that are raised in captivity. This is especially important during the stages when the fish lay eggs and the babies are born, as this affects how much money can be made and how well the fish grow. The testes are two organs that hang from the back of the fish's stomach, near or below their swim bladder[3], [4].

The size of these organs can be different. In young individuals, they can be small strands of tissue, while in adults, they can be large and flabby. In some cases, they can make up about 12% of the body weight. There is a tube called the vas deferens that carries mature sperm from the testis to a hole in the urinary papilla where it is released. The testis is made up of tubules or sacks called seminiferous tubules. These tubules have a lining called spermatogenic epithelium. The process of the male gamete maturing involves the multiplication of sperm mother cells, which develop into sperm cells. Many of these eventually go through a cell division called meiosis to become single-celled sperm. Sperm cells stick to the surface of a pear-shaped structure called the pyriform, where they nourish cells in the seminiferous epithelium known as Sertoli cells, until they are ready to be released. The male hormone testosterone is produced by cells in the testis called interstitial cells. These cells are found in the supportive tissue of the testis or in the outer layer of the seminiferous tubules. The ovary in female teleost fish can have different structures. In some species, it is a simple group of ovarian follicles. In other species, it is a more complex organ. This not only creates eggs but also serves as a storage for sperm, a place where babies can grow and be nurtured. The fully grown ovaries can make up to 70% of a person's overall body weight[5].

The fish have little orange-white balls in their belly. The main cells in the ovaries are called ovarian follicles. These lines are like an empty space or a space that could become empty, and they have a very complicated series of wrinkles in their cover. Eggs go into this space as they grow. In some animals, the eggs are released through a part called the oviduct. However, in less advanced animals like salmon, the eggs are put into a fold of tissue called mesentery. Eventually, this tissue tears and the eggs are released into the belly, and then are pushed out through the genital opening. Oogonia are cells that are starting to mature. They are surrounded by a layer of small cells called epithelial cells. When oogonia and epithelial cells are together, they form the ovarian follicle. The cells on the surface grow as the egg grows and are separated from it by a layer that gets thicker over time called the zona pellucida. These special cells called granulosa cells take care of feeding the egg and producing its yolk. If an egg cell starts to break down before it is released, other cells invade it, and then those cells are invaded by certain immune cells. In many animals, there are eggs at different stages of growth in multiple generations. Teleost fish have different levels of ability to reproduce.

Fish that release their eggs into the water without taking care of them usually produce a lot of eggs to make up for not caring for them. The adult cod fish can lay around 9 million eggs each season, while the Nile tilapia fish, which carries its babies in its mouth, only lays a few thousand eggs in multiple batches throughout the year.

The teleost's nervous system spreads throughout its body in a network of centers and pathways that communicate and integrate information. This includes neurons and their long branches. The brain and spinal cord have a lot of nerve cells. These two parts make up the central nervous system (CNS). The peripheral nervous system (PNS) includes the nerves that come out from the central nervous system (CNS) and their nerve endings or organs used for special senses. Only some parts of our nervous system can be controlled by conscious effort. This includes the nerves that control our skeletal muscles and certain muscles in our head that we can control voluntarily. In higher species, autonomic components of the system control the regulation of heart rate, chromatophores, gill movements for breathing, peristalsis, and other functions of smooth muscles. The brain cells of fish are similar to those of other animals, but some groups of cells, like the Mauthnerian groups, are much bigger than those found in mammals. There are other cells called supporting cells, like astrocytes, oligodendrocytes, and microglia, present in the body as well. CNS tissue is split into two parts: grey matter and white matter. Grey matter has the cell bodies of neurons and neuroglia, while white matter contains myelinated axons.

The brain and spinal cord are kept safe by a layer called the meninx primitiva. This layer surrounds a liquid called cerebrospinal fluid, which is made by the choroid plexus. These little pockets in the brain, similar to the glomerulus, can be found in different places compared to mammals because of how the teleost brain folds. The spinal nerves, especially in the area near the dorsal root ganglia, are usually covered by clusters of cells that look similar to those found in the intestines of fish and other loose connective tissues. The brain of teleost fish is similar to that of other animals, but there are many differences in how it looks and how complex it is. To make it easier to explain, it is typically divided into five parts including the front part called telencephalon, the middle part called diencephalon, the middle-back part called mesencephalon, the back part called metencephalon or cerebellum, and the bottom part called medulla oblongata. The telencephalon, also known as the forebrain, is in charge of smelling, some parts of seeing colors, remembering things, and controlling behaviors related to reproduction and eating. The parts in our nose called olfactory bulbs are linked to the telencephalon through axons from the telencephalon. These axons are known as the olfactory tract. The front part of the brain is called the telencephalon. It doesn't have a clear space in it called the lateral ventricle but it is usually separated into two parts: pars ventralis and pars dorsalis[6], [7].

The sense of smell in lower fish is mainly controlled by the dorsalis, but as fish evolve, this part of the brain becomes less important. In higher fish, it becomes a complex processor that does more than just sense smell. Actually, when the front part of the brain is removed in fish, it messes up a lot of their actions like being startled, things they have learned, and their ability to reproduce. The diencephalon is a part of the brain that can look different in each person, but it is usually small. It can be split into three parts: the epithalamus, thalamus, and hypothalamus. The epithalamus is made up of two parts: the pineal body and the habenular nuclei. The pineal body can detect light and might have some hormone-related functions. The habenular nuclei help coordinate information from the pineal body and the telencephalon to the thalamus. The back part of the thalamus is connected to the retina and the optic lobes. The thalamus is a complicated part of the brain, and it is difficult to understand its structure and similarities between different species. This thing has many centers that come in different

sizes depending on the type of creature. For the most part, the lower parts of the brain called the diencephalon help process and connect information from our senses of taste and smell. In fishes, the hypothalamus is easily identified and tends to be fairly big. It seems to mainly include cells that coordinate signals from the front part of the brain and signals from the lateral line. A part of the lower lobe of the hypothalamus controls the way we eat. It gets information from our sense of smell and taste, and it also controls the muscles in our jaw that we use for eating. The neurohypophysis, also known as the pars nervosa, is a part of the hypothalamus that extends downward like a pouch. It contains axonal tracts from the preoptic ganglionic neurons.

DISCUSSION

These sections may be very large during reproduction in certain species, but they do not have the same subdivisions as in more advanced animals. Directly behind the infundibulum is a part called the saccus vas culosus. This part produces cerebrospinal fluid. The mesencephalon is a big part of the brain. It is divided into two parts: the optic tectum on the top and the tegmentum on the bottom. Typically, the optic tectum is a relatively big part that is split into two round structures called corpora bigemina by a line. This text is mainly about how the brain processes information from the eyes. It focuses on the area called the tectum, where signals from the optic nerves are received and coordinated. These signals cross over at a point called the optic chiasma before reaching the tectum. In fish with properly developed eyes, there is a part called the optic tectum that has a outer layer containing cells that do different visual jobs. For instance, cells with branches that point in a perpendicular direction to the surface of a part of the brain called the tectum are believed to be in charge of keeping track of position and recognizing small details in what we see. Another group of cells that are lined up parallel to the tectal surface appear to be part of how we see things moving. The cerebellum in fish varies in size and shape between different species. This is generally related to receiving and coordinating signals related to body position and balance. In many fish, there are two parts. One is called the vestibulolateralis lobe, which gets signals from the inner ear and the lateral line. The other part is called the corpus cerebelli, which is located more towards the back and it gets signals from the spinal cord about body movements and positions. The size of a certain part of the brain is connected to how well the lateral line is developed[8], [9].

The medulla and spinal cord blend together without a clear separation. It has four main sections of nerve fibers, including the ones that sense and control our internal organs and the ones that sense and control our body's movements. The dorsal and ventral tracts make up the beginnings of cranial nerves V to X. In fish called cyprinids, the inner part of their brain called the medulla has a part that sticks out to cover the large taste buds they have. These taste buds come from their well-developed taste receptors. The medulla only provides autonomic supply to the oculomotor and vagus nerves. The vagus nerve also supplies the branchial vascular bed, heart, stomach, and swim bladder. The parasympathetic system does not usually control the nerves in the intestine. The control of breathing when we're nervous is done by a group of motor neurons in the medulla called the respiratory center. This center helps regulate our breathing patterns and doesn't rely on higher mental control. The nerves that send signals to taste receptors are found in a part of the brain called the medulla. The medulla also contains nerves related to hearing and balance. The medulla controls the coloring cells called chromatophores. The Mauthner cells are two big nerve cells found in the medulla at the eighth nerve root[10], [11].

They have long branches that go down the spinal cord and assist in coordinating swimming movements. The spinal cord of teleosts goes from the head to the tail of the body. In some

higher teleosts, it ends in a structure called the urophysis, which is responsible for producing hormones. The spinal cord of teleost has grey and white matter that are clearly separated. The grey matter becomes more complex as the fish evolves, but the two dorsal horns of grey matter are joined or fused together. There are many big nerve cells in both the back and the front of the spinal cord. The top and bottom roots of the spinal cord do not have a clear separation between nerves for movement and nerves for feeling like in other animals: both parts have a mix of nerves for both. The main characteristics of the cord tracts are the very big ventro medial axons and the Mauthnerian axons that come from the medulla. Peripheral nerves are nerves that are located outside of the brain and spinal cord. There are 10 cranial nerves that help with sensing and moving different parts of the head. These nerves also help with both voluntary and involuntary actions. The vagus nerve also helps with supplying the main organs in the body. The eye is a special sense organ found in teleosts. It is very similar to the eyes of other vertebrates.

The skeleton, also called the dry matter, is seen as the unchanging part of the vertebrate body, unlike the soft tissues. In this review, we give examples that the amount of dry matter in teleost fishes can vary, just like it does in other vertebrates. People who study the development of skeletons in model organisms usually think of the skeleton as staying the same during the time they are studying it. On the other hand, subjects like evolutionary developmental biology, biomechanics, physiology, or immunology have a more active perspective on the skeleton. Because the vertebrate skeleton serves many different purposes, it is constantly changing throughout a person's life. The skeleton does more than just protect, move, and help us eat. It has other important jobs as well. In the beginning stages of growth, the backbone of fish called the notochord is a key part of their development and sends important signals throughout their body. Afterwards, the hard skeleton inside the animal's body helps control the way it uses minerals, and it also makes hormones. The skeleton stores fat, helps us hear and make sounds, and creates sexual features in our bodies. In this brief review, we mainly look at changes in the skeleton that are clearly visible in their shape. We show different examples of how the bones of fish can look different and change based on their type and level of flexibility.

The white part of the eye, called the sclera, is the outer layer and it has places where three pairs of muscles that move the eye are connected. These muscles are controlled by the third cranial nerve. The sclera also has areas of either cartilage or bone to help support it. The cornea, which is like a window for the eye, bends light in a way that is similar to water. The layers of this structure include a protective outer layer, a tough layer underneath it, a middle layer, and an inner layer made up of two parts. The lens in a teleost is not flat like a lens, but round like a sphere. It sticks out partly through the colored part of the eye to give a really wide view. The eye's short focal length means that the fish can see a wide area and things in the front and back clearly. Moving the lens closer to the back of the eye helps a little with focusing. This is done by the retractor lentis muscle. In lots of animals, the clear part of their eye called the lens or cornea can have a color. The blood vessels in the eye called the choroid help provide nutrients to the retina by creating a network of tiny vessels under the white part of the eye. They are connected to a big gland in the eye called the choroid gland. This gland has small blood vessels that help in producing oxygen and making sure there is enough oxygen for the retina.

However, it also helps in monitoring the blood. The way oxygen is released is the same in both the swim bladder and gas gland. This means that certain syndromes can occur in both organs at the same time. The fluids in our eyes, called ocular humours, have not been studied in much detail. However, they are similar to the fluids found in the eyes of other animals. The

iris is mostly fixed and does not have well-developed muscles to control its size, even in more advanced animals. The teleost retina is the part of the eye that can sense light. It is organized in a similar way to other animals with backbones. The innermost part of the retina is made up of clear nerve cells. These cells cover the rod and cone cells, which sense light, and there is a layer of dark pigment around the edges of the retina. Most shallow water fish can see colors, but fish that live at deeper depths where the water absorbs long-wavelength light do not have cones or color vision. This results in a low-intensity blue-green monochrome illumination. The substances in our eyes that help us see different colors, which are called rhodopsins, can change based on the surroundings of the fish. The best type of light for fish to see and move through water is the same wavelength of light that water transmits the best. Oceanic fish are more affected by blue light, while freshwater fish can see red light better. Some fish have two different types of eyesight pigment, which can change depending on the season or when they move between saltwater and freshwater. The labyrinth is a part of the body that helps with balance and hearing. It evolved from the anterior lateral line and is a complex sensory organ. It has two parts joined togetherthe curved canals and the otolith organs. The semicircular canals are three curved tubes made of tissue that are found in the skull. The ends of each canal connect to a hollow space that is shaped like a labyrinth.

One end of the hollow space expands to form a round chamber called the ampulla. Inside the ampulla are small ridges called cristae, which have sensory hairs similar to the mechanoreceptors found in the lateral line. The sensors are triggered by the movement of liquid in the canals in the ear, which shows how quickly something is spinning. The signals are then sent to the cerebellum through a special pathway in the ear. The otolith organ is made up of three connected chambers called the utriculus, sacculus, and lagena. The curved canals connect to the little sac. In each part of the chamber, there are special white stones called otoliths. These stones rest on top of a part of the body that senses things and is made up of cells called sensory cells. These cells are similar to the ones found in the lateral line neuromasts. The inside of an inner ear is filled with a fluid called endolymph. Inside the fluid, there are tiny particles called otoliths which are heavier than the fluid. These otoliths moving over the sensitive tissue of the ear provide stimulation when gravity or low-frequency sound vibrations are detected. The otolith organs are important for sensing sound, sensing movement and sensing changes in balance. The lateral line system is a different organ found only in lower vertebrates. It has similarities with the labyrinth in terms of origins and nervous components. The main parts are the side line tubes, but some species also have well-developed head tubes next to them.

Our record is not complete for teleost species that have known types of skeletal changes. There are many more examples from different types of animals that can be found in books and articles. In simpler terms, the examples of the various ways teleost fish skeletons can change have been scattered in scientific literature or mentioned briefly as developmental noise. Our goal is to show that the teleost skeleton can change and adapt at all stages of life. Any analysis that is based on the bones should consider this. Certainly, there is a lot more that can be discussed about how the bones can change and the effects this can have. Although we know some of the ways that skeletons can change and the reasons behind these changes, there is still ongoing debate about these processes in fish and other animals with backbones. Modularity and heterochrony are ways that help the flexibility of bone structures The idea that epigenetic factors can make changes in how our bones develop is widely agreed upon now. It is now called 'Wolff's law of bone transformation', but the term 'bone functional adaptation' seemed like a better choice of words. The concept of how bones change to better suit the needs of teleosts is well known and has been studied by several researchers. Please rewrite the text you would like simplified. Different experiments have shown that the shape,

structure, and gene activity in the jaw bones of fish can change when they have different food to eat. In reply to tough food items, when the cichlid fish Astatoreochromisalluaudi's jawbones experience more pressure, they change and adapt. Eating tough food helps make our bones grow more and stronger on the inside.

The canal is a small, hollow groove on the side of the fish's body. It has a hard structure and is covered by skin, which has little holes along it. The mechanoreceptors are found at the base of the canal and change position along with the pores. These 'neuromasts' are activated when movement in the environment causes the water inside the canal to move. This movement then physically moves the receptors of the neuromasts. These are cells in the shape of a pear that have hair-like structures. These structures go up into a jelly-like cup. The lateral line neuromast organs can detect small movements in water caused by sound waves up to 200 Hz. Some fish can feel the vibrations made by moving prey that are up to 32 meters away. The lateral line nerve gets most of its nerve supply from the vagus nerve, which is the ninth cranial nerve. The lateral line nerve runs parallel to the canal but is a little closer to the middle. The way the pancreatic tissue is spread out differs a lot between different types of animals. The endocrine part of the body is different and has small groups of cells called Langerhans, which are spread out in the tissue of salmon or eel-like fish. In some fish, there is a small amount of scattered endocrine tissue and a big compact one that varies in size called the Brockman body. The size of the Brockman body changes as the fish grows and develops. Inside a thin protective casing, there are three types of cells in the body. These cells make a hormone called glucagon, another hormone called insulin, and some cells that we don't know what they do yet.

There are big changes in the size of islets during reproduction and old age, and also with changes in diet. Also, there are differences in the amounts of different types of cells that occur during different seasons. Insulin makes blood sugar levels go down, but fish don't quickly lower their blood sugar like mammals do. Insulin is released when blood sugar levels are high to help lower them and provide energy for the cells. This is about how glucose is broken down, not how it is stored as glycogen. Insulin stops the liver from creating new glucose from amino acids and decreases the breakdown of liver protein. Insulin's main job is to help save protein and amino acids and assist with building body tissues. Glucagon does the opposite of insulin and raises blood sugar levels by breaking down liver glycogen. It also helps the liver to use amino acids and make glucose. The urophysis is a gland at the back of the body that produces hormones. It is only found in sharks and bony fish. It has a protective covering like the rest of the cord and has a lot of blood vessels that go to the renal portal system. The text is talking about a structure made up of big brain cells with different shapes. These brain cells have long branches that come from the spinal cord and are similar to the stalk of another part of the brain called the hypophysis. They end at walls next to small blood vessels in the brain, similar to those of a specific part of the brain called the hypothalamus. The urophyseal hormones are small proteins that mainly help regulate the balance of water and salts in the body.

One of these hormones also has a specific effect on the smooth muscles of the reproductive tract. The pseudobranch is a red, gill-like structure found in some fish. It is connected to the first gill arch and is located on the inside of the fish's operculum. It has tiny blood vessels next to hard cartilage sticks. The pseudobranch is connected to the choroid of the eye through blood vessels. The choroid is made up of small blood vessels and long, thin cells that are similar to fibroblasts. fish without a pseudobranchsuch as Anguillidae fish always don't have a choroid rete. Although the exact functions of the organ in question have not been completely determined, it is believed to perform hormonal and regulatory roles. It may also

have a role in providing more oxygen to the blood vessels in the retina. The fish reproductive organs, called gonads, not only produce eggs or sperm but also release hormones that affect many different parts of the body. The way they function is determined by the output of gonadotropins, which come from a part of the body called the pituitary gland. The pituitary gland is like the conductor of a group of hormones in the body. The hormones produced in the reproductive organs cause the skin to thicken, the color of the skin to change, and the development of certain body parts like breeding tubercles, kypes, and swelling in the urogenital area. Male and female hormones also have important effects on how our bodies use carbohydrates, fats, and proteins. Androgens help the body grow by increasing the amount of protein and RNA in the liver, kidney, and muscle. This stimulates processes that build protein and promote growth. Oestrogens typically cause the body to store more fats and start making vitellogenic proteins.

Moreover, when teeth are constantly replaced, they become wider and have a shape similar to molars. The kind of food you eat can change the way your head looks when you are a young Cichlasomamanaguense fish. Parsons and his team indicated In cichlids, when they eat hard food, it causes their body to make more Bmp4, which affects the shape of their jaw. This happens in other fish too, not just cichlids. Similarly, when the Wntsignalling pathway is manipulated and reduced locally, it has a big impact on the jaw shape of cichlids. Mechanical pressure impacts the growth and shape of bones in both adults and young individuals, and it also affects the early development of bones in certain types of fish Endurance swimming training tests with the fish species called Danio rerio have shown that their tail bones grow faster. In fish that were trained, their hypurals became hard at 20 days after the eggs were fertilized. But in fish that were not trained, their hypurals became hard only at 35 days after the eggs were fertilized. Fiaz and his colleagues. A study found that young zebrafish can start benefiting from swim training during their early stages of development. In animals that were trained from 5 to 14 days after being fertilized, the growth of cartilage and bone structures in the head and tail area, as well as the development of the anal and dorsal fins, happened faster by up to three days.

So, besides the weight put on the bones, other factors affect how fast bones develop and become solid. One example of nutritional factors, besides minerals, are vitamins and fatty acids. The bacteria in our stomach can make our bones grow faster or slower. Other than speeding up or slowing down, certain factors related to how genes are expressed can start the process of bone formation. An example of this is when tendons harden due to stretching. In mammals, tendons become bone or cartilage at the spots where they attach to each other or to bones gave an example of a bone called kinethmoid that strengthens when it experiences pressure or movement. The kinethmoid bone is a bone that connects the front part of the upper jaw with the back part of the skull. This bone sticks out of the mouth and is a characteristic shared by cypriniforms. The kinethmoid grows as a cartilage in a ligament. It is a type of bone that is like a sesamoid. In zebrafish, the kinethmoid bone starts to harden at where it connects with the ligaments, at the same time when the animals stick their upper lip out more. This change may have eventually caused the kinethmoid bone to develop from a tendon through epigenetics. They prove their idea by showing that bones found inside the muscles of these fish are completely surrounded by muscle tissue and do not connect to other bones. These intermuscular bones are similar to tendons found on the sides and along the spinal cord. The joint between the basiparyngeal joint and the jaws developed because the bottom surface of the skull was rubbing against the top of the pharyngeal jaw. The growth of a flexible joint between bones that move against each other is a straightforward and quick process during an individual's development and over time in the evolution of the species.

CONCLUSION

The skeleton of teleost fish is a flexible and adaptable organ system. We have shown examples of fish bones at different levels that prove how they can change in response to certain factors. These changes can be in their structure, shape, number, presence, and how much mineral is in them. The skeletons of adult fish go through changes to adapt to their movements, repair any damages, maintain the right balance of minerals, reach sexual maturity, and as they get older. Morphological changes need a change in the structure of the cells. This involves making new cells and changing the existing ones. These changes are easiest to understand when comparing teleost skeletons to mammalian skeletons. Teleost skeletons generally do not have osteocytes, but they have a lot of osteoclasts that break down bone. They also have a specific way of managing minerals and have tissues that are between bone and cartilage. In the natural world, there are different things that can happen at the same time to change the structure of an animal's bones. An animal that shows an ancient skeletal feature may have a different number of bones from others in its group. When bones are under pressure, they can change and become better suited for the pressure. Teeth can also change and the inner part of the skeleton can be remodeled. In older age, a person may develop thickened bones or extra physical characteristics like a kype. The fish skeleton is always changing and flexible.

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CHAPTER 3

TELEOSTS SYSTEMATIC PATHOLOGY AND PATHOPHYSIOLOGY

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ABSTRACT:

The structure and functions of fish are primarily changed to adapt to two main environmental factors. Aquatic environment and the things in it can be managed or directed.Poikilotherms cannot control their body temperature. Factors are also very important in determining the outcome.A sequence of events that occurs after any abnormal change in the body.Microbial infection, traumatic damage, or lack of nutrients can cause health problem.In fish disease, it is easier to see the importance of stress factors compared to diseases in other farmed or wild animals. The term "stress" means different things to different groups of employees. Stress is the combination of all the body's responses to try to keep a normal metabolism when faced with a physical or chemical force. A definition that was more closely related to the situation of diseases in fish. He said that stress happens when something in the environment or something else makes an animal react in a way that is more extreme than usual. This can either push their abilities too far, or disrupt their normal functioning so much that their chances of staying alive go down a lot. However, accurately measuring stress has been difficult in pathogenesis research because the concept is applied to many different things. The body's response to environmental stress is called the general adaptation syndrome (GAS).

KEYWORDS:

Cell Death, Heat Shock, Inflammatory Response, Stress, White Blood.

INTRODUCTION

The alarm reaction is when our body goes into high alert in response to a sudden or dangerous situation. Can you please provide the text that you want me to rewrite in simple words. The stage of resistance is when the body is adjusting to a new situation in order to maintain balance and stability. The task is to rephrase the given text using simpler language. This is when someone has reached a point of extreme tiredness and their body can no longer keep up with the changes happening around it. The body is unable to maintain a stable internal environment. The changes that happen during the General Adaptation Syndrome (GAS) are not specific to any particular species or stressor. Things like lack of oxygen, infections, fear, intense physical activity, and anesthesia all lead to similar responses in both higher and lower vertebrates. The way people react to stress will be different for each person, and will include some responses that are specific to that particular stressor, and others that are not. GAS (stress) can cause common changes no matter what kind of stress it is. The happenings in GAS are controlled by the body's hormonal and nervous response.

Adreno-corticotropic hormone (ACTH) and corticosteroids cause the body to retain sodium and chloride ions while getting rid of potassium ions. This leads to higher levels of glucose in the blood and changes in nitrogen metabolism. It also stimulates the thyroid and increases the production of thyroxin. Additionally, it reduces the number of lymphocytes in the blood and increases the number of neutrophils. The sympathetic nervous system also responds, causing the spleen to contract, breathing to speed up, and blood pressure to rise. He wants to make it clear that not all fish show the same changes in their hormones when they are feeling

stressed. For instance, when fish are exposed to pollutants, their response is changed or altered[1]. In 1992, researchers discovered that it can be easily affected by things like how it is taken care of, illnesses, and chemicals. They found that when small amounts of cortisol and ACTH are injected into fish, it makes their white blood cell count go down. But if they inject a lot of ACTH, it makes their white blood cell count go up. Giving a fish small amounts of ACTH or putting it in cold water for a little while can make the number of white blood cells in its body change in the same way. When stress stimulates the HPI axis, it causes cortisol levels in the blood to go up. This leads to a series of events in fish known as the stress response. Injecting cortisone into fish has been proven to cause a slower white blood cell response to inflammation and prevent proper wound healing. When ACTH and corticosteroids are injected into a type of fish called teleost fish, it reduces the number of cells in the lymphoid tissue in the kidney and spleen. However, the thymic tissue, which is different from mammals, does not seem to be affected much by ACTH in fish. In mammals, ACTH destroys cortical thymocytes. Even in fish that were given a harmless saline injection, there was a noticeable amount of tissue death in the kidney and spleen, which was not seen in fish that were not injected. Besides increasing the production of corticosteroids, when the brain's hypothalamus stimulates a tissue called chromaffin tissue, which is typically found in the anterior kidney of fish like salmon, it causes a response in the nervous system and releases catecholamines. These things have effects on other parts of the body, especially on the way blood circulates, how the body regulates water and salt levels, and how it uses energy[2], [3].

Cells usually react to stress by making changes in how genes are used, which makes the levels of a group of proteins called heat shock proteins increase in the blood and tissues. HSP molecules are made when the body is under stress. They not only help the body deal with stress, but they also help fight against cancer and chronic infections. They might also be used to make new vaccines. The HSPs, also called extrinsic chaperones, are a group of very important proteins that are found in different sizes. They are present in many different organisms and help with important cellular processes. Cellular stress causes the production of a substance called kiloDaltons (kDa) ranging from 16 to 100 kDa in all living cells. The text is about how certain genes in cells can be activated by heat or other stressors in both fruit flies and other animals. The years 1989 and 1993 are mentioned in this text. Inside cells, there are proteins called chaperones, also known as HSPs (heat shock proteins). They can be found in the cytoplasm of normal cells that are not under stress. These chaperones make up about 5-10% of the total protein in healthy growing cells. HSPs were discovered to increase when fruit fly cells were exposed to heat. It is now known that HSCs are usually found in the cytoplasm, nucleus, and mitochondria. They are found in all cells and are necessary for many important functions in the body. These functions include keeping proteins in the correct shape, repairing damaged parts of cells, helping with the production of certain proteins and hormones, and maintaining the structure of cell membranes. This is really important for fish and other cold-blooded animals because they have to change their cell membrane lipoproteins when the temperature changes. When cells are put under stress, such as from cold, heat, UV radiation, toxins, pathogens, lack of nutrients, protein breakdown, lack of oxygen, acidity, damage from microbes, or any kind of stress, the cells increase the production of a certain type of proteins called HSPs[4], [5].

The levels of these proteins can be found in the cells at two or three times higher concentrations than the usual proteins, as well as in the fluids around the cells. The text is not provided, so it cannot be rewritten in simpler words. The term stress proteins, which is a broader term, is also used to describe them. The process of producing HSPs is not only caused by heat stress, but can also be caused by any intense stress. When HSPs are increased,

it is usually seen as a response to stress in cells. The control of how heat shock protein genes are turned on or off is done by specific molecules called heat shock factors that interact with certain parts of the genes. Animals and plants HSFs are very similar in their structure, but there are notable differences in how they work and the specific members in different groups of living things. For instance, some bugs like fruit flies have only one HSF. On the other hand, other animals like fish and vertebrates have three or four HSFs. The text is incomplete and does not provide any information to be rewritten in simpler words. Could you please provide more context or content to be simplified. In animals with backbones, HSPs are put into different groups and given names based on what they do, how similar they are to each other, and how heavy they are in kilodaltons. The families mostly consist of different groups of proteins called Hsp100, Hsp90, Hsp70, Hsp60, Hsp40, and some smaller Hsp groups. Many people in the HSP family have partners called HSCs that are present in cells normally without any stress[6], [7].

These are very important in controlling how proteins are made in a cell. HSP families like HSP 90 and HSP 70 are very important for helping other proteins in our cells fold correctly. They also play a role in the process of getting these proteins to their correct location in the cell. These proteins are also involved in regulating how proteins fold, move, and clump together. They also have other important roles in our immune system, programmed cell death, and processes related to inflammation.When cells are exposed to harmful substances, either man-made or from bacteria, proteins inside or on the surface of the cell become damaged. This happens because the bonds holding the proteins together weaken, and the parts of the proteins that don't like water are exposed. This causes mistakes in how proteins fold and group together. He called this damage mechanism proteotoxicity. When cells experience stress, they produce more HSP 90 and HSP 70 to help repair damaged proteins and keep them safe.If stress harms the immune system of an animal, both in general and specific ways, it will become more vulnerable to getting sick. This increase has been discovered in fish. When the body is very tired, certain bacteria from the gut and surroundings can enter a fish and cause harm. Therefore, it is important to be very careful when analyzing bacterial findings in these fish, because sometimes there can be a large number of bacteria that have entered after the fish has died.

However, if the fish are stressed, the presence of harmful microorganisms in their environment is more likely to cause a serious disease outbreak. while the response is adapting to changes During these times, when fish are trying to regain balance in their bodies, the invasion of pathogens adds more weight and becomes a growing obstacle. The biggest thing that causes stress for fish and affects the balance with their surroundings is the temperature of the environment. Every type of living thing has a temperature range that is normal for it. There is also a highest and lowest temperature that it can handle. If the temperature goes outside of these limits, the species cannot survive. As the temperature gets very high or very low, there is a higher chance of getting sick from harmful germs, especially when it's really hot. Temperature can cause disease, even if it's within a normal range. However, it's usually the sudden change in temperature that causes the problem, not the actual temperature itself. Changes in temperature can impact how quickly microorganisms grow. The amount of oxygen in the water, how quickly waste products are removed, and how well the body's defense system and antibody production work are also important factors. Studies have shown that the response of the body's defenses, like phagocytosis and inflammation, to temperature is similar across different species. So, the rate at which the body fights off diseases and heals wounds is constant at a particular temperature. The hotter it gets, the quicker different reactions happen as long as it's a safe temperature for the species. (The white mountain cloud

minnow, which is a tropical species, has the ability to heal quickly at a very fast rate compared to other species at higher altitudes.

DISCUSSION

Atlantic salmon, which are a type of fish that lives in moderately warm areas, are able to tolerate a wide range of temperatures. Many types of fish, especially salmon, die a lot during mating season. These are normally linked with fungal and bacterial attack. In the Pacific salmon, all these deaths happen during their first and only time they spawn. The things that cause stress when a person becomes sexually mature are mostly hormones. However, not having enough food and being tired from traveling can also contribute to stress. In addition, the balance of fluids in the body can also have an effect on stress. The biggest change in hormones is when there is a lot more 17-hydroxycorticosteroids in the blood. This change can be seen under a microscope with increased activity in both the pituitary and adrenal glands. However, once someone is fully grown, the pituitary gland starts to show signs of damage while the adrenal gland becomes enlarged. High blood sugar, linked to the growth of the Islets of Langerhans in the pancreas, has been observed in various species including salmon. As a person reaches sexual maturity, their body begins to produce more gonadotropins. In rainbow trout, it has been discovered that testosterone is transformed into a substance called 5-dihydro-testosterone in the skin. This might explain the big changes that happen to the tissue structure and how likely it is to get infected in grown-up men. In 1995, Other changes that occur, which make spawning salmon more vulnerable, include alterations in the arteries of the heart and deterioration of the kidneys[8].

The inflammatory response is the natural way our bodies protect against tissue damage, regardless of the cause. This response happens in all animals with backbones. This means that when there is an injury, certain changes occur in the affected tissue. However, these changes only happen if the injury is not so severe that it completely destroys the tissue. The order of events is mostly the same in all levels of vertebrate evolution. However, in creatures whose body temperature changes with the environment, like poikilotherms, the speed at which these events occur is influenced by the temperature. The signs of inflammation in animals heat, redness, swelling, pain, and loss of function - have been known since ancient Rome. Each of these signs can be related to different aspects of the inflammatory process. However, it is unclear if warmth can be seen as an important indication in animals that rely on their environment for body temperature, rather than producing their own heat. The main things needed for an inflammatory response are to keep the injured tissue intact and to have a working blood supply. The inflammatory response doesn't have a specific target. After getting hurt, exposed to radiation, infected by bacteria or viruses, or harmed by chemicals or toxins, the body reacts by becoming inflamed. In the past, people believed that inflammation was mainly a way to protect the body. However, it is now known that inflammatory reactions can actually cause or greatly contribute to many serious illnesses. In most cases, the body's response to an insult at a certain location includes cells and fluids that work together to maintain balance, even when faced with the insult.

They also give the details of where the insult happened and how the problem can be solved easily. The way an inflamed area looks depends on the tissue, how long it has been inflamed, what caused the injury, and the temperature. However, there is a general pattern that happens when our body responds to inflammation. The main thing that sets off the body's inflammatory response is when dead cells release signals, which starts a chain reaction of events in the body's defense system. One of the main signals is the release of HSPs. Some of the heat shock proteins (HSPs) can also bind to proteins that are not normally found in the body, such as viral or toxin antigens that come from damaged cells. These HSPs, whether

complexed or not, have various roles in the inflammation process. They help in the production of cytokines and activate macrophages. However, there are some cells in the body that are constantly going through a natural process called apoptosis, which is programmed cell death. In the past few years, scientists have discovered that certain viruses can cause a process called apoptosis. This can happen either directly, for example with alphaviruses or adenoviruses, or indirectly by affecting how cells function. The text is quite short and already simple to understand. When cells die naturally, they release substances that can cause inflammation. However, when cells die through a process called apoptosis, the debris they produce does not cause inflammation[9], [10].

They said that HSPs act as signals for inflammation and also help the immune system by carrying antigens. Some proteins help start an immune response when the body is under stress. These proteins work together with antigens to cause inflammation. On the other hand, normal cell death is controlled by different proteins called HSP 90, which don't need to work with other proteins to have an effect. If a cell is not stressed, it will not trigger an inflammatory response when undergoing apoptosis.When cells in our body are stressed because of things like injury or blocked blood vessels, they release signals that start inflammation. These cells are not dying in the usual way. This may not last for a long time but it is unusual. This is about identifying different signals that come from damaged tissues. These signals help us tell the difference between infections, healthy cells, and abnormal cell damage. These molecular patterns include different types of HSP that have been rated higher. These signals are decoded by receptors. Depending on the meaning of the signal, they either activate, change, or stop an immune response. Endogenous HSPs are signals released by tissue damage that activate our immune responses.

These substances are increased when the body is under stress and are released by cells that are stressed, infected, damaged, or cancerous. However, they are not released by cells that are undergoing a natural cell death process. In simple words: Certain chemicals in the body, specifically those in mast cells, are strong triggers for inflammation. One of the main chemicals is called 5-hydroxy-tryptamine. They can come out from any damaged tissue because most tissues have some mast cells. The first steps of acute inflammation happen when certain chemicals and signals from damaged cells affect the blood vessels and surrounding tissues. These things make the small blood vessels get bigger, bring more blood to the area, and make the openings in the vessels wider. This allows big protein molecules, like fibrinogen and immunoglobulins, that are usually kept in the blood, to get out into the tissue. White blood cells move through small openings called fenestrae to enter the tissue that is affected. Cellular migration depends a lot on the thing that is making it happen. This is especially true in certain bacterial infections caused by aeromonads.

The proteins in the serum that go into the tissues have an impact on the body through their antibodies and other compounds that work together. Fibrinogen, which is activated when prothrombin is released from thrombocytes, forms fibrin to create a framework of fibrous strands around the injury. Neutrophils are a type of white blood cell called polymorphonuclear leukocytes. These cells are often the first to leave blood vessels and are important because they have lysosomes. The cells use these substances to kill organisms they have eaten. When the cell dies, the substances are released and destroy nearby tissues as well as other cells. This process creates a buildup of cells, fluid, and dead tissue called an abscess. Neutrophils are not as important in fish inflammation as they are in larger animals. In the beginning of an inflammation, they can be seen in large numbers, but usually not in the later stages. Therefore, abscesses are not commonly found in fish. Monocytes are a type of immune cell called mononuclear macrophages. These cells, along with other cells in the area

that have increased in number due to inflammation, engulf and remove the damaged tissue and harmful substances. These factors in the immune response called MIF and MAF can affect them and make them active. They seem to be the most important cells that enter tissues during inflammation, and can change into big cells called 'giant' cells.

When cells are damaged but not deadly, the damage can often be repaired when the thing causing the damage is taken away. When cells are damaged in a way that doesn't kill them, their sodium pump mechanism at the cell membrane often stops working properly. This causes fluid to build up inside the cell. When there is a small difference, the cells get bigger and look slightly grainy or less clear. This change is called cloudy swelling and it can be reversed. If it is very serious, it causes a condition called osmotically driven hydropic or vacuolar degeneration. This condition makes the cytoplasm move away and be replaced by large clear vacuoles. Changes in the nucleus of a cell that can be undone are not very noticeable, but there might be a gathering of tiny particles inside the nucleus. If the sodium pump stops working for a long time, the proteins in the cells can change because the charge of the electrolytes is different.

This can make the inside of the cells look shiny in certain parts. This is called hyaline degeneration and it often happens when a muscle is injured. In fish with severe stress or poisoning, a change happens in the liver cells. This change makes the cells shrink and become very dark. The nucleus also becomes very condensed. If the harmful effect that causes changes that can be undone is very strong, the cell will die, causing changes that cannot be undone. At a microscopic level, the first sign of damage is seen in the mitochondria, which are parts of cells. However, the most clear and irreversible damage to the cell is usually found in the nucleus. Cell death can be seen under a light microscope when looking at tissue samples. This process of cell death in a fish can happen quickly or slowly. The changes that happen will also be different depending on the situation. The breaking down of cells caused by the release of certain enzymes from small cell structures called lysosomes takes different amounts of time, especially in fish where it depends on their body temperature and the temperature outside when the cells were damaged[11], [12].

Colliquative or liquefactive necrosis is a type of tissue death where the affected area becomes liquid or watery. This happens when there is a lot of water in tissues, like in the brain, or when enzymes are released that quickly break down cells. This is mostly found in abscesses in mammals, but it can also happen in acute furunculosis and vibriosis of teleost fish. The liquid formation happens because of enzymes or toxins released by cells or bacteria. Coagulative necrosis is when cells in the body die because of a lack of blood supply and oxygen. This causes the cells to change in shape and become dry and firm. This happens when an area doesn't get enough blood because of a blockage or other problem. In this section, coagulative necrosis can be seen as a light pink area where the cell nuclei are destroyed but the shapes of the cells can still be seen. This usually happens in the middle of fast-growing tumors or tubercles and in a long-term bacterial condition called bacterial kidney disease. When bacteria that eat dead tissue invade a part of the body where dead tissue has formed, the condition is called "gangrenous. Fat necrosis is a condition where the fatty tissues in the body die. This is a type of cell death that causes fat tissues to turn into soap-like substances. This is often linked to a condition called acute pancreatitis. In acute pancreatitis, enzymes called lipases are released by damaged cells and they affect fat cells all over the front part of the abdomen. Usually, this is found in a virus disease called infectious pancreatic necrosis (IPN) that affects salmon. In simple terms, the fat cell looks grainy inside and has a faint shady outline.

Apoptosis is when cells naturally die and are removed from a tissue when they have lived their full lifespan. This can be recognized as different from necrosis because it only affects one cell, while necrosis usually affects multiple cells next to each other. This means that in this case, cells undergo a specific process where they develop a very dark and condensed nucleus, and the overall size of the cell gets smaller. The dying cell can be distinguished under a microscope by its very dark broken nucleus and the tightly packed cytoplasm. These cells are easily identifiable because they don't cause an inflammation response from the body. However, they do lead to cell death and are eventually consumed by other cells if the animal stays alive.The information in this section is mostly derived from studying clinical samples and observing how they relate to disease, instead of conducting extensive experiments. There is not enough information about the nervous system and endocrine system, and this needs to be addressed urgently. The person can then think about how these systems might be affected by different things that can cause problems, and make a knowledgeable diagnosis. The skin of a fish is well-suited to its needs as a protective barrier in its natural environment. However, because it is delicate, it can easily be harmed in fish farms or dirty water. This can cause problems with regulating its body's water levels and lead to infections from bacteria.

Changes in the skin are the things we can easily see when looking at fish. The most obvious changes are injuries and different colors, but there are many other ways the skin can respond. It is best to think about these responses based on where they happen on the skin. It is hard to study the cuticle using standard techniques because it is delicate and easily damaged. When you come into contact with a lot of germs and harmful substances, your body can become thicker or change its texture. This makes it look bluish or greyish in certain light. This surface effect is very noticeable in infections caused by protozoa. The protective layers that cover the skin and gills of our body release substances to keep them healthy. They work by using the natural germ-fighting abilities of the mucus and by carrying antibodies, lysozymes, complement, C-reactive proteins, and kinins that are made in the skin layers. If the mucus and cell processes on the skin fail to keep it clean, then infection may happen. In intensive culture systems, things like how much organic matter there is and how many bacteria there are, especially if there is decaying food or waste, can cause an increase in the number of protozoa that eat bacteria, like Trichodina sp.

Many of these creatures can enter the skin and cause problems by attracting other harmful bacteria. The outer layer of your skin, called the epidermis, does not have blood vessels, so it has limited ability to respond to changes. These changes often indicate a disease in the deeper tissues. In cases where the response is more than just the normal wear and tear, it usually starts with a blood vessel change in the skin. The first sign of an inflammatory response in the skin of fish is when the cells start to separate from each other due to fluid buildup. When the outer skin cells die, they can change in a way that causes the nucleus and cytoplasm to break apart. This leads to strange clumps of dark-staining genetic material spreading in the area. The most common reason for these skin problems is when certain types of bacteria, like Aeromonas spp. and Pseudomonas spp. , release harmful substances called toxins. and Vibrio anguillarum in the deeper layers of the skin. When there are long-term inflammatory injuries in the skin, it often causes less severe swelling on the top layer of the skin. This swelling may have lymph cells or, if there has been a lot of damage to the skin's pigment cells, certain cells within the top layer of the skin may have many dark pigment particles in them. Hyperplasia is a common occurrence in fish skin, where cells multiply and expand. This happens at all levels and is often accompanied by swelling. Chemical pollutants, hormonal triggers, and a type of bacteria called Flexibacter sp. are some of the reasons why something happens. And suspected viruses, and it is a common result of skin problems.

Epidermal hyperplasia is a condition that occurs more often in all species studied when it is colder. In young salmon, having too many skin cells and developing too quickly can lead to a skin infection caused by Flavobacterium bacteria. This is more likely to happen if the fish stay in salt water during their breeding season. Changes in the skin layers called the dermis and hypodermis should be examined together when studying diseases because they both react to the condition. The dermis, which is a type of tissue, has been the most commonly studied part of the skin when it comes to inflammation and the healing of wounds in fish called teleosts. Most studies have focused on salmon, but a few have also looked at other types of fish called pleuronectids. Most people agree that fish and mammals have a similar reaction when they experience acute inflammation. The reaction has three phases a blood vessel, a fluid leakage, and a cell part. How long each phase lasts depends on the temperature. Certain skin infections are linked to aeromonad diseases, particularly furunculosis in fish like salmon. In this disease, the bacteria cause a serious tissue infection that produces a lesion with dead cells, bacteria, and an exudate that contains a thick, fibrous substance and inflammation. These sores eventually burst open and release infectious material into the water. Fish that have these sores when stressed are a big cause of contagious outbreaks.

CONCLUSION

It is rare, but sometimes happens with deep injuries. These may cause bones to break and become infected, which makes them unable to heal. One type of injury in sea bream fish, caused by Aeromonashydrophila, resulted in the death of spinal bones and spreading to the tissue of the spinal cord. This caused the fish to lose movement in their back end. Some workers have described problems with the bones in the spine that are caused by being exposed to pollutants. These include a type of mineral called zinc, a type of chemicals called organochlorine and organophosphate, and a type of chemicals called carbamate. The person has a condition that is likely a type of fluorosis. It caused their bones to grow excessively because the cells responsible for building bones, called osteoblasts, were either stuck or multiplying too much in their spine. This caused the growth of the bones in the spine to go higher than previously known. These faults may not show up until later, usually in bigger fish that already had spine problems, because of how they were handled or transported. Bacterial infection, specifically if caused by organisms that lead to chronic granulomas, can cause the formation of sores in the periosteum or nearby tissues. Usually, the lesion grows into the softer tissue, but sometimes it can damage the bone. This doesn't happen often, but it has been linked specifically to injuries that go deep inside the body. These things can cause breaks in your bones, and those breaks can also get infected which stops them from healing. The problem was caused by a bacteria called Aeromonashydrophila. This bacteria caused damage to the backbones of the fish and even reached the tissue of the spinal cord, causing paralysis in the back part of the fish. Some people have found that pollution can cause problems with the bones in your spine. This includes zinc, chemicals called organochlorine, organophosphate, and carbamate. Sheepshead minnows had a unique problem with their spine because they were exposed to a weed killer called trifluralin. This illness is likely a type of fluorosis, which caused the bones in the spine to grow too much because of too many osteoblasts. This caused the spinal bones to grow and press on something above them.

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CHAPTER 4

IMMUOLOGY OF FISH: EXPLORING CELLULAR DEFENCES MECHANISM

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ABSTRACT:

The first type is found in all living things and is called nonspecific because it can be triggered by many different things like germs or powders. Specific ways of responding to stimuli are only found in animals with backbones, and these ways of responding are unique because they are triggered by and aimed at the specific molecular structure of the stimulus. When an antigen enters the body, it activates the immune system to recognize and destroy it. This immune response is important for protecting the body against infections and diseases. Antibody production is also called antigens. Normally, proteins or microorganisms are called antigens. However, it's important to know that big molecules have various parts that can cause antibodies to respond and attach in different ways. These places are called antigenic determinant sites, or epitopes. The defense mechanisms can be split into specific and nonspecific groups, but it's important to know that they work together in the body and rely on each other in many ways. For instance, macrophages can eat up a lot of bacteria, but they are much better at it if the bacteria have antibodies on them. However, macrophages need to handle antigens before the lymphoid system can react in a particular way. The defense factors that protect against a specific disease is a complicated mix of different mechanisms that help to fight off infections. This chapter will explain how our bodies defend against germs and infections. These mechanisms serve as the body's initial protection against any invading pathogens. They don't have the ability to recognize specific pathogens but instead provide a general barrier to prevent their entry or limit their spread. These nonspecific factors can include physical barriers, such as the skin and mucus membranes, as well as chemical barriers, such as enzymes and natural substances in the body that can kill or inhibit the growth of pathogens. Overall, the first-line defence mechanisms work quickly and are always ready to defend the body against harmful invaders. Some things in our bodies are always there, but they can change when we get sick. The immune system has special ways to fight off infections that require changes in the lymph nodes. These methods are part of the second line of defense.

KEYWORDS:

Blood Cells, Dendritic Cells, Germinal Centers, Mast Cells, White Blood.

INTRODUCTION

All animals can experience different types of stress. When animals feel stressed, their bodies react in similar ways using similar methods. So, the living thing reacts to a problem that could be dangerous for its overall wellbeing. This response involves three main regulatory systems: the brain, hormones, and the immune system. In fish and other small animals, the body's reaction to stress has been well studied. It involves certain hormones that play important roles in this response. Therefore, when we're stressed, our brain sends a signal to start the sympathetic-chromaffin axis. This makes our body produce and quickly release catecholamines into our bloodstream. Other stress hormones, like corticosteroid releasing hormone (CRH), adrenocorticotropic hormone (ACTH), and cortisol, are produced by a part

of the brain called the hypothalamic-pituitary-interrenal axis. Cortisol is a hormone in fish that shows how stressed they are. But, we don't know much about the cortisol levels or how stress affects the secretion in other fluids found in fish, like the mucus on their skin, in their guts, gills, or bile. We also don't know how these fluids or the fish's body react when they are stressed. A new study has used a different method to solve a big problem that stress studies have when trying to find signs of long-lasting stress in fish farms. As a result of checking cortisol levels in scales, researchers could determine if a fish was stressed at that time and if it had experienced stress before[1], [2].

Fish react differently to different stressors at different levels of their body. These levels include gene, molecular, cellular, systemic, and performance responses. The traditional idea is that the body's stress response occurs after the brain detects stress and sends signals to release certain hormones. These hormones help the body respond to stressful situations, but eventually the body returns to its normal state. If we assume that these mechanisms exist, there is a problem with this traditional idea because it doesn't take into account some of the smaller reactions and how they affect the overall stress response. Therefore, the things that cause stress can make certain sensors in our body react and cause a reaction in certain parts of our body. These parts are usually the ones that are in contact with the outside world, like our gills, nose, stomach, and skin. The changes in the mucosal tissues will cause changes in specific receptors in that area. These changes can also release substances like hormones and peptides that will affect the overall body's response. In this situation, it means that the way we understand things is happening more in specific body parts rather than in our brain or nerves. For example, germs, small amounts of harmful substances, or certain types of food can cause a reaction in a specific area of the body. This reaction will then cause a larger response in the brain, pituitary gland, or head kidney. Furthermore, when examining how organisms respond to stress in their gills or gut, the findings indicate a general response that involves various regulatory pathways like oxidative, immune, or endocrine[3], [4].

The connection between the endocrine and immune system after stress has been extensively explained. Multiple studies have shown that when animals are stressed, their immune system becomes weaker. This can make them more likely to get sick from germs and can also make vaccines less effective. But we don't know much about how fish are affected by immune suppression. Stress can have different effects on the immune system in fish. One effect is that there is an increase in neutrophils, which are a type of white blood cell. Another effect is that there is a reduction in the number of lymphocytes, which are another type of white blood cell, and a decrease in the body's ability to make antibodies. Stress can also reduce the activity of a certain protein called complement and decrease the production of certain chemicals called cytokines. These effects are caused by the release of a hormone called cortisol. The absence of instruments to identify and distinguish different types of immune cells has made it very difficult to study how stress affects specific groups of cells. So far, not many research studies have been done to understand how stress affects immune cells like B or T lymphocytes. Furthermore, currently, we have limited knowledge about the impact of vaccines that focus on mucosal surfaces instead of B-lymphocytes. In this review, we will talk about B-cells and how stress and vaccines can affect them at the mucosa surface[5], [6].

B-lymphocytes are a type of immune cells that play a role in defending the body against invaders. Mucosal immunity refers to the immune system's response in the mucosal areas, such as the respiratory and digestive tracts. This article focuses on studying the interaction between B-lymphocytes and mucosal immunity in fish.A type of cells called B-lymphocytes are found in all animals with a backbone. These cells make antibodies that help protect the body against infections and diseases. This function has remained the same for a very long

time in the process of evolution. Interestingly, B cells have natural abilities like eating up harmful things, making antibodies on their own, or producing certain chemicals that are also found in other living things. Lampreys have a type of cells called VLR-B cells. But, fish were the first animals to have cells called B cells and make immunoglobulins (Igs). B cells are responsible for making antibodies, which are also known as Ig. Igs are made up of heavy and light chains. They have a constant region that is the same for all Igs of the same type, and it is made up of heavy chains. They also have a variable region that gives them their unique properties, and it is made up of both heavy and light chains. Fish have three types of antibodies that are found on their B-cells.

These antibodies are called IgM, IgT (or IgZ in some species), and IgD. Although teleosts have different isotypes, they do not have the ability to switch classes through a process called class switch recombination. Interestingly, a special enzyme called activation-induced cytidine deaminase (AID) is involved in this process. This enzyme exists in fish and is even able to cause a process called CSR when it is put into a mouse. Therefore, the reason why rainbow trout and zebrafish produce different isotypes is because of the way their heavy chain locus is structured. This means that when the IgM isotype is being expressed, the generation of IgT/IgZ transcripts is blocked, and vice versa. This has been proven true in rainbow trout and zebrafish. Rainbow trout have a type of B cells that only express IgT, while zebrafish have a type of B cells that only express IgZ. In carp fish, scientists have found two types of IgZ called IgZ1 and IgZ2. These two types of IgZ are expressed differently in different parts of the fish's body like the whole body or the lining of the body. This situation is a lot like what happens in people, where there are two IgA present and how much they show up is different depending on the part of the body. Teleosts have two types of IgD+ B cells. IgD+/IgM− B cells found in channel catfish and European rainbow trout; IgD+/IgM+ B cells found in all teleost species studied so far. In American rainbow trout, we have not yet described a population that has IgD+ but not IgM.

Besides their ability to adapt, B-lymphocytes also have a few natural abilities, like being able to engulf and destroy harmful substances, making their own antibodies without prior exposure, and producing certain signaling molecules called cytokines. Mammals and fish have B-cells that can naturally defend the body, but their level of importance in protecting the organism may be different in certain situations. For example, in mammals, phagocytic B cells are found in the abdomen and liver and make up 5-15% of all B cells in those areas. However, in fish, phagocytic B cells are found in all parts of the body, such as the blood, spleen, and head-kidney, and make up 60% of all B cells. So, it seems that B cells are more important in fish than in mammals. It is important to mention that dendritic cells are a main type of cell in the body's natural defense system in mammals. They connect the body's initial defense response with a more specific and targeted defense response. Dendritic cells are important for the immune system in mammals. They must interact with T cells to start the adaptive immune response. But in fish, the presence and role of dendritic cells is not well known. Their function and where they are found in the fish's body is still not well understood. So, unlike B cells, fish dendritic cells are not as common as their mammalian counterparts and haven't been found in all parts of the body yet. So, it is very likely that fish B cells are doing some of the jobs that dendritic cells do in mammals. In teleost fish, B-lymphocytes play a big role in connecting innate and adaptive immune responses. As a result, B cells in vaccination are important for both producing specific antibodies and initiating the initial response. Therefore, the natural abilities of B cells, which have not been studied much after getting a vaccine or infection, will greatly contribute to the effectiveness of the vaccine[7], [8].

How fish and other animals respond to vaccines or challenges includes both overall and specific reactions. So, the main organs in charge of making white blood cells, increasing T cells, and capturing antigens in the body are the head kidney, thymus, and spleen. Local response occurs in all parts of the body where the immune system fights off germs using natural defense mechanisms like lysozyme, lectins, proteases, complement proteins, and antibodies. This helps keep the tissues safe from harmful bacteria and viruses. So, when there is an outbreak, both the central and local responses are activated. The local response can start working in a specific area without the central organs being activated yet. The responses that happen in the fish's mucosal are a type of independent local responses. So, the inside parts of our body that are in contact with the outside world are always collecting information, making changes, and staying balanced to keep animals alive. Any disturbance in the balance of the body, like a stressful situation, can cause a problem that might harm an animal's health.

These mucosal surfaces have different jobs, like taking in nutrients, exchanging gases, and protecting against infections. Mucosae are parts of the body that can fight off germs and protect us from getting sick. They can do this in both animals with backbones and some animals without backbones. Despite the big differences in how animals look, all vertebrates have special tissues in their bodies called mucosal-associated lymphoid tissues (MALT). These tissues help control the immune system when there are problems in the mucosal areas of the body. In teleost, there are four types of MALTs: nose-related lymphoid tissue, skin-related lymphoid tissue, gill-related lymphoid tissue, and gut-related lymphoid tissue. These four tissues have some similar characteristics. First, they do not have organized lymphoid structures like lymphoid nodes or germinal centers, so leukocytes are spread out in the tissues. Second, they have secretory Igs in the mucus, which are moved into the cavity by a polymeric Ig receptor. Third, they have a special type of immunoglobulin called IgT/Z that is found in the mucus. Lastly, they have bacteria that live in the tissues, and some of these bacteria are covered with Igs.

DISCUSSION

In animals like mammals, these cells are important for fighting off infections and protecting the body. Some fish have certain cells in their blood that look similar to cells found in mammals, specifically eosinophils and basophils. However, not much research has been done on these cells to understand their functions. But now we are starting to understand that some fish have cells that are equivalent to mast cells. Many animals have eosinophilic granular cells (EGCs) in their skin and gills. the inner lining of the digestive system Salmonids are a type of fish. They look similar to mast cells, but the staining of the granules is slightly different. Unlike mammalian mast cells, their granules do not change color when stained. However, scientists can use special techniques to show specific color reactions in the cells of fish through histological processing.

Fish EGCs are similar to the mast cells in mammals. Recently, they have found serotonin in EGCs but not histamine. However, a new study has found that perciformes have histamine in their bodies. This study also suggests that the effects of histamine are controlled by certain receptors. This means that the storage of histamine in mast cells has happened at least two times in the evolution of animals with backbones. In mammals, mast cells release stored substances called vasoactive amines. This can happen in different ways, such as when the body is sensitized with immunoglobulin E (IgE), when certain components of the immune system called complement are activated, or when certain enzymes or compounds like compound 48/80 are present. We don't know much about how EGC or mast cells release their contents in fish. Fish do not have IgE, and it is very uncommon to hear of fish having severe allergic reactions that cannot be replicated. But, if fish EGC or mast cells are exposed to

compound, they can release their stored substances and cause blood vessel reactions and skin reactions similar to allergies. So, it might be possible that in fish, a process called EGC or mast cell degranulation is controlled by CRP or complement. These AMPs are molecules that have antimicrobial properties, meaning they can kill or inhibit the growth of microorganisms like bacteria and fungi. When a harmful germ enters the body, it triggers a complex response called inflammation. This response involves many defense mechanisms that help the body fight off the germ. The causes and effects of inflammation are explained in another part of this book. It is enough to mention here that these characteristics are seen in both fish and mammals. The main things that happen in acute inflammation are widening of blood vessels and white blood cells moving from the blood to the site of inflammation[9], [10].

Fish have mechanisms that are similar to mammals for inflammation, but they may not have histamine like mammals do. This means they may use different substances to cause inflammation. The body's response to an injury or infection happens in two phases. In the first phase, there is an increase in a type of white blood cells called neutrophils. These neutrophils move from the blood vessels to the site of inflammation. In the second phase, monocytes and macrophages appear at the site of inflammation. Neutrophils gather quickly after an inflammatory trigger and reach their highest level within 1-2 days. Inflammation happens when our body gets hurt or when we have an infection. There are different substances that help stimulate and control this inflammation, such as hydrogen peroxide, certain chemicals that change how our blood vessels work, substances that help our immune system attack germs, and certain proteins and hormones that help with communication between cells. Quick-acting substances like hydrogen peroxide and serotonin start the reaction, with hydrogen peroxide levels appearing within 5 minutes of injury. Afterwards, substances like eicosanoids and cytokines draw in and stimulate white blood cells. When the leucocytes reach the inflamed area, they release substances that control the response. This usually happens because they are stimulated by their PRRs. Fish have C3 and C5 components that break down into C3a and C5a compounds. These substances might cause the release of certain chemicals from certain cells in our bodies. C5a really attracts neutrophils. Eicosanoids are substances made from specific types of fat in our bodies. These substances can cause inflammation and have strong effects on our immune system. Cells release them shortly after they are made in response to stimulation[11], [12].

These are different substances in the body called prostaglandins, thromboxanes, leukotrienes, and lipoxins. These molecules are released by fish white blood cells like macrophages, neutrophils, and thrombocytes. LTs and LXs help fish neutrophils to attack and eat foreign particles, and they also strongly attract them to the site of infection. PGs interact with substances in the body that cause blood vessels to expand and become more permeable. However, they also reduce certain reactions in cells, such as the release of oxygen by certain immune cells, the growth of certain white blood cells, and the production of antibodies. A type of cyclooxygenase called COX-2, which makes prostaglandins, can be triggered by inflammation in fish. Some chemicals called cytokines are part of the body's response to inflammation in fish. These are substances called IL-1β, TNF-α, and IL-6. They cause inflammation in mammals when there is an infection with certain types of bacteria. In fish, IL - 1 β is released by different types of cells, like epithelial cells, macrophages, monocytes, and neutrophils. This happens when the fish is exposed to crude bacterial lipopolysaccharide or purified peptidoglycan a substance found in crude LPS.

IL-6 is found in the same types of cells and it helps to increase the production of AMPs like hepcidin and cathelicidin-2, but not cathelicidin-1. This shows that the genes that respond to IL-6 are very specific. Chemokines like IL-8 (or CXCL8) are also sent out to attract and

activate neutrophils. Cytokines also help reduce inflammation to protect cells and prevent autoimmune reactions. Specifically, when fish macrophages produce a substance called transforming growth factor - β 1 (TGF - β 1), it helps reduce inflammation in the body. In goldfish, when bacteria or TNF-α stimulate the macrophages, they produce TGF-β1. This TGF-β1 protein then stops the macrophages from making nitric oxide when TNF-α is present. Neuroendocrine factors, such as fish growth hormone and certain neurotransmitters, can make phagocytes produce more oxygen, which helps in fighting infections. This shows that the endocrine and nervous systems can control and regulate inflammation and the ability of phagocytes to engulf and destroy harmful substances in fish. White blood cells release many of the substances mentioned above when they are activated by special receptors that recognize patterns found on harmful bacteria or viruses. sugars), lipopolysaccharides (LPS) found in the outer membrane of Gram-negative bacteria, lipoteichoic acids (LTAs) found in the cell walls of Gram-positive bacteria, flagellin (a protein found in bacterial flagella), and bacterial DNA.

These molecules can trigger an immune response when recognized by receptors on immune cells. LPS and mannose), and nucleic acids (like DNA and RNA). Bacterial or viral genetic material (DNA or RNA), proteins called flagellin, substances called peptidoglycans and lipoteichoic acids from certain types of bacteria, proteins called lipoproteins, and substances called fungal glucans. The PRRs are a group of receptors called Toll-like receptors (TLR), which are found on the outer part of white blood cells or inside cells. There are many different types of fish that have family members similar to 13 genes found in humans and mice. These fish include representatives from all six major subfamilies. Some genes in fish (e. gTLR - 1, - 3, - 4, - 5, - 7, and - 11) have extra copies due to duplication events. We are still figuring out the specific traits of the fish TLR, but some studies have found both similarities and differences compared to the TLR in mammals. There are different types of proteins inside cells that can sense and detect harmful substances that enter the cell's cytoplasm. These PRRs are found in the cytoplasm and are responsible for detecting viruses (RLRs) and bacteria (NLRs). People from both groups in fish are recognized, with the first group consisting of RIG-1, MDA5, and LGP2. Research shows that these groups activate antiviral responses in fish cell lines.

In birds and mammals, the spleen and lymph nodes have special places called germinal centres. Dendritic cells in the germinal centers collect immune complexes using receptors on their surface that interact with complement. Special memory cells that are specific to the antigen and are trapped in the germinal centers can be found there. These memory cells are able to find their way back to the germinal centers. These structures are thought to be important in how the immune system remembers and defends against diseases. Fish and other cold-blooded animals do not have germinal centers like mammals do, but they can remember previous infections and their immune response is similar to germinal centers found in mammals. When the soluble antigen is injected, it takes some time for the lymphoid tissues to start absorbing it. This only happens after antibodies can be detected in the bloodstream. Right now, antigens and antibodies get stuck in the reticulin fibers of the spleen and also on the surface of cells within the MMC. This substance stays in the MMC for a long time, usually up to one year. The antigen is likely stuck in an immune complex and gets trapped right away when immune complexes are injected into the ellipsoids. The antigen-antibody complexes are mainly held outside of cells.

In the kidney, antigens are mostly absorbed by certain cells called reticuloendothelial cells. These cells break down the antigens quickly inside them. However, some antigens still remain on the outside of certain cells in the kidney called MMC cells. The capture of tiny

substances called Aeromonashydrophilabacterin is a little different. After they are injected, they are quickly taken up by special cells called macrophages in the spleen and kidney in a similar way to how carbon particles are taken up. But when antibodies are made, the antigen can be found outside the cells. It is first found on the reticulin fibers of ellipsoids and then on the surface of cells in a certain part of the body, which is similar to how soluble antigens are located. Antigen always stays with Ig in these areas outside of cells. The reason why soluble antigen and particulate antigen are taken up differently by cells is likely because bacterial particles are easier to be engulfed by the cells. Therefore, although the first absorption of tiny particles is similar to that of carbon inside certain immune cells, the way they are contained afterward is different. Carbon stays inside the cells, while the antigen is found outside the cells on certain structures called reticulin fibers and also on the surface of cells within the immune system. We do not yet fully understand the importance of antigen trapping in fish. The functions of antibodies include protecting against viruses and toxins, activating the immune system, and helping to fight bacteria.

Bacteria and viruses are types of tiny organisms. Antibodies are a type of proteins called immunoglobulins (Ig). In teleost fish, there are three different types of Ig known so far. These types are IgM, IgD, and IgT also known as IgZ. The B cells that make these Igs seem to be separate from each other, especially for making IgM and IgT, it was discovered that there are different types of B cells in fish. The main part of Ig is made up of two heavy chains and two light chains. These chains together make a region that can bind to an antigen. The classification of the Ig class is determined by the physical and chemical properties of the H chains. In mammals, IgM in the blood is made up of five basic units called pentamers. In teleosts, IgM in the blood is made up of four basic units called tetramers.

However, in some species, there can be a form of IgM in the blood that is made up of only one basic unit called a monomer. IgT in the blood is always made up of one basic unit called a monomer. Ig is also found in the mucus of the skin and gut, as well as in bile. New research suggests that cells that produce IgT may be important for producing Ig in mucosal areas. In the gut, IgT is present as a polymer in mucus. This information agrees with previous experiments using labeled homologous Ig, which found that the antibody found in bile and on the skin did not come from the blood. The text is talking about the transfer of antibodies and genetic material from a mother to her offspring, possibly in fishes called plaice and carp. The health of parent fish can affect the immune system of their babies.

CONCLUSION

As we mentioned earlier, there is still a lot we don't understand about how teleosts respond to mucosal infections. This includes how hormones and the immune system play a role in keeping things balanced in the mucosal areas of their bodies. Concerning the body's response system, there are special cells in the gut, gills, and skin that produce hormones. One hormone called cortisol is found in the mucus of the skin and gut. So, hormones also play a big role in the various processes that happen in mucosal tissues. As said earlier, all the tissues inside fish that cover surfaces like the inside of their mouths have MALT, which helps control their immune system. In recent years, there have been important advancements in understanding mucosal immunity. For example, we have found salmonid ILT and discovered IgT as a type of mucosal immunoglobulin. We have also identified a functional NALT. However, we still do not fully understand the connections between the immune and endocrine systems in the gut, skin, gills, or nose. Even though it is well-known that stress affects our immune system, there are still gaps in our understanding. Most of the research on stress and the immune system focuses on gene activity, and very few studies have looked at how cells or proteins respond to stress. So, it looks like interrenal cells are the ones that make cortisol the most.

But we don't know for sure if these cells that make cortisol are only found in the head kidney or maybe also in some other parts of the body, although it's not very likely. This means that the body can produce cortisol in certain areas, similar to how the immune system can react in specific places when triggered.

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CHAPTER 5

EXPLORING THE NEOPLASIA OF FISH: CAUSES, SYMPTOMS AND PREVENTATION METHODS

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ABSTRACT:

Just like in bigger animals, fishes can also get a disease called neoplasia. Fishes are the biggest group of animals with backbones. But, cancer in fishes is usually not harmful and only a few have malignant disease. The goal of this discussion is to give a general idea about cancer and the different types of cancer diseases in fishes based on their organ systems. This includes a few types of cancer that are common in aquatic or exotic animals. The talk also discusses the different noncancerous problems in fish that might be mistaken for cancer, and how cancer in fish is mostly treated with surgery.It is difficult to exactly define neoplasia, but the definition we have here excludes certain things like the growth of new tissue during long-lasting inflammation, parasite infections, the healing process of wounds, and a specific type of inflammation called granulomatosis. Cancer growth usually involves cells dividing more frequently and becoming less specialized. Although these cells are still part of the body and rely on its blood supply and supporting connective tissue, they do not respond to the usual limits on cell growth like other cells of their kind.

KEYWORDS:

Blood Vessels, Blood Supply, Cancer, Fish, Tumors.

INTRODUCTION

As fish are living longer under human care because of better ways of taking care of them, improved technology and better veterinary care, cases of cancer are being observed more often. Fish are being more and more used in laboratories to study how cancer develops, and they are also being used to help monitor and detect pollution in the environment. Some examples of tumors in fish are hemangioma, hemangioendothelioma, and hemangiosarcoma. These tumors can be either benign, intermediate, or malignant and affect the cells lining the fish's blood vessels. Hemangiopericytomas are tumors that can also be found in fish. These tumors are made of a type of cell called pericytes, which are found next to the walls of small blood vessels. Newer reports have found hemangiomas in scamp fish called Mycteropercaphenax. In 1985, a type of cancer called hemangiopericytoma was found in rainbow trout. In 1991, a goldfish had a similar type of cancer called hemangiopericytoma. In the same year, a disease outbreak happened in man grove killifish, causing them to develop tumors in their hearts. Both the male fish called giomas and a type of cancer called hemangiosarcomas were observed in laboratory zebrafish Danio rerio that were intentionally exposed to a substance called 7,12 dimethylbenzaanthracene[1], [2].

To our understanding, this is the first report of a type of cancer called hemangiosarcoma in common carp. The text is talking about different types of fish getting certain kinds of tumors or growths. One is in a rainbow trout, another in a goldfish, and the third one is in a type of fish called a man grove killifish. Both male zebrafish and a type of cancer called hemangiosarcomas were studied in a lab experiment. The zebrafish were exposed to a substance called 7,12 dimethylbenzaanthracene, which can cause cancer. Ethyl nitro

soureamay have also caused blood vessel growths in zebrafish. To our understanding, this is the first time we have reported a type of cancer called hemangiosarcoma in the common carp. The tumors found in these fish were somewhat different from each other, but they were mostly similar to tumors found in young neurons. The main things that can be seen in neuronal tumors are long, carrot-shaped cells, the formation of bunches of cells in a circle, a lot of cells, and areas where cells have died. To figure out what type of tumor it is in humans, characteristics like age, where it is, what it looks like under a microscope, what proteins it has, and its structure are looked at.

Regardless of the type, certain tumors found in developing brain cells can show different levels of certain markers. These markers include synaptophysin, neuron-specific enolase, and S-100. In people, some retinoblastomas have extra labeling with substances called retinal S-antigen, retinol-binding protein, and rod or cone opsins. The presence of these substances depends on how differentiated the retinoblastoma is. Medulloepitheliomas and PNETs usually show positive results for vimentin. In this report, it is difficult to classify the cases further because the tumors are often anaplastic and it is challenging to confirm mammalian immunohistochemical techniques in fish. In these cases, the tumors were thought to be very abnormal, with small and disorganized cells, and they either had unclear or no specific features. We tried to use special staining techniques to look for certain proteins in the tissue, but the results were not helpful because there were no reliable internal positive controls. The reason that the immune response didn't work may be because the cells weren't fully developed. Other things that made it more difficult were the removal of calcium during the first steps and, for a lot of the cases, keeping them in formalin for a long time[3], [4].

The presence of Flexner-Wintersteiner rosettes in many of the fish tumors was seen as an important feature because these structures are typically found in specific types of tumors such as retinoblastomas, pineoblastomas, medulloepitheliomas, and olfactory neuroblastomas. It was likely that the tumors in the fish originated from the retina (retinoblastoma) since they were mostly located in the vitreous chamber and had very few normal retinal structures remaining. Retinoblastomas can form in any part of the retina. Typical features of this condition are cells with dark nuclei and very little space around them. They also form small structures called rosettes, and these rosettes are surrounded by a protective membrane. In some cases, the tumors may have cells that resemble the cells found in the retina and have projections filled with elongated structures called mitochondria. In this report, some of the tumors had similar structures that could be seen as early forms of these cells. Can you explain which text you would like me to rewrite in simpler words. Retinoblastomas are not common in domestic mammals, but there have been a few cases reported in a dog and a llama. In fish, retinoblastomas have been diagnosed occasionally. The text is about some cases of retinoblastoma in different animals. The cases were diagnosed by looking at the cells in the eyes of the animals.

The cavefish had some extra things on its body that looked like pretty flowers. There were no signs of the sickness spreading to other parts of the body, just like the other cases mentioned in this report. In the situations mentioned in this report, all cancerous growths were growing slowly, and there were no spread of cancer to other parts of the body. One of the removed cases had the reappearance and spreading to the other optic nerve in the first month after the surgery to remove something. The tumor in the other eye could have been a completely new development. However, it also spread along the optic nerve and into the protective layers around the brain, which indicates that it may have come from the main tumor. The lump in fish number six. 8 had brain cells that were changing into different types of cells, which could indicate the presence of abnormal tumors. This growth was identified as a type of tumor

called a well-differentiated medulloepthelioma. Medulloepitheliomas can develop from undifferentiated cells in the ciliary body or in the back part of the eye.

These tumors are not often seen in domestic animals. Most cases of tumors are found in horses. These tumors are usually aggressive but rarely spread to other parts of the body. In fish, there have been cases of tumors in the eyes of goldfish and Japanese medaka fish. The tumor in the goldfish was a one-time occurrence and did not show any changes in the nerves. In simple terms, the Japanese medaka fish developed abnormal growths called tumors after being exposed to a substance called methylazoxymethanol acetate for a short period as part of an experiment. In all situations, the tumors grew into nearby areas, but they did not spread to other parts of the body. Medulloepitheliomas are different from other embryonal tumors in how they look under a microscope and the specific genes that are involved. They come from a basic layer of cells in the spinal cord and brain and can turn into different types of cells in the nervous system. In people, ocular medulloepitheliomas usually start in the ciliary body and are usually cancerous. The way they look under a microscope is unique, with the formation of tube-like structures and papillary structures made up of abnormal cells aligned along a layer called the basement membrane. The teratoid types have cartilage, glial tissue, andskeletal muscle in them. Under a microscope, the outer surface of fish has many basic cell connections and a thin layer called the basal lamina[5], [6].

We found small parts inside the tumor that looked like brain tissue, but the overall characteristics of the tumor did not match those of a medulloepithelioma. The doctors found out that the person has retinoblastoma by looking at the cells under a microscope and where the tumor is located. However, they also need to consider the possibility of a poorly differentiated neuroblastoma. The groups or large numbers of cichlid fish. The eyes were not examined under a microscope, but based on where the mass was found, it could have come from the eyes. Instead, the masses may have come from the side of the fish's body, specifically a part called the lateral line that goes from its nose to its tail. The lateral-line sensory structures are groups of special cells called neuromasts that are similar to the hair cells found in the inner ear. In this situation, we couldn't see a direct extension from the lateral line. It was not possible to confirm that the tumor started in the eye even after further examination. The features seen under a microscope were similar to a type of tumor called medulloepithelioma, but it's important to also consider a different possibility called olfactory neuroblastoma. The electric eel had a big growth on its gill cover that wasn't connected to its eye or brain. This was confirmed by looking at its tissue under a microscope and using a special type of scan while it was still alive. This growth was different from the eye tumors because it had two groups of well-developed nerve cells.

Sections of normal skin had structures that looked like onion bulbs. These structures were similar to ampullary electroreceptors found in other gymnotiform species. Ampullary organs are made up of cells that sense things and other cells that support them. These cells are believed to come from early cells in the skin. The ability of the cancer cells to become different types of cells might explain why there are two different types of cells that can be seen under a microscope. Due to where it is located, how it is formed, and its likely source, this growth was identified as a peripheral PNET. Researchers have found abnormal growths in the skin of young coho salmon. These growths are found near the lateral line, which is a sensory structure in fish. The tumors in the skin of these fish are similar to the ones seen in their eyes and skin, although no specific patterns were noted. Generally, cases of brain tumors in fish were not very common. There could be problems with genes that are causing this issue. It is unlikely that people were exposed to poisons because the environment was well-controlled and the cases happened irregularly. Grown-up fish can repair their eye tissues

when they get hurt. They can even replace damaged cells in the eye with new ones. Sometimes, this reaction can be too extreme and it might make it more likely for certain cells in fish to change into cancer cells[7], [8].

DISCUSSION

In fish, skin tumors are very common and can be seen on the outside of their bodies. Tumors that grow from the tissue on the inside or outside of our body, or from the glands, are identified by their ability to grow in groups or layers of the same type of cells. This can help us determine if a tumor comes from the epithelial tissue, even if it is very abnormal. These things are also known for their ability to promote the growth of small blood vessels and connective tissue in order to provide food and oxygen to a fast-growing tumor. Sometimes, especially in fish, when they have hepatomas from aflatoxin poisoning, the reaction of the tissue around the tumor may not be enough. The tumor grows too quickly and its blood supply cannot keep up, so it becomes starved of nourishment and dies. This damage can cause the blood supply to die, leading to a blockage and bleeding that can be deadly. It can also be contained and not cause as much harm. Non-cancerous growths on the skin or digestive tract are typically raised and bumpy tumors that grow freely. The lumpy surface of papillomas looks like a cauliflower and is called verrucose. The same kind of abnormalities found in organs like the liver, kidney, and glands are called adenomas.

In fish, tumors on the skin that can be seen from the outside are commonly reported. Tumors that originate from the skin, body surfaces, or glandular tissues are characterized by their ability to grow in groups of similar cells. This characteristic can indicate that these tumors come from the epithelial tissue, even in cases where they are very abnormal. They also have the ability to make blood vessels and supporting tissue grow to provide food and oxygen to rapidly growing tumors. Sometimes, especially with a certain type of liver cancer caused by aflatoxin poisoning, the body's reaction to the cancer may not be enough and the tumor can't grow anymore because it doesn't have enough blood to feed it. This causes the tumor to die. This kind of tissue death can lead to the death of the blood supply and severe bleeding, or it can be contained. Non-cancerous growths on the skin or digestive system usually form raised and bumpy tumors that spread out without control. The lumpy surface of the growth looks like a cauliflower and is called papillomas. Adenomas are the same type of damage that can occur in small parts of the body, like the liver, kidney, or glands[9], [10].

There is a vague line between neoplasia and epithelial hyperplasia. Some writers like to use the term hyperplastic epidermal disease when they are not sure how to classify certain cases. The bumpy growths caused by carp pox and Atlantic salmon papilloma can be thought of as either excessive cell growth or as cancerous diseases, depending on how you define them. Also, Canadian researchers found that the walleye fish can have various types of sores caused by a herpes virus or retrovirus. These lesions were either hyperplastic or neoplastic. The number of papillomas in certain fish groups can be very high. In one study, 55% of the fish examined from the Pacific coast of North America had one or more papillomas. This happened in young fish that were either 0 or 1 year old. The problems mainly occurred on the side of their body with pigment in their eyes. These bumps in Pacifi c flatfish have big, oval "X cells" inside them. Some workers think they are useless parasites, but most of the evidence suggests that in the case of Pacific flatfish papillomas, they are most likely cells that have been transformed by a virus. These things are usually not connected to how much pollution humans create. And in certain places, some types of flatfish are found more often while others are hardly found. None of the different ways that researchers have tried to cause X cell papillomatosis by placing cells or injecting tissue from a lesion or normal tissue have been successful.

This suggests that it might be caused by a contagious and harmful substance. This information is supported. A study from 1983 suggested that the nuclear inclusions found in degenerate X cells may come from a virus. Although growths caused by X cells are only found in flatfish in the Pacific, occasionally flatfish species in the Atlantic can also experience increased growth of tissues on their skin. But typically, these sores are made up of uniform groups of skin cells that are 50-60 cells thick. Sometimes, when looking at these plaques with a special microscope, researchers have found that viruses are present. One of the most commonly researched diseases in fish is 'cauliflower disease'. It is an oral papilloma that affects European eels. It is possible that several things may cause the conditions, as the research. A virus and pollution in the environment are the most likely causes. This means that fish with these growths on their skin can be different shades of gray or black, depending on how much coloring is present. These growths are not harmful. Although they are often found on the lips or head, they can also be found on the fins or body surface. These fish, usually found in coastal waters that have a mix of fresh and salt water, usually die because they don't get enough food to eat. The speed at which the tumors grow depends on the temperature around them. By the end of summer, the lesions may start to shrink or die off. Atlantic salmon and common carp can both have papillomas[11], [12].

These papillomas can be found in certain populations at high levels. It is believed that a virus is the cause, but in both cases, they have not been able to find one. In Atlantic salmon, the problem is usually not harmful, but it appears as a flat or plaque-like sore instead of a raised one. This issue is commonly observed in young salmon during their first year. The number or rate of something happening can vary a lot. It can be very low, or it can be as high as 50%. The illness usually starts to show up in farm animals around the middle of the summer, and the abnormal growths get bigger quickly until they can be 2 - 3 cm in size by the fall.Tumours that come from mesenchymal tissue can be classified based on where they originate from and if they are harmful or not. So, a fi broma is a harmless tumor that starts from a type of cells called fibroblasts, and fibrosarcoma is the cancerous version of it. Similarly, osteoma and osteosarcoma are words used to describe harmless and cancerous growths that come from a type of cells called osteoblasts.

Benign tumors in fish are usually easy to diagnose because they are made up of cells that closely resemble the cells they came from, in terms of appearance and staining properties. They are usually contained within a protective fibrous shell and usually take up space, causing harm by displacing or damaging nearby tissues. Malignant mesenchymal tumors usually grow quickly and have lots of cells. They don't make many fibers or ground substance. Fish sarcomas are a specific type of tumor and they are soft and growing rapidly. They are also similar to liver cancers in fish, showing signs of infarction necrosis and bleeding. These injuries quickly spread to other parts of the body, and they often become so distorted that it's hard to tell what type of cell they originated from or make a clear diagnosis in the new locations. Tumors made of fibrous connective tissue are the most common type of tumors that come from the body's supportive tissue. Fibromas can either be loosely attached to the body by fibrous tissue tags, or firmly attached to the original tissue. On the outside, they look like bumps on the body of an animal. Usually, they have a layer of skin covering them, which may or may not have scales.

Their outer layer often has color. The surface that has been cut is a solid, shiny mass of evenly colored light pink to slightly white tissue. Sometimes, there may be a dead tissue in the middle. The cells in a typical fibroma are long and shaped like spindles. They have a lot of stain and very little cytoplasm. Mitosis is a process that does not happen often, and during this process, cells are divided by tight bundles of collagen. They can happen in any kind of

tissue that connects to other parts of the body, but they are usually found with the skin's adnexa or with tissues in the abdomen. These lumps are usually hard, raised, and connected to the body by a stalk. They are enclosed and separate from the surrounding tissue. Fibrosarcomas are cancers that spread locally instead of spreading to other parts of the body. They can be identified by the very pale staining of fibroblast cells, which are arranged in a swirling or fence-like pattern. Intermediate malignant tumors often have long, thin nuclei. However, these nuclei can quickly turn into anaplastic sarcomas, which are soft, pink, and rapidly growing tumors that invade nearby tissues. Anaplastic sarcomas have large, irregular cells and often have nuclei with an abnormal number of chromosomes. These types of sores can be very difficult to connect with the part of the body they come from. Fibromas and fibrosarcomas are sometimes found in a tumor that comes from a mixture of different tissues.

This tumor can develop from the fibrous part of either a blood vessel or a glandular tissue growth. In these cases, the words fi brohaemangioma or fi broadenoma are used. The causes of fibromas, which can happen a lot in fish that are farmed or in the wild, are believed to be things in the environment or infections. However, we don't know much about the specific things that are causing fibromas in these cases. These tumors occur in around 5% of adult fish. Both groups showed evidence of small particles that are likely viruses coming out of the cell membrane of sick fish. A rare and strange cancer called fi brosarcoma was found in the swim bladder of farmed Atlantic salmon. Tumors in pigment cells can happen in different types of fish and some mix-breeds. The most common type is called malignant melanoma, which scientists have studied in fish crosses between swordtails and platyfish. Platyfish have different colors because of the way their skin cells are spread out. The color of each pattern is determined by one gene that can be changed by other genes. In hybrid animals, the gene that causes color in melanophores is there, but the genes that control how many melanophores there are might not be present. This can cause the melanophores to multiply too much and not be controlled properly. The final outcome is the growth of skin cancers called melanomas. Some melanomas can also develop in the eyes.

In the beginning, it is hard to tell the tumors apart because the cancer cells may not have any color. The fully grown tumours feel soft, look black, and are a little higher than the skin. Cells that are closely packed together and have a lot of color in them form a network that looks like interlacing. Often, these cells invade the tissue that is next to them. A lot of aggressive skin cancers have been found in a type of fish called estuarine argyrosomids, as mentioned by Kimura and others. The digeneanCryptocotyle lingua is a parasite that infects certain types of coastal fish. These fish may develop a noticeable change in their tissue called melanosis, but it is not considered a true cancer. Cryptocotyle lingua has been found in several types of fish, including cod and marine catfish. Less often, there have been reports of other types of pigment cell tumors. Some examples of these include red - orange color, white crystals that reflect light, and yellow color.

Vascular tumors are often found in bony fish. Capillary haemangiomas are the most common type of haemangiomas, even though there are also other types like cavernous haemangiomas and haemangio-endotheliomas. In 1985, there was a study about tumors found in a type of fish called Mycteropercaphenax. The tumors were very similar to each other. Haemangiomas come in different sizes and can be reddish-brown or blue. They are raised and hard growths. Histologically, they are tightly packed clusters of blood vessels lined with endothelial cells, surrounded by a collagen-filled matrix. The sores can grow into the dermis, but usually start in a layer called the stratum spongiosum. They form a skin covering and spread outwards, sometimes causing ulcers. Tumor areas may contain a lot of collagen and have many granule cells called eosinophils. Teratomas have been found in guppies and platy fish, and they likely

happen in many other types of animals. These things are usually found in the belly, can be seen on the front side, and are made up of different tissues and organs that are not organized. Nephroblastoma has been seen in rainbow trout and striped bass.

CONCLUSION

The causative agent of tumors or neoplasms are abnormal cells that grow uncontrollably in the body. In fishes with bones, tumors in the tissues that connect the body parts, like fibroma and fibrosarcoma, are very common. Fish can get cancer just like other animals. Some things that can cause cancer in fish are viruses, certain chemicals in the environment, repeated physical injury, hormones, getting older, being male or female, having certain genes, and how well their immune system works. Looking at the unusual cells using techniques that study the changes in tissues. Cancer is divided into different types based on where it starts in the body and whether it is harmless or dangerous. Harmless lumps usually look similar to normal cells, grow slowly, are separate from nearby healthy tissue, and do not spread to other parts of the body. Most non-cancerous growths are generally not dangerous and tend to go away on their own.

Exceptions are harmless growths in the brain and certain organs in the body that can be very dangerous because of where they are and the harmful effects they have on the body. Cancerous growths are typically not well developed, can spread quickly, invade healthy tissues, and tend to spread to other parts of the body. The names of these new growths are usually called "malignant" or end with the words "sarcoma" or "carcinoma".

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CHAPTER 6

THE VIROLOGY OF FISH: EXPLORING THE WORLD OF MICROBES

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ABSTRACT:

Viral diseases affect both fish in the wild and fish raised on farms. Sometimes, when diseases spread among fish, it can almost wipe out a specific group of sockeye salmon or cause such big losses that commercial aquaculture businesses have to close down. The aquaculture industry is finding new fish viruses and learning that viruses can affect a wider range of fish species than previously known. Right now, there are fish viruses in 14 of the families that the International Committee on the Taxonomy of Viruses has classified for vertebrate viruses. The families Iridoviridae, Adenoviridae, and Herpesviridae contain fish viruses with DNA genomes.nThe families Picornaviridae, Birnaviridae, Reoviridae, Rhabdoviridae, Orthomyxoviridae, Paramyxoviridae, Caliciviridae, Togaviridae, Nodaviridae, Retroviridae, contain fish viruses with RNA genomes. Some viruses grow best at the same temperature as their host, which is usually between 8 and 15 degrees Celsius. Some viruses can go from one type of animal to another and make them sick. For example, they can infect different types of fish, cows, pigs, and people. As people increasingly want fish from aquaculture and different types of fish are farmed, it's likely that new viruses will be discovered, and some might be classified as new groups or even families.

KEYWORDS:

Chinook Salmon, Fish Virus, Genetic Materials, Rainbow Trout, White Sturgeon.

INTRODUCTION

The study of fish viruses goes hand in hand with the growth of fish farming, which started over 3000 years ago. The way cyprinid fishes are raised in China was explained in the past. Since then, more types of fish have been grown for eating and selling as pets. Fish farming has led to the discovery of fish viruses, such as spring viremia of carp and carp pox. The earliest recorded case of carp pox was in 1563.The way fish viruses reproduce and spread is similar to how viruses in warm-blooded animals do. However, scientists have found new types of viruses in different virus families by studying their genetic makeup and how they behave. For instance, the aquabirnaviruses belong to a different group in the Birnaviridae family. They are identified based on the way they react to certain tests and the types of hosts they infect. The novirhabdoviruses are a type of virus that infect fish. They are different from other fish viruses because they have a special gene that is found between two other genes. No other virus like rhabdovirus has a gene that creates a protein not involved in making new viruses. So, studying fish viruses is a helpful area of research that gives us opportunities to learn about how diseases spread in a large number of animals[1], [2].

Many people have worked very hard to create plans to stop a virus from spreading and to control it if it shows up at a place where baby animals are being raised. In aquaculture, like with other animals we raise for food, it is important to have disease control measures that are affordable, work well, and are easy to use in the real world. Avoidance is still the best and cheapest way to control the fish diseases mentioned here. Currently, it is necessary to have

eggs and fry certified as specific pathogen-free in order to transport them between different states and countries. To stop the spread of the virus, all the eggs and fish that could be infected at the facility are destroyed. Specific disease-free eggs or fish are grown in clean water. Scientists have created vaccines for different types of diseases that affect fish. These vaccines can be made using weakened forms of the pathogens, killed versions of the pathogens, or by using DNA technology to create specific parts of the pathogens. Some vaccines work better than others, but none of them are currently approved and available for purchase.

Because of the type of animal and how many babies it can have, scientists can create models for how diseases spread and study the impact of the environment. These models can show things that might not be easily seen when studying small groups of animals. We can study groups of 500 to 1000 fish when researching fish. It is also possible to study how a virus affects an organism's growth stage. This is not always possible with mammals that are warm-blooded, because they develop inside their mother's body for a long time. With fish that lay eggs, we can study how different stages of growth affect the spread of viruses in the animal very early in its life.Scientists are finding out more about how living organisms work by studying diseases caused by viruses in fish. Because there is a need to control diseases in aquaculture, scientists are motivated to find and study more fish viruses.

Infectious hematopoietic necrosis virus (IHNV) is a harmful virus that causes a severe illness in young fish. This virus is a member of the Rhabdoviridae family and is part of a group called IHNV-like viruses.In 1953, a virus was discovered in sockeye salmon that were being raised in fish farms in Washington. In 1960, there were illness outbreaks among salmon that were kept in a special place called a hatchery in California. The virus spread to new locations because people fed other animals with raw sockeye salmon guts without pasteurizing them. Even though they stopped, the disease continued to spread in the 1970s because infected eggs were sent to Japan, the eastern USA, and Europe. Scientists were able to grow the IHNV virus for the first time in a lab because they had salmon fish cells to use.The IHNV particles can look like either a bullet or a cone. The virus belongs to a different group and has six genes that are organized in a particular sequence on its genetic material[3], [4].

The gene responsible for creating the nucleoprotein is represented by the letter N. P is the gene that creates the phosphoprotein. M is the gene that creates the matrix protein. G is the code that tells cells to make the glycoprotein. The NV gene makes a protein that is not part of the viral particle. In simpler terms, L is the gene that creates the polymerase. The International Committee on the Taxonomy of Viruses has decided to label IHNV as a different kind of virus known as Novirhabdovirus. This choice was made because scientists found a unique gene called Non-Virion protein gene. It is located between the G and L genes on the virus's genetic material.At first, people thought that IHNV was only in salmon fish in the Pacific Northwest of North America. But sending eggs or baby fish that have a disease has made the disease spread to Japan, Korea, Taiwan, China, Spain, Belgium, and France. Sometimes there have been a few cases of the illness in Colorado, South Dakota, Virginia, and Montana. IHN outbreaks occur mainly when the water is cold, usually 12°C or lower, and impact young fish. So, young steelhead trout in Washington often get sick in March or April.

At first, the virus was only in one kind of fish called Oncorhynchus. These types of fish are called sockeye, kokanee, chinook, cherry, biwa, chum salmon, and yamame, amago, steelhead, cutthroat, and rainbow trout. The virus can make the fish die when the water temperature is between 3 and 18 degrees Celsius. The virus can cause sickness and death in various kinds of fish such as Atlantic salmon, brown trout, brook trout, and Japanese char.

Coho salmon, arctic grayling, pink salmon, lake trout, and Arctic char have good resistance to IHNV. The virus can move to different cells, such as those from rainbow trout, chinook salmon, and cyprini, when the temperature is between 4 and 20°C. Plants cannot grow in temperatures that are between 23 and 25 degrees Celsius.The virus can easily move from contaminated food and water to other fish. But researchers who study IHN in the field have been discussing a lot about how the virus can be passed from parents to their babies. Clearly, when parents who have an infection have contaminated eggs and sperm, there is a greater chance of giving the infection to their children. Using iodophore treatment on eggs can help get rid of the virus in lots of situations. This helps to prevent it from spreading to future generations.In the body of a sick animal, IHNV is commonly found in certain areas like the front part of the kidney, spleen, liver, and pyloric caeca. There are various types of the virus that can attack either the brain or the liver[5], [6].

When fish are sick, they can feel very tired and have low energy. They might also move in weird ways, like spinning or moving very fast sometimes. Fish that have the disease show some signs like their color becoming darker, small spots of bleeding near their fins, a swollen belly, eyes that stick out, gills that are pale, and poop that is slimy and not clear. The kidney in fish, which makes blood cells, has very serious damage.Scientists discovered that fish, which were previously ill with a virus, have special substances in their bodies that can help them fight off the virus. Tests have demonstrated that these substances have the ability to halt the virus and this has been confirmed with a method known as ELISA. We don't have proof that rainbow trout have a strong immune response at the cell level because we don't have reliable tests to measure their immunity. However, tests in the lab have found that when fish cells are infected with CSHE-214, the immune cells from fish that have recovered from IHN destroy the infected cells faster than the immune cells from healthy fish do.

DISCUSSION

Fish rhabdoviruses are very harmful viruses that commonly infect fish that are raised in aquaculture, particularly salmon and trout. In 1938, a scientist named Schaperclaus found the first fish rhabdovirus in European rainbow trout. Then, 6 years later, another virus called the Sacramento River Chinook virus was discovered by Rucker. Since then, scientists have found and studied these viruses. They have grown them in cells and figured out their genetic information. The salmon virus is now known as Infectious hematopoietic necrosis virus (IHNV). This virus belongs to a new group called Novirhabdovirus in the Rhabdoviridae family. Other types of fish viruses in this group are Viral hemorrhagic septicemia virus (VHSV), Hiramerhabdovirus (HIRRV), and Snakehead rhabdovirus (SHRV). All these viruses have a genetic material called negative-sense ssRNA. The order of their genetic material starts from the end called the 3′-end and goes like this: leader-N-P-M-G-NV-L. In this order, N stands for the nucleoprotein gene, P stands for the phosphoprotein gene, M stands for the matrix protein gene, G stands for the glycoprotein gene, NV stands for the nonvirion protein gene, and L stands for the virion RNA polymerase gene. The NV gene is what makes the rhabdoviruses in the Novirhabdovirus group different, with 'novi' meaning nonvirion[7], [8].

So far, studying the NV genes of IHNV, SHRV, and VHSV using reverse genetic analysis has given uncertain outcomes. For IHNV and VHSV, removing the NV gene improved the virus-induced damage to cells in a lab setting and made the virus less harmful to fish. However, removing the NV gene for SHRV did not impact the creation of the virus or the damage it caused to cells in a lab setting, nor did it decrease the harm it caused when tested on live fish. Some outbreaks have caused significant mortality in affected fish populations. IHNV can be transmitted through direct contact between fish or through contaminated water.

The virus can also be spread through infected eggs, which can result in vertical transmission from parent fish to offspring. Infected fish may display clinical signs such as hemorrhaging, darkening of the skin, and abdominal swelling. There is currently no specific treatment for IHNV, so prevention and control measures are important to manage outbreaks and protect fish populations. This may include strict biosecurity protocols, proper disinfection of equipment and facilities, and implementing disease surveillance programs. Chinook salmon, also known as king salmon, is a type of fish found in the Pacific Ocean. They are large and have a metallic green-back with silver sides. Chinook salmon are a popular species for fishing and are also commercially harvested[9], [10].

They are known for their delicious taste and are often enjoyed as food. Rewrite: Three types of salmon include chinook salmon, Atlantic salmon, and masou salmon. Masou salmon have caused significant financial harm to fish farmers. This virus likes cold temperatures and grows best at 8-15°C. VHSV is a very harmful germ that can make salmonid fish sick. It can also affect other fish like Pacific herring, Pacific cod, whitefish, European sea bass, and turbot. It has been found to cause their deaths. This wide range of hosts has worried authorities in the USA since VHSV was first found there in 2006. It affects fish species like freshwater drum, round goby, smallmouth bass, bluegill, crappie, gizzard shard, and others in the Great Lakes. HIRRV affects hirame, also known as the Japanese flounder, which is a very popular and valued fish to eat in Japan. It can infect a type of fish called ayu and also salmonid fish. SHRV was discovered in Thailand, in snakehead fish that had a disease called epizootic ulcerative syndrome (EUS). It is not the cause of EUS, which is a disease caused by a fungus. However, zebrafish that are exposed to SHRV grown in tissue culture will get red spots and bleed, which can cause them to die.

Spring viremia of carp virus (SVCV) is different from other fish rhabdoviruses because it does not have an extra gene between its glycoprotein and L genes. When studying the SVCV genome sequence, it was found that it groups together with other viruses from the Vesiculovirus family, which also includes vesicular stomatitis virus. SVCV was first discovered as the cause of a sudden, bleeding disease in common carp in Europe in 1972. The illness has been discovered in Asia, the Middle East, and more recently in South and North America. Outbreaks in the USA have caused worry that certain types of fish that are native to the area and part of the minnow family, some of which are in danger of disappearing, might be easily harmed by a disease called SVCV. Some other viruses that are very similar to SVCV in their genetic makeup are found in different types of freshwater fish in Europe. These fish include pike, common bream, roach, and eels. There are also similar viruses found in grass carp, trout, and sea trout.Researchers compared the genetic information of different viruses in the Rhabdoviridae family and found that there are six different groups, or genera, within this family. These groups are called Lyssavirus, Vesiculovirus, Ephemerovirus, Cytorhabdovirus, Nucleorhabdovirus, and Novirhabdovirus. Currently, fish viruses called rhabdoviruses are only found in two groups known as Novirhabdovirus and Vesiculovirus. Studies using the genetic material from the P gene suggest that aquatic vesiculoviruses and arthropod-borne vertebrate vesiculoviruses are different groups[7], [11].

In 1985, scientists found out about a virus similar to the paramyxovirus in fish for the first time. During a regular check-up of young Chinook salmon in Oregon, cells taken from their organs were mixed with other cells and formed a clump. Pictures of the infected cells showed a virus with a bumpy surface and different shapes. The virus was about 125-250 nanometers wide and had a spiraled core that was 18 nanometers wide and 100 nanometers long. Trout and salmon babies did not get sick from the virus when they were tested again. Scientists in Japan used a special machine called an electron microscope to find a virus in young black sea

bream that caused a serious skin condition called epidermal necrosis. This virus is called a second fish paramyxovirus. This virus was never grown in a controlled environment outside of the body. The latest information about a fish virus comes from Atlantic salmon that are young and experiencing a problem with their gills in Norway. The genetic material of this virus has been copied and parts of the viral L protein have been studied to understand where this virus belongs in the Paramyxoviridae family. The Atlantic salmon paramyxovirus (ASPV) belongs to a group called Paramyxovirinae, which also includes viruses that infect humans such as the parainfluenza virus and Sendai virus.

In 1988, scientists first noticed picorna-like viruses in fish, specifically rainbow smelt, in New Brunswick, Canada. Since then, scientists have found picornaviruses in several types of fish such as barramundi, turbot, sea bass, grass carp, blue gill, grouper, Japanese parrotfish, and salmonid fish. In many of these descriptions, scientists thought the cause of the disease was a type of virus called picornavirus. They came to this conclusion because the virus was able to grow in cells in a laboratory and they saw small virus particles that looked like picornaviruses when they looked at them under a microscope. These virus particles also had a similar size and shape to picornaviruses. The study of the RNA taken from the blue gill virus has shown that it is a virus with only one strand of RNA. We haven't examined the sequence of the viral genomes yet, but some experts think that some of these viruses could be betanodaviruses. In many situations, fish that are sick and have these viruses have little particles that look like picorna viruses in their brain and medulla. The fish move in a corkscrew-like way, and eventually they die.

There is a group of viruses called Nodaviridae that can infect fish. One specific type of virus in this group is called Betanodavirus. The main example of Betanodavirus is a virus called Striped jack nervous necrosis virus (SJNNV). These viruses do not have a protective outer layer and have a shape with 20 triangular sides. They are very small, with a diameter of about 30 nm. The genetic material of the virus is made up of two strands of single-stranded RNA that have a positive charge. RNA1, the biggest piece of the RNA genome, carries the instructions for making the viral polymerase. RNA2 contains the genetic information that instructs the production of the virion capsid protein. There is another RNA called RNA3 that comes from a specific part of RNA1. It contains instructions for making a protein that is made up of 75 building blocks called amino acids. This protein is different from the proteins made by RNA3 in other viruses. However, the SJNNV B2 protein RNA and the B2 protein of insect-infecting alphanodaviruses both have the ability to suppress RNA silencing.

The betanodaviruses are what cause a disease called viral nervous necrosis or viral encephalopathy and retinopathy in different kinds of fish that are grown in tanks. The illness affects young fish and causes damage and holes in the brain, spinal cord, and retina in most situations. This information has been found in some types of fish, like striped jack, grouper, red drum, guppy, barfin flounder, red sea bream, tiger puffer, Japanese flounder, Atlantic halibut, amberjack, sea bass, and barramundi. Scientists recently found betanodaviruses in aquarium fish and invertebrates that appear to be healthy. This has caused worry that the disease could spread through the trade of aquarium fish, especially those from Southeast Asia. Comparing the sequences of the coat protein genes from 25 samples shows that there are four different types of the virus: TPNNV, SJNNV, BFNNV, and RGNNV.

The Retroviridae family has two parts, the Orthoretrovirinae with six groups, and the Spumaretrovirinae with only one group. The piscine retroviruses are a type of virus found in fish. They belong to a group called Epsilonretrovirus, which is a type of virus that infects fish. The specific types of piscine retroviruses include walleye dermal sarcoma virus, walleye epidermal hyperplasia virus type 1, walleye epidermal hyperplasia virus type 2, and

snakehead retrovirus. Scientists have figured out the DNA code for all of these viruses. There have been many reports of C-type particles that look like retroviruses, which are about 110–150 nm in size. These particles have been found in epidermal papillomas of European smelt and in cells grown in a lab from neurofibromas of damselfish. A retrovirus might be causing plasmacytoid leukemia in Chinook salmon.

The first discovery of a retrovirus-like agent in fish was reported in 1976. It was found in lymphosarcoma, a type of cancer, in northern pike and muskellunge fish. The cancer growths had a special enzyme that copies DNA like reverse transcriptase. This enzyme works best at a temperature of 20 °C. In 1992, scientists found the first proof of a fish virus called retrovirus. This virus was found in skin tumors that develop on adult walleye fish. These growths are formed on adult walleye fish during the fall and go away in the spring. The virus's genetic material was bigger than the genetic material of all other retroviruses that were known at that time. The analysis of the sequence showed that WDSV had three more parts that can be read: ORF C at the beginning, and ORF A and ORF B at the end. ORF A contains a gene that makes a protein similar to a D-cyclin (a type of protein found in retroviruses) and this protein is found in the center of tumor cells in clusters. ORF C is a gene that makes a protein that goes to the mitochondria and is linked to cell death. When the complete viral RNA is made, it shows up in shrinking tumors. We don't know what the protein in ORF B does, even though it is somewhat related to ORF A. Scientists have found that the WDSV protease cleavage sites have a glutamine in the second position. The WDSV reverse transcriptase stops working quickly when the temperature is higher than 15 °C. This discovery suggests that it is meant to function in fish that live in cold water.

Two more retroviruses have been copied from abnormal and excessive growths on walleye's skin. The genetic codes show that they are very different from each other (77% similarity) and from WDSV. Walleye epidermal hyperplasia viruses 1 and 2 (WEHV-1 and -2) have similar genetic structures to WDSV. Each of the viruses found in walleye causes sores when a liquid made from crushed tumors is injected into young walleye fish that haven't been exposed to the viruses before.The entire genetic sequence and how a snakehead fish retrovirus is converted into messenger RNA have also been studied and documented. The genetic material of the virus is organized in a specific way, with certain sections called LTR, gag, pol, and env. There are three more sections of genetic information. The first section codes for a small protein made up of 52 building blocks and weighs 5. 7 kilodaltons The second section codes for a larger protein made up of 94 building blocks and weighs 11 kilodaltons. The third section codes for a even bigger protein made up of 205 building blocks and weighs 24 kilodaltons. BLAST searches found no similar proteins and their functions are still unknown. The SnRV genome is different from the walleye retroviruses because it does not have a specific part called ORF between the Unique region in the 5' LTR (U5) and the gag region. It is not known how harmful SnRV is.In 2006, scientists discovered a new virus in fish that caused a specific type of cancer in the swimbladders of Atlantic salmon. The swimbladder sarcoma virus (SSSV) provirus is about 10. 9 thousand base pairs long. It has a basic arrangement of genes called gag, pro-pol, and env, which is similar to the arrangement seen in murine leukemia viruses. The study of genetic relationships suggests that SSV is very similar to a retrovirus found in zebrafish. These viruses are a new group of retroviruses found in fish.

Epizootic hematopoietic necrosis, which affects perch and rainbow trout and is caused by a virus called Epizootic hematopoietic necrosis virus (EHNV, genus Ranavirus). European sheatfish virus (ESV, genus Ranavirus), which affects sheatfish (Silurusglanis).European catfish virus (ECV, genus Ranavirus), which affects catfish. ESV and ECV are considered to

be the same type of virus called European catfish virus. Santee-Cooper ranavirus is a type of virus that infects three different species: largemouth bass, doctor fish, and guppies. These viruses are called largemouth bass iridovirus (LMBV), doctor fish virus (DFV-16), and guppy virus (GV-6). The white sturgeon iridovirus group (WSIV) is a collection of viruses that infect sturgeon fish in North America and Russian sturgeon fish in Europe. Red seabream iridoviruses (RSIV) are a type of virus that kills young red sea bream fish that are being raised in Japan. Researchers have seen the same thing happening in grouper fish in Thailand. Scientists have found two types of viruses in goldfish. These viruses were taken from the swimbladder tissue culture of goldfish that were not sick. Iridoviruses have been seen in the cytoplasm of red blood cells in fish with a condition called viral erythrocytic necrosis. This has been observed in both ocean-dwelling and migratory bony fish.

Herpes viruses have been found in three types of fish channel catfish, common carp, and koi carp. Carpio, goldfish, eel, rainbow trout, masou salmon, and lake trout are all types of fish. Some types of fish are called namaycush, sturgeon, walleye, and Japanese flounder. The channel catfish virus is a type of fish herpes virus. It belongs to a group called Ictalurivirus, which is not included in any of the three subfamilies (Alphaherpesvirinae, Betaherpesvirinae, and Gammaherpesvirinae) of the Herpesviridae family. The other fish herpesviruses, like CyHV-1, CyHV-2, CyHV-3, SalHV-1, SalHV-2, AngHV-1, and white sturgeon herpesviruses, are still part of the Herpesviridae family but have not been specifically grouped yet. Scientists have discovered evidence of herpesviruses in various types of fish, including sharks, eels, pike, flounder, perch, angelfish, grouper, and others, through electron microscopy.

Fish herpesviruses have different sizes and structures compared to the herpesviruses found in birds and mammals. The size of fish herpesviruses ranges from 134 to 295 kbp. This suggests that fish herpesviruses have evolved separately from those in birds and mammals. The genetic material of Ictalurid herpesvirus 1, also known as Channel catfish virus, has a special section called the unique long region, which is surrounded by a big repeated sequence. This repeated sequence is similar to the betaherpesviruses found in the Roseolovirus group. The SalHV-1 genetic material is structured more similarly to the alphaherpesviruses found in the Varicellovirus group. It has a special short region surrounded by a special long region that doesn't have any repeats. Comparisons of different genes in cyprinid viruses show that they are similar to each other and different from IcHV-1. The genes we studied are DNA polymerase, major capsid protein, intercapsomeric triplex protein, and DNA helicase genes.These viruses can cause serious diseases in the organisms they infect. When young catfish get sick with IcHV-1, some of them die and the ones that live can still spread the infection. The cyprinid herpes viruses cause a disease in goldfish and koi carp. This disease affects their hematopoietic tissue and causes lesions. In koi carp, it also causes papillomas on their caudal regions. SalHV-2 was found in the fluid from the ovaries of masou salmon.

It causes the creation of big cells with multiple nuclei and the breaking down of infected cells. Young masou salmon injected with a virus grown in tissue culture develop growths on their epithelial tissue. The herpesviruses that affect white sturgeon babies raised in hatcheries cause big problems and make them die.Scientists have found adenovirus particles in sores on various types of fish, including white sturgeon, dabs, cod, and Japanese red sea bream. Scientists have found and separated the white sturgeon adenovirus in a lab and have discovered its hexon protein and protease gene sequences. By comparing some DNA sequences of the sturgeon adenovirus with 24 other adenovirus types, we found that the fish adenovirus is not closely related to the other adenoviruses. It might actually be a new, separate group within the Adenoviridae family. Cod can get sick from a virus called

adenovirus. This virus makes the fish's skin grow more than usual. In California, there is a virus called white sturgeon adenovirus that affects young fish in hatcheries. Infection is when there is an excessive growth of cells on the surface of the body and the cell nuclei become bigger. In red sea bream, a type of cancer called lympholeukemia has been identified. In dabs, which are fish, growths called papillomas have been found in those infected with adenoviruses.

CONCLUSION

Viruses are tiny germs that can make you sick. They can only multiply inside your body's cells and use your body's tools to make more of themselves. In simple terms, a virus is made up of genetic material surrounded by protein and sometimes other molecules outside of a cell. In this state outside of the cells, it is not active in terms of metabolism. A virion is a structure that carries the virus genetic material from one cell to another so that it can infect the new cell. Once the virus enters a new cell, it starts making copies of itself. It creates the virus's genetic material and other parts of the virus as well. The process of making more viruses is called infection. Viruses are very small, measuring between 18 and 300 nm if they are round or bullet-shaped. Another important characteristic of viruses is that they contain either DNA or RNA but never both. The genetic material of a virus can be either DNA or RNA. RNA viruses are different because their genetic material is made up of RNA. The RNA or DNA can be a single strand or two strands. Some viruses have their NA divided into smaller sections, while others have it in a circular shape. Single-stranded NA can be either positive or negative. If RNA is in a positive state, a new strand that matches it is made before messenger RNA is made. If something is bad or not good such as a number or a result, it is considered negative. To make messenger RNA (mRNA), viral RNA needs to be transcribed by a special enzyme in the virus.

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CHAPTER 7

A COMPREHENSIVE OVERVIEW OF PARASITOLOGY OF FISH

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ABSTRACT:

The study of parasites in fish is important for taking care of their health and to make sure they can grow well and be produced for economic reasons. That's why we are finding new ways to keep fish healthy and control harmful germs.Parasites can harm fish that are kept in captivity. Parasites from different continents that are brought to new places may be dangerous to local fish that are not accustomed to them. One of these alien parasites is a type of worm called the eel swim bladder nematode Anguillicolacrassus. Endemic parasites can be found in many different forms in wild fish, but they usually don't cause any noticeable harm or illness. They are important parts of water communities. Many parasites that live on fish have complicated life cycles. These cycles involve different hosts at different levels in the food chain. There is still a lot to learn about how they affect the ecosystem. We want to understand how these parasites can change what their hosts do in the underwater food chainAdditionally, we are using our knowledge and expertise to find ways to measure the well-being of captive fish by determining their stress levels and immune system characteristics. Our aim is to give information on how to make fish in captivity live better.

KEYWORDS:

Digestive System, Life Cycle, Organism, Parasite, Whirling Disease.

INTRODUCTION

It is called a close and necessary relationship between two different organisms, where one organism, usually the smaller one, relies on the other organism for its survival. Parasitology is the study of parasites. The word comes from Greek words that mean beside, food, and study. This is the field of science that focuses on studying how parasites and hosts are connected. This field of study looks at different ways to understand and learn about parasites, like their family tree, how they look, how they interact with their environment, their life cycle, how their bodies work, how we can treat them with chemicals, how their blood reacts to certain tests, how their immune systems work, and how their bodies interact with chemicals in the environment. Fish parasitology is a scientific field that focuses on studying parasites that affect fishes. This refers to fish getting sick from parasites. A host is a living thing that is bigger than a parasite, is a different type of creature, and provides protection and food for the parasite. The final host is the host where the parasite grows up and makes more parasites. An aquatic bird that carries the early stage of a parasite, but cannot grow into an adult parasite itself, is called an intermediate host[1], [2].

The economic recession had a significant impact on the financial stability of many households. Unemployment rates skyrocketed, causing families to struggle with their finances. Many people were unable to pay their bills and fell into debt. This led to an increase in foreclosures and evictions, as people were unable to afford their mortgage or rent payments. Additionally, businesses also suffered from the economic downturn, leading to layoffs and job losses. Overallthe recession had a negative effect on the financial well-being of individuals and families.A fish that carries a harmful parasite but doesn't get sick from it

can spread the infection to other important animals. This fish is called a reservoir host. Virtual platforms and tools have become essential for collaborations, meetings, and presentations, enabling people to connect and share information in real-time. As a result, the reliance on technology has grown tremendously to maintain productivity and connectivity in various aspects of life during these challenging times.Trash fish can cause Ich disease because they carry infections[3], [4].

The dog can have a type of Entamoeba that can infect people. A paratenic host is a host where the young parasite does not grow but can still infect another specific host. In simple words, when Calyptosporafunduli is eaten, the sporozoites inside it do not multiply but instead go through a process of getting ready to become infectious. Vectors are organisms that carry and pass on the infective stage of a parasite from one host to another.These organisms are very tiny, so tiny that you usually cannot see them without a microscope. They are made up of only one cell. This cell is filled with a substance called cytoplasm, which contains one or more nuclei. Locomotor organelles are things like pseudopodia false feet, flagella whip-like tails, or cilia tiny hair-like structures. Nutrition can be either holozoic eating solid food, holophytic performing photosynthesis, saprozoic feeding on decaying matter, or parasitic living off another organism. Protozoans can live independently or as parasites. Other terms related to protozoans include suture line, polar capsule, polar filament, sporoplasm, and iodin vacuoles. Protozoans can reproduce in two different ways: sexually and asexually. They can also be ectoparasitic living on the outside of another organism or endoparasitic living inside another organism. They are usually located on the outside of the fish's body. Their capability to increase in number on or inside the organisms they live on or inside, like parasites[5], [6].

Ichthyophthiriusmultifiliis, Ichthyobodonecatrix, Myxobolus sp. are the names of different microscopic organisms. Trematoda is a group within a larger group called phylum Platyhelminthes. This text is talking about two types of parasitic flatworms called flukes. Monogenea: Monogeneans are a kind of parasitic worm that belong to the flatworm group called Platyhelminthes and the class Monogenea. They are a type of flatworms called flukes that mostly live on fishes. They can be found on different types of fishes, including ones with cartilage like sharks and ones with bones like most fish. Most of them live on the outside of the fish's body, but there are a few that can be found in the fish's mouth or urinary bladder. They mainly attack the skin, head, fins, body surface, nasal area, or gills. Their bodies are flat and symmetrical on both sides. They do not have a true sucker, but sometimes they have an oral sucker. They have a mouth and a muscular throat. They don't have a complete digestive system and usually don't have an anus. Its inner tube is called intestinal caecum. The main part of the body is called the haptor. It is found at the back of the body and has hooks and anchors made of a strong material called chitin. Monogeneans are animals that have both male and female organs. They have a simple life cycle because they need only one host to complete it.

Gyrodactyluselegans is a type of skin fluke. Diplozoonparadoxum is a twin worm. Dactylogyrusvastator is a gill fluke. The marginal hook and anchor are parts of these parasites. The developing embryo is a stage in their reproduction. Trematoda: Digenea is a subclass of parasitic flatworms called digeneans. They mostly live inside the host's body. They mainly attack organs like the liver, gall bladder, air bladder, and urinary bladder inside the body. In simple terms, they have a flat body that is not divided into segments. They also have two organs for grasping- one around the mouth and one on the underside, but these organs are not connected to anything inside their body. Sometimes there is a sucker at the front that is separate from the mouth called a rhynchus. They are hermaphrodites: They have

both male and female reproductive organs. The life-cycle of Digenean involves more than one host. Digenean goes through different stages of development in multiple hosts. And when they become adults, they live inside vertebrate animals and feed on them. The last home for digenetic trematodes is a creature with a backbone where the flukes make babies, and the in-between home is a creature without a backbone. Clonorchissinensis and Clinostomumcomplanatum are types of worms. They have long, flat and squished bodies. They are known as tapeworms because of their flat and broad top and bottom surfaces called surficia.

DISCUSSION

The body of a tapeworm is split into three sections. The front part is small and is called the scolex or attachment organ, which helps the tapeworm stay attached to its host. After the scolex, there is a small and thin part called the neck or growth zone. This is where the segments or proglottids start to form. The rest of the body is called the strobila. It is made up of segments called proglottids. They don't have a digestive system or any body cavity. They have both male and female organs. Each segment of their body has one set of male and female organs. The male and female organs do not mature at the same time, so each segment first becomes male and later becomes female. The strobila is made when new proglottids grow in the neck area, so the furthest ones from the neck are the oldest. The proglottids closest to the neck are usually male, while the ones farthest away are female. The life-cycle involves one or more animals in between, like insects or small animals. The two names are a type of parasite that lives in the human intestines. Acanthocephala is a group of worms that live as parasites. They are called spiny-headed worms because they have a long, flexible mouthpart covered in sharp hooks. They have a slim, tube-like body. The proboscis is a long tube that the final host uses to poke a hole in its own gut and also hold onto the gut wall to finish its life cycle[7], [8].

The proboscis is like a tube inside the body. It is separated from the rest of the body by a thin wall. They do not have a mouth, anus, or digestive tube. They also do not have a circulatory system. They exist as either male or female. The males and females are not together; the females are bigger than the males. They are worms that live inside animals. The adult worm lives in the stomach or intestines of different animals like fish, birds, and mammals. They can infect animals that live in the sea, in fresh water, and on land. Pallisentisophiocephali nematode is a type of worm that is also known as roundworms or threadworms. These worms live inside another organism as a parasite. Their body shape is mostly cylindrical, but it can also be fusiform or filiform and it is not divided into segments. The length of their body can range from 0. 5mm to 1 meter. The body has a strong, tough covering that can stretch and bend. They don't have any specific part to attach to things, and they can have a pointed shape at either one or both ends. The males and females are different. The females are bigger. The tails of males are curved, but the tails of females are straight. They usually look clear or pale or slightly yellow; their color comes from what is in their intestines, especially if there is blood. They have a full digestive system. Some kinds have one host, while others have two or three hosts throughout their life cycle[9], [10].

The names of three types of worms are Ascarislumbricoides, Procamallanusheteropneustes, and Camallanuslacustris. Leeches are a type of worm with segments. They are part of the Annelida group and the Hirudinea subclass. These worms have bodies that are the same on both sides. They live mainly in freshwater, but some live in the ocean and others live in damp land. The body is somewhat flat and shaped like an oval with a pointed end. They are big enough to see without using a telescope. They have suckers on the front or back of their bodies. They live on other creatures. They have both male and female reproductive organs.

Their body is divided into two sections a small and narrow front part, and a larger and wider back part that is sometimes flat. The most notable characteristic of leeches is their digestive system, which is designed for consuming large amounts of blood. The names of these three organisms are Piscicolageometra, Placobdellaparasitica, and Macrobdelladecora. Crustaceans have a hard outer covering called the exoskeleton, which they shed to grow. Their bodies are divided into three parts the head, the middle part called the thorax, and the back part called the abdomen. The head and thorax can come together to make a cephalothorax, which might be protected by one big shell. The thorax and abdomen are divided into segments. Each segment can have a pair of body parts. The head usually has two pairs of feelers, jaw-like parts, and more[11], [12].

The thoracic segments have legs, some for walking and some for eating. The lower part of the body has legs and ends with a small tail, which has the opening for waste. The legs are movable in segments. This is seen in Copepoda.The head and chest are sometimes joined together to make a cephalothorax. This creature called Ergasilus sp. does not have a hard outer shell and its eyes are not made up of many small parts. It has a long pair of small antennas and a shorter pair of antennas. It is a type of small creature that lives on fish and can be found in freshwater and saltwater. It can be found on the skin, fins, and gills of fishes, but it is usually found most often on the gills. They are called gill lice and can cause serious harm to fish when they heavily infest them. They have also been found to spread other diseases to fish. Ergasilus is a type of parasite that only uses fish as its host. Ergasilus can swim around for long periods without being attached to anything, and when the male and female swim together, they mate. The male then passes away. Egg incubation happens when the eggs are still attached to the female. The babies are born and released into the water. The young animals go through four growth stages before they become fully grown. There are many types of Ergasilids and they can live on different hosts.

Ergasilus can infect many different types of fish such as eels and herrings. Ergasilus hurts fish by sticking to them using special hook-shaped antennas. The feeding apparatus hurts the host fish more when it puts the long needle into the skin and tissues, leading to bleeding. Ergasilus survives by drinking the blood and body fluids of its host. Interesting facts: Ergasilus does not harm or cause sickness in humans. Ergasilussp is a type of parasite. This can be seen on the gills of various types of freshwater fish. Cooking fish destroys the parasite. ErgasilusspSalmonicola are small animals that attach themselves to fish by burrowing a special body part called a bulla under their skin or gills. This little bubble helps keep the young Salmonicola animal in one spot, usually on a part of the fish's bone or cartilage. This means that it stays in one place on the fish for its whole life. Gill tissues can get damaged a lot from the parasite sticking to them, eating them, or just being there. The parasite eats the fish's flesh and body fluids. As the parasite gets bigger, the females develop two egg sacs at the end of their bodies. You can see these things without using any tools. In some types of Salmonicola, the bags that hold the eggs are dark brown or black. In other types, they are a lighter color, like cream or tan.

The life cycle of Salmonicola is straightforward. The pouches of eggs on the back end of the female's body release eggs into the water. The eggs turn into baby worms inside the egg shell and then break open to spread and infect another fish. The baby parasites will die in one or two days if they can't find the right fish to live on. The anchor worm is a type of parasite that often infects fish. It is easy to see without using any tools and can grow up to 10 to 12 millimeters in size. The parasite digs into the fish's body, going under a scale. Usually, only the body and tail of the parasite can be seen. If the anchors used to attach itself to the fish stay on, it can cause damage and lead to bacterial infections at that spot. Learnaea can lay eggs in

the pond that are difficult to see and can hatch when the environment and water temperature are suitable. Usually, the parasite sticks to the back or tail fin of the fish. It is also commonly seen in many quantities on the stomach of fish when they are first caught from the muddy ponds. Caligusspp are types of parasites. It is a parasite that takes advantage of opportunities, and it causes problems for fish in the northern Atlantic, both in the wild and in farms. Caligusspp are tiny parasites that live on fishes' bodies. It has been discovered on over 80 different types of fish. The more fish we farm in the ocean, the more likely it is that this parasite will cause infections. Caligusspp are a type of tiny parasites. Branchiura, also known as fish lice, are flat crustaceans that temporarily live on the skin and gill chambers of fishes.

The body is flat from top to bottom. It has a hard shell that covers the head and chest. It has two compound eyes that cannot move and a mouth that sucks in food. The small antennae have been reduced. The first pair of mouth parts look like suckers. The tail is small and not divided into sections, and it does not have any gills. The fish louse, also known as Argulus Sp., lives on the skin of largemouth bass. Argulus is a type of parasite that lives on the skin, fins, and gills of fishes. They can make fish very sick and can even cause them to die if there are a lot of them. They have also been suggested as ways for other fish diseases to spread. Argulusspp are parasites commonly found on fish. It means that the organism's life cycle only involves fish as hosts. Argulus can swim freely for a long time and they mate while swimming. Bunches of tiny Argulus eggs are laid on things under water. When the eggs hatch, the young Argulus must find the right place to live within a few days or they will die. Isopods are creatures that can choose to be parasites or not. They attach themselves to the outside of animals and make depressions in the skin and muscles. Some live inside the mouth or gills of animals. When they do this, it stops the animal from eating normally or breathing properly. Glochidia are baby molluscs that live in fresh water. They attach themselves to fish fins and gills. They have hard shells made of calcium with tiny hooks on the inside. When the baby insects touch a fish that they can use as a home, they grab onto the fish's gills, fins, or skin. Then they are covered by the fish's cells. In simple terms, this means that at this point, they change and become young molluscs, and then they separate from the fish.

Originally, it was believed that myxozoans were made up of a single cell. However, they have been found to actually be made up of multiple cells and are closely related to Cnidaria. They are typical parasites found in fish and they need both invertebrates and fish to multiply and complete their life cycle. So, myxozoan infections are often found more in wild fish or fish that are bred a lot in outdoor fish ponds. The living things usually live in a particular host and specific body parts. So basically, the way the disease shows up depends on the germ that causes it, the living thing it infects, and where it infects that living thing. This means that certain tiny organisms called coelozoicmyxozoans live in holes in the body and usually don't cause much sickness. In contrast, histozoic forms, which live in the body's tissues, are more likely to cause illness. Fish infected with Myxozoan parasites in enclosed fish tanks cannot spread the infection unless the specific hosts that are needed for the parasites' life cycle are also present.

Myxozoans are split into two groups, Myxosporea and Malacosporea, and both groups can infect fish. Most myxosporeans usually have a life cycle that involves using certain worms as their host. However, there have been a few instances where they have a direct life cycle. In contrast, malacosporeans use bryozoans as the main host.There are two very important diseases caused by a type of parasite called myxosporea, which can infect fish that are kept as pets or for decoration. Goldfish get sick with renal dropsy because of a tiny organism called Sphaerosporaauratus. The illness is identified by kidney damage and fluid buildup in the abdomen and is commonly diagnosed by finding spores in kidney tissue samples. Fish that

are affected develop a very swollen belly, but they may not show any other signs of being unwell. Radiographs can show a lump in the back part of the kidney. The final diagnosis is made after examining the body and confirming it through a microscope. There is no real treatment option available. Henneguya is a type of tiny organism that can sometimes be found in fancy pet fish. It causes bumpy, white growths that usually appear in the fish's gills and can be seen without a microscope. Henneguya can be easily recognized by the split-tail part of its spore, which can be seen under a microscope. If you dry up ponds and put a lot of lime in them, you can get rid of infection.

This seems to happen because it reduces the number of the animals that spread the infection. An aquarium infection can go away on its own if there are no other animals that can carry the infection. Sometimes, finding a cyst by accident is not a big deal. However, if cysts are spread all over and not just in one place, it can cause serious harm.Some common diseases in aquaculture are whirling disease, proliferative kidney disease, and proliferative gill disease. Myxoboluscerebralis is the cause of whirling disease. Fish become infected when they are young and a parasite affects the cartilage in their backbone and head. This causes their bones to grow in abnormal ways that can be seen. When baby fish are scared, they often start spinning their tails quickly in circles. The illness is sometimes referred to as blacktail because the part that connects the body to the tail and the tail itself may become darker in color. Fish that have been cured of an illness can still carry the illness. Grown-ups do not display changes in their behavior, but problems with their bones caused by infections do not go away. Whirling disease can be stopped if you buy healthy breeding animals and keep them in a place without the worms that carry the disease. A possible diagnosis of whirling disease is made by finding spores on the skulls of infected fish. The diagnosis can be confirmed through examining body tissues or testing the blood. Some states are worried about whirling disease.

The Monogenea flatworms are parasites that only live on skin and gills. They have simple life cycles and are often harmful to their hosts. Some species like to live inside certain body parts like the throat, stomach, back kidney, or bladder. Freshwater parasites are very small, usually between 0. 1 and 08 millimeters They can only be seen using a microscope. However, there are some types of parasites that live on marine fish, which are bigger and can be seen with the naked eye. Monogeneans have a unique organ called the haptor that helps them stick to surfaces. The haptor has big and small hooks. In aquariums and fish farms, fish can quickly get parasites due to being infected and transferring worms to other fish in the tank or pond. Although some species of fish only thrive in specific environments, the ones commonly found in fish tanks are not as picky. The two most common types of monogeneans in freshwater fish tanks are gyrodactylids and ancyrocephalids. Gyrodactylus is a type of parasite that often affects pet fish. It usually gives birth to live babies and is commonly found on the skin and eyes of the fish. On the other hand, ancyrocephalids, another type of parasite, lay eggs and attach themselves to the gills of the fish. Dactylogyrids are small parasites that lay eggs in the gills of certain fish, such as goldfish and koi. If there are a lot of these monogeneans, they can cause a large number of fish to die.The capsalids are a big group of parasites that live on brackish and marine fish. They include Neobenedenia and Benedenia, which are important parasites on marine fish. They stick to and eat the skin, including the eye and gills. The capsalids lay eggs that are sticky and can easily be spread through objects called fomites.Fish that are infected with monogeneans may behave in a way that shows they are irritated, such as quickly moving and rubbing their bodies against things in their tank. Fish become light in color when their colors fade. They breathe fast and their gill covers puffs up, showing swollen and light-colored gills. Small areas of skin show up with small areas of bleeding and sores. If the eyes are affected, you may notice a sore on the cornea. Death can happen suddenly or over a long period of time. Praziquantel, which is a medicine,

is the best treatment for a certain type of infection called monogenean in fish. It works by putting the fish in a bath with a specific concentration of praziquantel for a long time. This treatment is used for both freshwater and marine ornamental fish. Formalin is the only way to treat food fish. When you use formalin to get rid of egg-laying monogeneans, it is better to treat them multiple times, with a week in between each treatment. This is because the eggs of these parasites are not easily killed by the chemicals in formalin. In the past, a substance called organophosphates found in a concentration of 0. 25 mg per liter of water has been used to treat ornamental fish. However, it is now believed that using praziquantel is a better and more effective treatment option. It is best to not use organophosphates in systems with elasmobranchs, characins, and cichlids. Freshwater dips of 1-5 minutes can partly remove some monogeneans on marine fish. However, this method does not harm or remove the eggs. To avoid getting sick, don't bring in fish that are already sick.

CONCLUSION

Fish diseases are big problems for the fish farming industry in coastal states of India. Aquatic animal diseases and measures to prevent them have not been focused on as much as diseases in livestock animals. The expansion of aquaculture farming is causing new issues related to diseases in fish, and as we learn more about how diseases develop, we are able to better monitor and control them. The world is becoming more connected and global trade in the fish farming industry is growing. This means that there are now more ways for germs and diseases to move from one place to another. The movement of aquatic animals across borders helps diseases spread quickly.

The research on parasites in fish farming in India is very important. However, there is a lack of detailed studies on how these parasites spread, how they affect the fish, and there are not enough studies on parasites in general. The problems we can investigate in this field, as well as the things we need to focus on in the short and long term, are listed below. There is a need for fish parasitologists to work together and connect with each other. They should figure out what the most important research topics are in the field of fish parasites. They should also use biotechnology to help diagnose and control these parasites. Additionally, fish parasitologists should strengthen their connection to the field because there aren't many people working in this specialized area. They can do this by either working on a specific research project at their institute or by collaborating with other fisheries research institutes or institutions that study fish parasites.

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CHAPTER 8

MICROBIAL WORLD: EXPLORING THE BACTERIOLOGY OF FISH

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ABSTRACT:

Bacterial diseases cause a lot of deaths in fish, both in their natural environment and in fish farms. Most of the microorganisms that cause diseases are naturally found in the environment and help break down organic and mineral matter in water. They use these substances to grow and reproduce. Several researchers have found that the types of bacteria found in fish are similar to the types of bacteria found in the water they swim in. In 1980, a group of researchers called Kim and others. In the year 2006. These tiny creatures are basically harmful germs that enter the body of a fish that is already weakened by stress or other diseases. The most important group of small organisms in this context is the bacteria that can move, called motile aeromonads. There is a possibility that other bacteria also have a big role, but we haven't studied them enough yet. Some types of bacteria rely on fish to survive and cannot live without them. Even though they can live in water for different amounts of time, they seem unable to reproduce much outside of their host. The diseases caused by these main pathogens are usually caused by stress. Fish that are infected but still healthy do not die as long as the environment is good. However, they can carry the virus for a long time and infect other fish, especially when they are stressed.

KEYWORDS:

Bacteria, Disease, Digestive System, Fish, Organisms.

INTRODUCTION

Many research papers about the microflora of fish only talk about bacteria and ignore other organisms like eukaryotes. Anaerobic bacteria that live in the digestive tracts of fish have not received much attention or study. This could be because it is difficult to study them using current methods. However, there is growing evidence that these bacteria are present in large quantities in both freshwater and marine fish. This article will gather and summarize the information about bacteria found in fish. It will focus on the types and amount of bacteria present in healthy fish and their role. We won't talk about different problems that fish can have because there is already a lot of information available about it. However, sometimes disease-causing germs can be found on fish that don't appear to be sick. It is unclear whether these associations represent a stage where a person has the disease but doesn't show symptoms, a first step before the disease develops, or a mutually beneficial relationship. For instance, a type of bacteria called Flavobacteriumpsychrophilum can cause diseases in salmon and rainbow trout. Scientists have discovered this bacteria in different parts of healthy Baltic salmon, such as the kidney, spleen, brain, fluid in the ovaries, eggs that haven't been fertilized, and sperm. It seems that fish are regularly exposed to these bacteria in water and sediment[1], [2].

These living things will definitely affect the tiny plants and animals that live on the outside of fish, including their breathing organs. Also, our body's digestive system will get water and food that contains tiny living things called microorganisms. Definitely, colonization can begin when the egg or larvae form, and then carry on as the fish grow. So, the amount and

types of tiny organisms in the eggs, on the food, and in the water, will affect the microscopic life in the growing fish. Additionally, it is known that we can somewhat change the microorganisms in young fish by using probiotics, which are live food supplements containing microbes that can temporarily or permanently live in the digestive system. Based on what has been written, we can conclude that there are three possible outcomes when bacteria comes into contact with fish. The animals and plants that live near the fish can become friends with and even live on the outside of the fish. There could be a buildup of living things where there is harm, like when scales are missing or the skin is scraped. The organisms can get into the mouth through drinking water or eating food, and travel through or settle in the digestive system. The tiny living things that touch fish bodies can be stopped by the small living things already on the fish or by chemicals on the fish that stop them from growing[3], [4].

The main problem is to figure out if we can tell the difference between the normal bacteria on fish and other bacteria that might be on them temporarily. This could be bacteria in the water near the fish or in their stomach or intestines. Sadly, it seems that most publications do not talk about this problem. the surrounding soil. The rhizosphere is the area around plant roots, and the phylloplane refers to the surface of leaves. The place around leaves, called phyllosphere. We know that bacteria that come from outside sources can live in fish. For instance, the bacteria called Escherichia coli can survive and grow in the digestive system of rainbow trout after eating contaminated food.At first, only a few types of bacteria, called coryneforms and Pseudomonas, are found in the digestive tract of the sac fry. It is possible that some bacteria are eaten during the yolk-sac stage, which leads to the creation of the first bacteria in the intestines. It has been found that bacteria start growing in the digestive system of turbot larvae when they begin to eat. At that time, Aeromonas and Vibrio bacteria are most common.

When studying the bacteria in the intestines of young sea bream and sea bass fish, researchers found that giving them rotifers as food resulted in a lot of V. In simpler terms, the text is about a bacterium called anguillarum, specifically the V strain. Tubiashii and nonvibrio groups are two different groups of organisms. However, when given Artemia as food, the majority of V was able to regain strength. Alginolyticus is a type of bacterium called Vibrio. V proteolyticus is a type of bacteria. Harveyi and V. Natriegens can be explained in simpler terms. These experiments showed that the changes in the main parts of the microorganisms showed the presence of bacteria in the food. Yes, the presence of vibrios was not observed until the larvae reached the end of their developmental stage. The younger fish have fewer different kinds of organisms compared to the older fish. Some researchers think that this might be because certain plants are affecting the diversity of organisms. Many different types of bacteria have been found in the stomachs of adult fish that live in freshwater[5], [6].

Some of these bacteria include Acinetobacter, Enterobacter, Escherichia, Klebsiella, Proteus, and Serratia. Another type called Aeromonas has also been found. Scientists have been able to identify these bacteria using a method called microplate hybridization. Sobria and A are two things or concepts. Veronii, Alcaligenes, Eikenella, Bacteroides, Citrobacterfreundii, Hafniaalvei, Cytophaga/Flexibacter, Bacillus, Listeria, Propionibacterium, Staphylococcus, Moraxella, and Pseudomonas. In a study with pike perch, researchers found that Moraxella and Staphylococcus were only found in this fish's habitat and not in the digestive system of other fish species. New studies have shown that the types of microscopic organisms in the intestines of rainbow trout vary depending on where they come from, like a fish farm. These studies found that the most common types of organisms in the intestines are bacteria called Citrobacter, Aeromonas, Pseudomonas, and Carnobacterium. These bacteria are part of a

group called Proteobacteria, and there are also some other types of bacteria that are called Gram-positive bacteria.

Scientists have found certain types of bacteria in the stomachs of adult marine fish. These bacteria are called Aeromonas, Alcaligenes, Alteromonas, Carnobacterium, Flavobacterium, Micrococcus, Photobacterium, Pseudomonas, Staphylococcus, and Vibrio. Vibrio is the most common type of bacteria found in the fish stomachs. iliopiscarius means a person who fishes on riverbanks. There are special groups of big bacteria called gigantobacteria that live inside the stomach of surgeonfish in the Red Sea and Indo-Pacific Region. In simple terms, researchers found methanogens in the digestive system and poop of flounder fish from the North Sea. They used a specific method called nested polymerase chain reaction to detect these methanogens. In this study, the 16S rDNA sequences showed that there was a high similarity to a specific type of archaea called Methanococcoidesmethylutens. Carnobacteria are often found on or inside fish, especially in their stomach and intestines.

So far, research has focused on categorizing different organisms, specifically noting the existence of C. Piscicola and C are two things. Piscicola is similar to bacteria and can potentially be used as probiotics in aquaculture. Other types of bacteria that produce lactic acid and are found in the protective layer in the body have been compared to Lactobacillus plantarum, Leuconostocmesenteroides, and Streptococcus species. In another study, certain types of bacteria were looked into. These bacteria included Lactobacillus, Enterococcus durans, Lactococcus, Vagococcus, and C. Divergens means things that are different from each other, while C means a term or category for something. Scientists found piscicola in freshwater fish, specifically brown trout, and studied their characteristics using numerical analysis. A new type of creature, called C, has been discovered. A substance called inhibens was found in the intestines of Atlantic salmon. It was shown to kill bacteria that can harm fish, particularly Aeromonassalmonicida and Vibrio anguillarum[7], [8].

DISCUSSION

Water that has a lot of organic material in it, which helps bacteria grow, and that has rapidly changing temperatures, too many fish in one place, injuries, and being moved around are the most common things that make fish more likely to get sick. These things are very likely to happen in fish farms. In the past few years, there has been a big increase in aquaculture around the world. This has caused the expected rise in bacterial diseases that have been known for a long time, and also the development of new infectious illnesses. When studying bacteria found in sick fish, we should consider environmental stress. Simply treating with medicine or giving vaccines may not fully heal the fish unless we also address the underlying environmental factors. The ability of a tiny organism to invade and cause harm is a very important part of how dangerous it is. Some types of bacteria like Aeromonassalmonicida or Mycobacterium marinum are known to cause serious diseases in fish without needing much evidence of stress. Other bacteria like Aeromonassobria or Aeromonashydrophila can only infect fish that are already under a lot of stress. There is another type of bacteria that can make fish sick. These can be described as organisms that feed on dead or decaying matter and are able to attack and damage the organs of fish temporarily. They might contribute to the fish's death, but they are not directly harmful on their own. They also rapidly reproduce in the body once death has occurred, so they can easily be separated from those individuals. Because of this, it is important to be very careful when understanding the meaning of bacteria found in sick or dead fish that are collected for testing[9], [10].

All systems for organizing types of living things have a subjective element to them, and this is especially true when categorizing bacteria that cause disease in fish. These bacteria come

from different groups and the only thing they have in common is that they can make fish sick. There are many similar harmless species in the water, but we don't have a detailed way to classify them or their families. This is mostly because there was not a strong economic reason for studying and defining fish pathogens and fish spoilage bacteria that are not economically important. Scientists have found out that about 92 different types of bacteria can cause diseases in fish that live in fresh water or the ocean. As we get better at identifying bacteria and updating how we organize and classify them, the number of different types of bacteria that are known to cause disease keeps changing. Some changes in the classification of bacteria have happened. For example, Haemophiluspiscium is now known as atypical Aeromonassalmonicida. A new category called Renibacterium has been made for the bacteria that cause kidney disease. Additionally, the bacteria previously named Chondrococcus or Cytophaga are now called Flavobacterium.

The dangerous bacteria Vibrio anguillarum got a new name called Listonellaanguillara in 1985, according to MacDonnell and Colwell. However, most people still call it Vibrio anguillarum, even though some reports use a different name. Most diseases in fish are caused by small bacteria that are shaped like rods and are part of different families of bacteria. These families include Enterobacteriaceae, Aeromonadaceae, Pseudomonadaceae, and Vibrionaceae. Normally, they bring about diseases that involve blood poisoning and ulcers. The long, gliding bacteria called Flavobacteriaceae can sometimes cause a lot of fish to die, even though they usually don't make warm-blooded animals sick. Certain types of microorganisms, which are mainly found in fish, can sometimes cause serious harm to the fish. These microorganisms are not very common, but they can still cause significant damage under certain circumstances. Some of these microorganisms are able to resist acid, which adds to the difficulty of treating them. Some types of Streptococcaceae, which were not thought to be important, are now being recognized as significant disease-causing agents in certain intensive fish farming conditions, like raising tilapias[11], [12].

Antibacterial substances are commonly used to treat fish diseases caused by bacteria. In some cases, they are also given to prevent diseases that may occur due to stress caused by activities like sorting or transporting fish. Drug resistance can happen naturally or it can be gained over time. For instance, certain types of bacteria that are Gram-negative can naturally withstand penicillin and bacitracin because these antibiotics work by stopping the production of cell wall parts that are only present in Gram-positive organisms. Most drugs that kill microorganisms work by stopping the cell ribosomes from working. Microorganisms can become resistant to these drugs by either changing the structure of the ribosomes through gene mutation or by getting infected with a resistant R-factor plasmid. Plasmids are small rings of DNA that can copy themselves independently. These bacteria can infect many different types of hosts and can easily move from one type of bacteria to another. Plasmids called R-factors have genes that make enzymes. These enzymes change antibiotics into forms that don't work. These small structures in bacteria can make them resistant to multiple antibiotics, which can result in the creation of strains of bacteria that are resistant to many different antibiotics. Aoki et al. were the first to show that R-factor can be transferred to fish pathogens. In 1971, a scientist discovered that specific types of bacteria called Aeromonassalmonicida had traits that made them resistant to many antibiotics and chemical treatments.

The workers found transferable R-factor plasmids in drug-resistant strains of different bacteria. The movement of genetic material has played a big role in spreading resistance to antibiotics. This sharing of genes between bacteria from different sources like humans, animals, fish, and the environment has been happening for a long time. In 2009, researchers

looked at how certain genes can make a type of bacteria resistant to different antibiotics. They studied a specific strain of bacteria called Edwardsiellatarda that causes diseases. This clearly showed how it is important to use antibiotics carefully in the water, whether they are used by humans or animals or in fish. Using low levels of antibiotics to prevent diseases can make it more likely for dangerous bacteria to become resistant to many medications. These things may eventually cause diseases that cannot be treated with antibiotics. In many parts of the world, this is already happening. Furthermore, when bacteria infected with R-factor are present in aquaculture systems, they can pass on antibiotic resistance to other microorganisms, which could include harmful bacteria for humans.

Vibriosis is a very important disease that affects fish in the ocean and other bodies of saltwater or slightly salty water. It was first found in eels and called red pest, but now it has been found in many different types of fish. In nature, the illness usually affects fish in shallow water during the end of summer when it's hot. In fish farms, the disease can happen at any time of year, but it is more likely, and more severe, in late summer. There have been reports of outbreaks in freshwater animals caused by eating leftover fish from the ocean. In 1968, Hacking and Budd wrote a paper on a certain topic. In 1971, another person named V. also wrote a paper on the same topic. Anguillarum is a harmful bacteria that causes significant damage to freshwater ayu fish in Japan. The experts used to think that the infected fish in fish farms came from scavenger animals that eat around the cages. But now we know that it is actually caused by a bacteria called V. Anguillarum is a common type of bacteria found in the digestive system of healthy fish, both in the wild and in raised environments.

It is also commonly found in the tissues of small aquatic animals like rotifers and other invertebrates. The time it takes for a disease to develop in fish can change depending on the following factors: temperature, how strong the strain of the disease is, and the amount of stress the fish are experiencing. Different temperatures are needed for the disease to grow. Salmon and turbot start having problems at temperatures between 10-11 degrees Celsius, while flatfish and Anguillidae usually start experiencing problems at temperatures around 15-16 degrees Celsius. Deaths in a disease outbreak in farmed fish can be more than 50%, especially in young fish. Clinical pathology refers to the study of diseases in animals. The first signs of losses or harm usually appear in the fish that are most at risk. These signs can include loss of appetite, getting darker in color, and sudden death. In young turbot and salmon, these may be the only signs, but they may also develop swelling around the eyes or in the abdomen. In old fish, the disease progresses in two stages a severe phase and a long-lasting phase.

The fish that are severely affected have swollen, dark skin sores that burst and release bloody fluid. The sores may be very deep and dead. Internally, the main thing is that the spleen gets bigger and turns into liquid. The kidney also turns into liquid, and there are small red spots on the inner and outer lining of the abdomen. Focal bleeding may also be seen on the outer layer of the heart and the gills are typically lighter in color. In bigger fish, there are also severe bleeding wounds inside their muscles. In fish with long-term infections, skin sores can form and turn into granulomas. Gills usually stay pale, and when bleeding occurs in the abdomen, it can cause sticky connections between the organs. The mouth area and the eye are often damaged in certain types of fish, particularly in gadoids and turbot. The first sign is when the cornea becomes cloudy, which can later lead to the formation of ulcers in the eye and the removal of orbital contents. Looking at the tissue samples from cases that happened suddenly, we found serious problems with the heart muscle.

We also saw damage in the kidneys and spleen, as well as swelling around the eyes. In simpler words, acute cases have less serious heart problems but are marked by skin lesions.

These skin lesions are red areas that go deep into the muscles. Even though these skin problems are contained for a while by a layer of compacted skin cells, they will eventually develop into open sores. There is a serious muscle cell death happening, with a cluster of cell debris, white blood cells, and bacteria in the middle of the affected area. In the liver, there is a small area of dead tissue, while in the spleen and kidney, there is a large loss and death of blood cell-producing elements. In the kidney, damage spreads to the filters, tubes, and sometimes the hormone-producing cells of the surrounding tissue. In long-term situations, the strong toxin from the Vibrio bacteria causes a type of anemia where red blood cells are destroyed. This leads to a lot of iron buildup in certain parts of the spleen and kidneys that produce blood cells.

The bacteriology of angle may be a complex and multifaceted field of think about that envelops a wide run of subjects, from understanding the part of microbes in angle wellbeing and illness to their noteworthiness in aquaculture and natural biological systems. This talk will give an diagram of the key angles of angle bacteriology, counting the sorts of microbes related with angle, their parts in angle wellbeing and malady, the significance of bacteriology in aquaculture, and the environmental importance of fish-associated microbes. Angle are an basic component of worldwide nourishment security, giving a noteworthy source of protein for human utilization. Be that as it may, the wellbeing and well-being of angle populaces are regularly undermined by different bacterial pathogens. Understanding the bacteriology of angle is pivotal for the administration and maintainability of fisheries and aquaculture hones. Fish-associated microscopic organisms play differing parts in oceanic biological systems, from keeping up water quality to affecting the wellbeing of sea-going living beings.

Angle harbor a different cluster of microbes both remotely and inside. These microscopic organisms can be broadly categorized into commensal (safe), advantageous (probiotic), and pathogenic bunches. Commensal microscopic organisms are regularly safe and frequently give benefits to angle. They can be found on the skin, gills, and within the intestine of angle. These microbes are vital for forms such as absorption, supplement retention, and security against pathogenic trespassers. For illustration, a few commensal microbes can compete with pathogenic microbes for assets, avoiding infection. Probiotic microscopic organisms are intentioned included to angle societies to advance their wellbeing and move forward development. These advantageous microbes can outcompete pathogenic organisms, fortify the fish's resistant framework, and upgrade supplement assimilation. Common probiotics utilized in aquaculture incorporate different strains of lactic corrosive microbes and Bacillus species. Pathogenic microscopic organisms are capable for a wide extend of illnesses in angle. These microbes can taint different tissues, counting skin, gills, and inside organs. Common angle pathogens incorporate Aeromonas, Vibrio, Flavobacterium, and Edwardsiella species. Pathogenic microbes can cause side effects such as skin injuries, blade spoil, gill harm, and systemic contaminations, driving to horribleness and mortality in angle populaces.

Natural stressors, such as destitute water quality and temperature vacillations, can debilitate angle resistant frameworks and make them more helpless to bacterial diseases. Management practices that minimize stressors are basic for illness avoidance. Aquaculture could be a critical source of angle for human utilization, and the administration of bacterial maladies is pivotal for its supportability. Bacteriology plays a central part in a few viewpoints of aquaculture. Bacteriology is basic for diagnosing bacterial infections in aquaculture. Refined and distinguishing bacterial pathogens from contaminated angle tissues are key steps in malady conclusion, permitting for focused on treatment and illness administration. Understanding the the study of disease transmission and biology of fish-associated microbes

is basic for illness anticipation. This incorporates overseeing water quality, actualizing biosecurity measures, and creating immunizations against particular bacterial pathogens.

Given the potential dangers related with anti-microbial resistance, bacteriology educates the dependable utilize of anti-microbials in aquaculture. Checking anti-microbial resistance designs in fish-associated bacteria is fundamental for minimizing the improvement of antibiotic-resistant strains. The utilize of probiotics in aquaculture may be a developingfield. Probiotic microscopic organisms can enhance fish health and diminish the predominance of pathogenic microscopic organisms in aquaculture frameworks. Bacteriology investigate makes a difference distinguish reasonable probiotic strains and optimize their application. Fish-associated microbes are not as it were imperative for angle wellbeing but too play a noteworthy part in sea-going environments. Microbes are basic for supplement cycling in sea-going situations. They break down natural matter, discharging supplements that are taken up by phytoplankton and other oceanic living beings. Fish-associated microbes contribute to this prepare by metabolizing natural materials in angle squander. Certain microscopic organisms offer assistance keep up water quality in aquaculture frameworks by changing over poisonous alkali and nitrite into less hurtful shapes. This is often vital for avoiding water contamination and guaranteeing the wellbeing of angle populations.

CONCLUSION

In summary, studying bacteria in fish is important for learning about and taking care of underwater ecosystems and fisheries. Bacteria are really important for fish to stay healthy, keep diseases away, and make sure our food is safe. It is important to keep an eye on and manage the number of bacteria in aquaculture systems. This is necessary to make sure that fish stay healthy and that the seafood we eat is safe. Furthermore, studying bacteria that are found on or near fish helps us learn more about the different types of microscopic organisms and how they interact with each other in water habitats. New developments in studying fish bacteria have allowed scientists to learn more about how these bacteria cause diseases and how they can be used to improve fish health. More research is needed to make sure we have enough fish to catch and eat while also keeping our seafood safe. Microscopic organisms connected with other microorganisms within the sea-going environment, impacting the generally microbial community structure. These intuitive can have cascading impacts on environment flow, counting supplement cycling and nourishment web intelligent. Considering the composition and differing qualities of fish-associated bacterial communities can serve as environmental wellbeing indicators for oceanic biological systems. Changes in bacterial communities can flag unsettling influences within the environment. The field of angle bacteriology proceeds to advance, driven by progressions in atomic science, genomics, and natural checking strategies. Metagenomic approaches permit for the comprehensive think about of microbial communities related with angle. These procedures empower the distinguishing proof of particular bacterial species and their useful parts in angle wellbeing and environments.

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CHAPTER 9

FUNGAL WORLD : EXPLORING THE MYCOLOGY OF FISH

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ABSTRACT:

We know that aquatic fungi can make fish sick. Almost all freshwater fish, some saltwater fish, and fish eggs that are developing can get a fungal infection. The most usual fungal diseases of fish are saprolegniasis, a disease caused by Achlya, branchiomycosis, epizootic ulcerative syndrome (EUS), and ichthyophoniasis. Saprolegniasis is a common infection that affects freshwater fish and some estuarine fish in warm and tropical waters all around the world. There have been many reports of different types of Achlya infecting fish, but unlike Saprolegnia, there is no consistent and regularly seen medical condition. Branchiomycosis, also known as gill rot, is a type of parasite that affects the tissue in fish's gills. EUS is a common condition that affects wild and farmed fish living in freshwater and estuarine environments during certain seasons. Ichthyophoniasis is an internal fungus that causes a chronic and systemic disease called granulomatosis.

KEYWORDS:

Brown Alage, Fish, Infections, Mycology, Oomycetes.

INTRODUCTION

The plants that do not have tubes to transport water and nutrients are called nonvascular plants. These plants are different from algae because they do not have chlorophyll, which is a substance that helps plants make food. In the past, these plants were called fungi. When a cell doesn't have chloroplasts, it can't use sunlight to make energy. This means it has to live as a parasite or by using dead material for energy. With the new use of molecular techniques to classify organisms, it is now clear that using one term to describe such diverse groups is not appropriate. As a result, they are now commonly called two different groups: Fungi and Oomycetes. There are over 100,000 types of fungi and oomycetes, which have many different shapes. Some of these can cause serious diseases in fish that are important for the economy. The types of fungi that live on fish are not very common, but they are very hard to categorize. Many of them are classified as imperfect fungi because we only know them in their asexual state, even though it is believed that they also have a sexual stage. The types of fungi and oomycetes that often harm fishes From a diagnostic standpoint, these organisms can be divided into two groups: fungi with cross cell walls called septate fungi, and those without called aseptate species. These can be found among both fungi and oomycetes[1], [2].

The Oomycetes are a very important group of diseases that affect fish. These organisms look like fungi but they are actually more closely related to golden-brown algae. They belong to a group called Chromista or chromalveolates, so they are not considered true fungi. These organisms are called Stramenopiles, which are a group that includes golden-brown algae and diatoms. Oomycetes are divided into three groups: Saprolegniomycetidae, Hipidiomycetidae, and Peronosporomycetidae. Most fish and animal disease-causing oomycetes are part of the Saprolegniomycetidae group, which includes two categories: Saprolegniales and Leptomitales. In the group of Saprolegniales, there are three main types called Saprolegnia, Achlya, and Aphanomyces. Everyone can make fish or shellfish sick. Some types of

Saprolegnia, a type of fungi, such as S. Scientists think that ferax are partially the reason why amphibians are decreasing in natural environmentsThis infection is causing a lot of damage to crayfish populations in the wild. It is one of the top eight unwanted invaders on a global list. Oomycetes cause a specific type of disease that is easily recognizable. A particular oomycete infection in a bug was the first ever recorded case of this kind of disease in any animal with a backbone. Oomycetes are found in many water environments, but only a few of them are parasites. But they all have the same trait of making mobile spores with two tails. Asexual reproduction in Oomycetes is done through zoospores which are made in a special structure called a zoosporangium.This is the most important way they spread and reproduce. However, they also have sexual reproduction where two gametes fuse together to form a thick-walled spore called an oospore or resting spore. This is why they are called Oomycetes. do not have dividers between cells, coenocytic have multiple nuclei in each cell, and usually branched. They are similar to fungi but belong to a different group of organisms. They don't have divisions between them. Saprolegniales and Saprolegniaceae are families of organisms called Oomycetes[3], [4].

Among the different orders within Oomycetes, most of the fish diseases are caused by the family Saprolegniaceae. The main genera causing these diseases are Saprolegnia, Achlya, and Aphanomyces. The classification system for the members of the order is complicated, but scientists are starting to understand it better using molecular methods to determine how they are related. Oomycetes are a type of organism that are similar to fungi, but they are actually protists. They are classified with diatoms, brown algae, and golden-brown algae. In the past, people often called them pseudofungi. The Saprolegniaceae are types of mold that live in water. They have a lot of branches and do not have any walls dividing their structure. They look like tufts of cotton in the water. The strands called hyphae have different shapes in different organisms, but they all have a substance called cellulose. Although the long strands that make up a fungus are not separated, the reproductive structures are separated from the other strands by a structure called a zoosporangium. Inside this structure are two swimming cells called zoospores. Different species can be distinguished by looking at how their spores are released and how their zoospores behave. With certain species like Saprolegnia and Achlya, it is also important to look at their oogonium, which is their sexual structure, in order to tell them apart. Some types of animals live in slightly salty water, but they cannot live in water that is too salty[5], [6].

This group is really important in the study of fish diseases, but scientists have had a hard time figuring out how to classify it. There are many reasons for this, but it started in the late 1800s when people became interested in a disease that was affecting Atlantic salmon. The disease was caused by a type of fungus-like organism called an oomycete. At that time, scientists believed that a type of fungus called Saprolegniaferax was the only cause of the condition. However, it is now believed that the researchers were actually studying the later stages of a condition called ulcerative dermal necrosis (UDN). Later on, a scientist named called the species Saprolegniaparasitica. This name was given to include all the Saprolegnia fungus that was infecting fish and reproducing without the need for a mate. Afterward, most people agreed that using certain characteristics of oogonium, the taxon S. The term parasitica should be replaced with the similar word saprobiotic which refers to the common species Saprolegniadiclina. This species is also known as the SaprolegniaparasiticaSaprolegniadiclina complex[7], [8].

For a long time, it has been difficult to determine the specific classification of the fish disease-causing saprolegnias. This caused a lot of confusion among experts, as mentioned by Diéguez-Uribeondo et al. It was stated that it is difficult to accurately determine the specific

type of parasite Saprolegnia using traditional classification standards and tools. To clear up this confusion, conducted a thorough study that looked at both the evolutionary relationships and classification aspects of the S. Diclina is a medication. A group of species that are parasites. They looked at the genetic material of a specific part of the cells in a type of fungus called Saprolegnia. They also studied the appearance of the cysts, how they grow and the ability to produce new spores in many different samples of this fungus. The S is a single letter in the alphabet. Diclina is a condition. The parasitica complex is taken from various hosts and places. The results agreed with Beakes et al. 's suggestionIn 1994, the name S was given to someone. Parasitic isolates were obtained from lesions on live fish, including salmonid. These isolates had bundles of hairs and a retracted germination pattern.

So also, Saprolegnia attack in a assortment of fishwithout any self-evident earlier damage. In any case, infinitesimal injuries may have been display and Tiffney certainly found that plainly visible damage incredibly expanded the probability of contamination. Work carried out by Richards and appeared that in episodes of saprolegniasis in produce ing brown trout, a shape of Saprolegnia with a moo degree of homothallic sexuality has nearly continuously been included. This oomycete shows up unable of creating sexual structures, in spite of delayed incubation on a assortment of media, but to a constrained degree at moo temperature. who reliably confined a comparable sterile shape of Saprolegnia from injuries of UDN of Atlantic salmon. The infective organize of the oomycete is the zoospore, as has been conclusively illustrated by NolardTintigner in experiments employing a variety of oomycetes to contaminate guppies and swordtails. Temperature incorporates a signifi cant impact on the create ment of Saprolegniacontaminations.While contamination fol lowing injury may happen at any temperature congruous with fishlife, most epizootics happen when temperatures are moo for that fish species.

In any case, the stretch of tall temperature may too actuate Saprolegnia attack. Channel catfishwithin the southern Joined together States are as often as possible influenced by a saprolegniasis known as winter slaughter , which comes about in incredible financial misfortune. Influenced fishappearSaprolegnia plaques on the skin amid the winter period, additionally create endophthalmia. A specifi c species is accepted to be included, in spite of the fact that its scientific categorization has not been completely defi ned, and the moo temperature is accepted to smother the typical basic and resistant instruments which would control it. In spite of the fact that the fingernail skin of the skin is itself considered to have a few against oomycete movement, bringing forth salmonids have a especially well created cuticle and however Saprolegnia disease is common. Essentially, intelligently develop salmonids regularly create diseases, while juvenile fishprimarytained beneath indistinguishable conditions don't . The expanded thickness and bodily fluid generation of sexually develop salmonid skin are sex hormone initiated impacts, and steroid metabolic changes have been appeared to happen specifically inside salmonid epidermis, in connection to sexual development. Tentatively, infusion of a assortment of hormones has helped the acceptance of oomycete contaminations in fish.

Saprolegnia injuries are central dark white patches on the skin of the fish, which, when inspected beneath water, have a cotton fleece like show up ance where the hyphal fi regrets expand out into the water. The early injuries are regularly nearly circular and develop by spiral expansion around the outskirts until injuries consolidate. At this afterward organize, the oomycete patches are regularly dim dim or brown in colour as the mycelium traps mud or sediment. In spite of the fact that dispersion is more often than not irregular, certain parts of the body may be especially included, for case the head locale in auxiliary contaminations of UDN of salmonids and beyond any doubt of the eel. Skin and gill injuries are by distant the

of disease of inside organs. Gill diseases of youthful salmonids frequently emerge from the mouth or branchial depression and can cause tall mortality in broil developed in surface water incubators. Intestinal disease in fi ngerling tolerate trout with Saprolegniaferax and a comparable disease, with Aphanomyces spp., which is by and large watched when broil still have remnants of yolk sac display. Contamination ordinarily happens by means of breeches within the epidermis or, within the last mentioned cases, through the intestine. There are no reports of contamination of inside organs through the vascular course, in spite of the fact that Nolard has depicted intrusion of blood vessels and resultant thrombosis, a condition more nor mally related with disease caused byBranchiomyces spp.

DISCUSSION

Saprolegnia is a type of fungus that often infects fish eggs that are being kept in an incubator. It usually starts on dead eggs and then spreads to nearby healthy ones. The time it takes for a wound to develop can be different depending on the environment. Sometimes when salmon fish get infected, they can die within 36 hours, especially if their gills are affected. 3Rewrite this paragraph using simpler language: Sure thing. Histopathology is the study of detecting and diagnosing diseases by examining cells and tissues under a microscope. The oomycete pathogen typically starts in one area and then spreads to nearby parts. It first invades a layer called the stratum spongiosum in the skin, and then continues to spread across the top layer of the skin, damaging it along the way. A shallow invasion of the skin can quickly cause problems with the body's fluid balance and the circulation of blood to the extremities. This can lead to shock because the body is unable to keep enough blood flowing. In more serious cases, typically when the surrounding environmental pressures are not as intense, the fungal growth can go through the skin and move between certain layers of muscles. In long-lasting injuries, there could be a bacterial infection that happens later. Although it is not frequently seen, that in their experiments with guppies, there were dead spots in the spinal cord which caused neurological symptoms. They also observed that there were blockages in the blood vessels caused by a type of fungus.

These fish are very small and the distance between their skin and spinal cord is short. In skin infected with Saprolegnia, there are many thin threads seen on the surface of the skin. These threads trap bits of dead cells and stuff from the water. Underneath this layer of mycelium, there are areas of dying tissue, which can range from shallow skin decay and swelling to deep muscle death and severe bleeding. Most skin sores are not deep, and the only change that can be seen in the skin is when it becomes soaked in water. This can be noticed by changes in how it absorbs certain stains and the collagen fibers in the skin become more blue. The body usually has a small reaction to inflammation, but when a bacterial infection happens at the same time, particularly when the body temperature is high, there is a noticeable increase in inflammation. The oomycete hyphae can be easily seen with a staining method called Grocott's technique, which shows up as a silver color[9], [10].

Loneliness or being alone. There are different ways to get rid of bacteria in colonies of Saprolegnia. All of these methods involve using bait and then growing them on agar. Prevention and medical care. Keeping fish in healthy and well-maintained conditions can help prevent diseases. Providing the right food, ensuring there are not too many fish in one place, and maintaining clean water are very important. However, even with these measures, adult male salmon might still get sick and die. If a fish gets saprolegniasis, it can be treated with different disinfectants on the outside. These are some substances: malachite green, copper sulphate, potassium permanganate, salt, and formalin. Malachite green has been a preferred treatment for a long time, but it is now illegal to use because it can cause mutations or birth defects.The genus Achlya is made up of several species that live off fish as parasites.

Unlike Saprolegnia, the zoospores of Achlya do not swim away from the zoosporangium. Instead, they form a hollow ball at its mouth. So, the first zoospore cannot move freely. Instead, the second zoospores that cause infection come out of the cyst and directly from the mouth of the zoosporangium. Many reports have shown that different types of Achlya can infect fish. However, unlike with Saprolegnia, there is no common and regularly observed medical condition associated with these infections.

In the tropics, things other than Saprolegnia were more important in causing deaths. This information comes from the research. They found that Achlya is very harmful to Puntius sp. fish that have been hurt or injured. and a type of fish called Colisa sp. This text means that there is only one species of Aphanomyces called Aphanomycesinvadans. It is a clone of this species. A major disease caused by a variety of organisms such as oomycetes, fungi, bacteria, and parasites, led to a significant outbreak among fish. Epizootic ulcerative syndrome (EUS) is a sickness that affects fish living in estuaries and freshwater areas. It is identified by the presence of unique fungal granulomas in tissue samples. Now it is also found in the Mediterranean and Africa. It moved from the Chesapeake Bay area in the United States to the eastern coast and the southern pond fish production areas. Economic experts have calculated that there are losses of at least $10 million every year. The illness is moving towards the west, and because it affects many aquarium fishes that are commonly sold internationally, it will probably spread even more. Almost all types of fish that live in freshwater and slightly salty water can get infected, but some specific species like Mugilcephalus, snakeheads, and Indian carps which are important sources of food are more likely to get sick.

It is different from other similar organisms because it grows slowly and has delicate hyphae. It is also very good at causing infections, just like it does in real life situations. Epizootic ulcerative syndrome is a disease that causes a lot of wild and farmed fish to die in a new area. The fish develop large, shallow ulcers that are grey or red in color and have a brown center that's dead tissue. Usually, ulcers are located on one side of the body. In a specific group of animals, all individuals with symptoms have sores in the same spot. Certain species die quickly, while others, such as the snakeheads, take a long time to die and can display a variety of severe and strange symptoms. This means that the back of the body has worn away completely and the bones in the head have decayed, showing the brain. The main problem in all cases is a big wound that goes deep into the muscle. It has a grayish-white dead layer on the surface made up of dying tissue and fungal strands. Below this is an area of damaged muscle tissue with cell death and very minimal cellular activity. When the injury has fully developed, the oomycete goes deep into the body and can invade the spinal cord or organs in the abdomen. The area is usually covered in a thick layer of long-lasting inflamed tissue made up of certain types of cells from the body. The strong mycotic damage that occurs is enough to kill most fish. However, opportunistic oomycetes, fungi, bacteria (especially Aeromonashydrophila), and protozoa also play a role in the eventual death of the fish.

People mostly agree that the organism belongs in the phycomycete group of the Entomophthorales, but there is still a lot of debate on exactly how to classify it. Ichthyosporidium looks under an electron microscope. They also put it in the group of Microsporidia. Currently, it seems that there are many tiny living things that are alike and likely connected. They are most likely fungi and are causing similar illnesses in different types of fish. The way animals grow and change throughout their lives can be different depending on the type of animal and the specific kind of fish. Different infections in marine fishes and explained in depth the process of their life cycle. The parasite goes through different stages in its life cycle. Its appearance changes when it is in different parts of the body and different animals. The stage commonly seen is called the resting or spore stage.

This is typically round or oval in shape and measures 10 – 250 micrometers in diameter. It has two walls that get stained positive with PAS and silver stains. The inside of the spore is often filled with small spaces, it has weakly blue color, can be stained with PAS, can also be stained with a silver dye called argyrophilic, and it contains more than one nucleus. These tiny particles may be found alone or in many amounts in different body parts and are often found together with other forms. The growing spore can be seen in a cross-section and is often noticed after death. It is made up of a part inside a cell that stretches out and is surrounded by a thick wall. This part pokes through another thicker wall.

These nonseptate macro hyphae increase in size to become up to 40 μ m wide. New spores, called hyphal bodies, can also be created from the hyphae. In salmon, the infection starts in their mouth. This is the first place where the infection happens. The hidden cysts in the digestive tract can turn into amoeboblasts. These amoeboblasts can then become amoeboid embryos when the outer wall of the cysts breaks. These things go through the lining of our body and get into our blood to spread to other body parts, particularly our muscles. They create new cysts which then attach themselves to nearby tissue and grow even more. Instead, cysts that are hidden in the gut may start to grow and infect the gut wall itself. They also come out of the body and, when they are ready, release harmful spores into the air. The living thing can grow on special food like Hagem's medium or Sabouraud dextrose agar mixed with 1% bovine serum. It can also grow in tissue culture medium. The growth happens a lot within 7 to 10 days when the temperature is best at 10 degrees Celsius.

In the past few years, scientists have been studying the evolutionary history of organisms with complex cells. Using information from DNA sequencing, specifically rRNA gene sequences, Grouped eukaryotes into eight separate categories or supergroups in the tree of life. These include opisthokonts, amoebozoa, plants, cercozoa, alveolates, heterokonts, discicristates, and excavates. Fungi and Mesomycetozoea, which are types of organisms, are grouped together with animals in the Opistokonta. The Mesomycetozoea are a group of organisms that are part of the animal group. They are located near the division between animals and fungi.

All the Oomycota are put into the Heterokont supergroup.Fungi are the most diverse group of living things on the planet, with 35 different groups and 129 categories. Most of the fungi that cause infections in fish are part of a group called Ascomycota. These fungi have spores that are thick-walled and unable to move. In the Ascomycota group, many different types of fungi have been found to cause infections in fish. Besides the Ascomycota, the Zygomycota, which came before them, have also been found to be able to cause disease. Most of the fungi that can cause infections in fish are not only parasites of fish. They also take advantage of other opportunities to cause infections. These are mostly types of fungi that can harm plants, live in soil, and can even cause infections in people with weakened immune systems.The fish pathogens in fungi, Mesomycetozoea, and Oomycetes are usually able to infect and cause diseases in many different types of fish. All three groups have the same number of species that are true generalists. Because more diseases are being reported and detected in farmed environments, most disease reports come from fish farms and involve fish species that are being raised intentionally for commercial purposes. This means that there might be a preference for certain fish species in reporting their vulnerability to these germs, and that their ability to infect a wide range of fish may be underestimated. Many species have only been found to impact one type of fish in the available information[11], [12].

Fungi and fungi-like pathogens have the special ability to infect many different hosts. They have the widest range of hosts compared to any other group of pathogens. Often, the most susceptible hosts are greatly affected by a strong and harmful form of a disease. The idea of

generalism in causing diseases is important because pathogens that can infect multiple hosts are more likely to appear through switching hosts. This is something that is often not taken into consideration. However, many experts agree that the best level of harm caused by a virus in one host is determined by a balance between how harmful it is and how easily it can spread to other hosts. So, the makeup of the community and how easily each person can get sick can change how easily a disease spreads and how severe the infection. We need to do experiments to understand more about diseases caused by fungi and similar microorganisms in different species of fish. This could mean situations where there is only one host and one pathogen involved, like in the study by Andreou et al. This means that the challenges faced were either caused by multiple hosts or a combination of multiple hosts. Furthermore, gathering information from experiments about the parts of these life cycles of disease-causing organisms that exist outside of a host organism, like zoospores, would help us measure how many are produced, how long they survive in the environment, and how well they can withstand different non-living factors such as temperature and pH levels. We need this information to create accurate models for testing how likely someone is to get sick, and to understand what factors control the different phases of infection and recovery. These models are called SIT or SEIR models.

CONCLUSION

Even though scientists have advanced in their understanding of tiny organisms and have been studying them for a long time, there is still a lot that we don't know about the role of small parasites in fish's environment. This is probably because fish live in habitats with cloudy water, making it difficult to observe and record them. But fish are important for the environment and for many people. Understanding viruses, prokaryotes, and small eukaryotes in fish populations is necessary to protect them and ensure there is enough food for everyone. Fungal and fungal-like microbes are causing serious declines in plant and animal populations. Here, we examine what we don't know about fungal and fungal-like parasites and pathogens in fish.

We look at how this relates to the environment and how it affects fish populations. This information can help us better monitor these pathogens in the wild and understand their impact on fish. As more fish are being moved around the world for farming and released into the wild for sport fishing, along with human-made changes to their habitats, we expect that the harmful effects of diseases on wild fish populations will become a big threat to the diversity of freshwater life.

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CHAPTER 10

NUTRITIONAL PATHOLOGY: UNDERSTANDING THE HEALTH OF FISH DIETS

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ABSTRACT:

Creating balanced diets and feeding them properly are crucial for successful aquaculture. The health of fish is strongly influenced by their diet. If fish don't get the right balance of nutrients, they can get diseases. These diseases can be caused by not getting enough of a nutrient, getting too much of a nutrient, or not having a proper balance of nutrients. Diseases only happen when the fish doesn't get enough of a certain nutrient. If fish eat too much, the extra food gets turned into fat and can cause problems with the fish's body functions. There are two types of deficiency diseases in fish. One is when fish don't get enough of the important nutrients like protein, carbohydrates, and fats. The other is when fish don't get enough vitamins and minerals. The lack of lipids is a big problem in practical diets for fish. Fish need a lot of protein to make amino acids and energy. Their food should have a lot of good protein because it is expensive. The growth and health of fish depend on the amount and type of protein in their food. Protein is important for fish growth and helps in the creation and functioning of necessary enzymes and hormones. The main thing that determines how good protein is for fish's nutrition is the amount and availability of essential amino acids. If fish don't have enough of these amino acids, they can get sick.

KEYWORDS:

Amino Acids, Fatty Acids, Free Radicals, Vitamin, Water Soluble.

INTRODUCTION

When a farmer sees that their fish are sick or dying, the first thing they usually do is call a fish doctor or expert in fish diseases. If we don't find any visible signs of disease in the fish such as bacteria or viruses, When fish get sick, people often blame their diet or the quality of the water. They think that a bacteria, virus, or parasite might be the cause of the problem. But when you call the local company that makes animal feed, the person trying to sell it often tries to say that the problem is because of bad water or other things that are not related to the feed. Throughout the series of events mentioned, the farmer often does not understand what is happening. The farmer continues to experience a lot of fish deaths and desperately needs a fair opinion and solution to their problem. Even though modern disease diagnostic labs are helping to improve the situation, there are still many problems related to nutrition-related diseases that have not been thoroughly explored. Veterinarians are often too busy with their normal disease diagnosis work, and nutritionists are usually not trained or interested in analyzing or addressing these issues. In simple terms, fish experts who study fish diseases and nutrition need to work together to make progress in the field of nutritional fish disease[1], [2]. This field focuses on studying health problems in fish that are caused by not getting enough nutrients or having an unbalanced diet. In comparison to other farming systems where fish eat naturally available food from ponds, fish in intensive farming systems rely entirely on a specific diet.

Many farmed fish have been given food even though there isn't enough accurate information on what nutrients they need in their diet. Because there is not enough information available, it is not surprising that certain nutrient deficiencies and imbalances in farming conditions have resulted in diet-related health issues. This paper focuses on summarizing the main nutritional problems that have been found in farmed fish. The feed is not made correctly because it has too much of some proteins that are missing important nutrients. The chemical score and the essential amino acids with limited availability in a few food proteins that can be used to make fish feed. To compare different protein sources, we have calculated their chemical scores based on the average dietary essential amino acid requirements of rainbow trout. Two types of fish that are being discussed are the silver carp and the common carp. Fish meal is better because it has a well-balanced amino acid profile. For instance, some plant proteins, yeast, meat and bone meal, blood meal, and hydrolysed feather meal do not have enough methionine. Oilseeds, hydrolysed feather meal, and algae do not have enough lysine. Some oilseeds and pulses do not have enough threonine. Fish silage does not have enough tryptophan. It is important to choose the right feed ingredients in order to achieve the desired balance of essential amino acids in the overall diet. Dietary imbalances can also happen when there are too much or too little of certain amino acids, like leucine and isoleucine, arginine and lysine, and cystine and methionine[3], [4].

For instance, blood meal contains a lot of valine, leucine, and histidine, but doesn't have much methionine and isoleucine. But, when animals eat too much blood meal, it affects their ability to have enough isoleucine. This happens because there is too much leucine in their diet, which makes it harder for them to get the isoleucine they need. Although there have been similar conflicts reported for cystine/methionine using hydrolyzed feather meal and arginine/lysine in farm animals on land, these conflicts have not been reported in fish that are fed combinations of synthetic amino acid diets. Lack of essential amino acids in our diet can occur when the proteins in animal feed are cooked at very high temperatures. For instance, when making fish meal, if it is heated too much, the proteins become harder to digest and have less value to the body. This happens because the amino acids in the proteins are destroyed by a process called oxidation, or they form connections that are more difficult to break down. The parts of lysine called free epsilon amino groups can easily get damaged by heat. They can combine with other moleculesreducing sugars in the food and form new compounds. Besides the reduced availability of essential amino acids (EAAs), heat-treated fish meals that contain free histidine and histamine can also produce toxic substances like gizzerosine (2-amino-9-(4-imidazoly1)-7-azanonanoic acid). Even though gizzerosine might cause gizzard erosion in chicks, rainbow trout that were given similar fish meals that were heated and had a lot of histidine and histamine showed signs of having thinner stomach walls, darker coloration, and death of cells in the stomach glands[5], [6].

DISCUSSION

It is uncommon for wild fishes to experience complete starvation. However, sometimes big changes in their environment, like when El Niño fails, can cause many fishes to die or even result in the whole year's group of fishes starving. A decrease in the number of fish or the size of fish is more likely when the conditions in the ocean change and there is less food available. Human activities, like using insect-killing substances on waterways or rice fields, can harm delicate species by taking away or greatly reducing their source of food. Many types of fish, especially in moderate weather, have changes in their food levels throughout the year because of the temperature and amount of light. So, many marine and freshwater animals lose weight and dry body mass during a long period of not eating in winter. Furthermore, a lot of sea animals lay eggs or give birth in the springtime after being very hungry during the winter.

This also impacts their fat storage and body parts like the liver, which becomes very fatty during the summer in many species. We need to be very careful when telling the difference between signs of nutritional disease and regular changes in nutrition throughout the year. The amount of energy fish need to stay alive is much lower at 5 ° C than at 24 ° C. However, even if they don't eat anything, their body still needs to break down tissues to get energy. The main reason for studying fish nutrition is because of the growth of the aquaculture industry[7], [8].

Most of the respected fish that people think highly of are meat-eaters and they are at the highest level of a food chain. Their food consists only of fish, small shellfish, and squid. As a result, their diet mostly consists of good, fresh protein. Food for these types of animals is made to help them grow quickly and cheaply. This cannot be done without knowing what the species being grown needs to eat. Fish need the same important nutrients as land animals and birds, but there are many changes and differences, even among fish of the same type. We need to think about these things when we are trying to figure out if a disease is caused by nutrition or if it has something to do with nutrition. Fish food for farmed fish can either be a complete diet or a supplement to boost natural nutrition in managed ponds 1985 is the year when something happened. Supplementary feeds are usually cheaper and not as good as a full diet. Nutritional diseases are when a fish's diet has too little, too much, or an improper balance of the necessary components. It can be difficult to figure out if a fish has a nutritional disease. Diets that lack proper nutrition can make a species more vulnerable to getting sick. These illnesses are more noticeable, but they hide the real reason why the species is more likely to get sick.

The importance of harmful toxins that are not naturally occurring, like aflatoxins, is now understood. The change in the ingredients used in animal feed from relying too much on fish meal to using more plant protein concentrates can accidentally introduce harmful toxins to the feed. Commercial animal feeds are made by big companies in advanced factories. In the past, there were more problems with lack of nutrients and harmful substances in fish feeds, but it still happens sometimes. The kind of problems caused by not getting enough nutrients or eating harmful food has also been different. Before scientists determined the exact amount of nutrients fish need and before vitamins were made into stable forms, fish sometimes didn't get enough vitamins from their food. Today, problems like lack of certain nutrients and harmful substances are more likely to happen because of the breakdown of fats in our food, the presence of mold due to incomplete drying of food pellets, and the lack of certain nutrients caused by interactions between different ingredients in processed animal food. However, sometimes commercial fish production doesn't have enough essential nutrients because they make small changes to the ingredients. This is especially a problem for fish that are growing quickly or for salmon that have recently been put in the ocean. There is a big chance that farm-made feeds can lack important nutrients or be imbalanced[9], [10].

This can happen because mistakes are made when mixing and adding nutrients to the feed. Most diseases caused by a lack of nutrients are complicated because they come from a lack of several different nutrients. However, the true understanding of nutrient-related illnesses can only be achieved by carefully determining the best levels of each nutrient and identifying signs of deficiencies for each person's diet. The clinical situation is made more difficult because there aren't specific signs that can help identify these conditions. The most common way to describe nutritional deficiency diseases is when someone doesn't have a desire to eat, their skin gets darker, they have low energy, and they don't grow well.Starvation can happen when people or animals don't have enough food to eat. It can be because there is no food at all, or because the food they have is not enough. In some cases, certain behaviors or things can prevent fish from being able to eat. Fish can go without basic needs like food and water if

they are unintentionally left in a place or if there is some other unexpected issue at a business. Not enough feeding may happen because of poor care or wrong count of animals resulting in not enough food because there are too many animals. Behavioural starvation refers to when wild fish or newly hatched fish refuse to eat artificial food that they are unfamiliar with or find unappetizing[11], [12].

This is a specific issue when trying to teach certain baby fish, like Atlantic halibut, walleye, sea bass, sea bream, and turbot, how to eat on their own. Larvae that don't eat can live for a month or longer, and sometimes people first think they have an infectious disease because of the losses. When the body's breakdown reaches a point called the point of no return, it becomes very severe, and they cannot recover. Fish that don't eat enough food are usually darker in color than usual and their flesh is soft. This happens because their body breaks down protein in their tissues. Hungry baby fish are often called pin heads because their heads look big compared to their skinny bodies. The gills might not have much color, and fish that are hungry may have a lot of parasites on them. When a fish is very hungry and dies, it may have no fat in its abdomen. Its gall bladder might be swollen because bile is not being released due to lack of food in its stomach. Additionally, all of its internal organs may not look healthy. The histopathological features include a significant decrease in the substance inside individual muscle fibers, with the formation of small empty spaces and movement of the nuclei towards the center of the muscle cell membrane, which is very noticeable. The digestive system and other organs show more fibroblast and collagen. The exocrine pancreatic tissue becomes darker and smaller. The melanomacrophage centers are noticeable, maybe because of the breakdown of substances that has happened, and there is a rise in their melanin and lipofuscin levels.

The most serious and common health issues come from the fat in our food. Fatty acids are important parts of fat that provide nutrition. Only a small amount of fat in the body is free fatty acid at any given time. Most of the fat is stored as triglycerides and phospholipids. The fat in your diet needs to give you enough essential fatty acids and energy. Essential fatty acids are types of healthy fats that come from plants or the sea. omega-3 and omega-6) are types of fats that are found in foods like fish, nuts, and vegetables. These fats are good for our health because they can help lower the risk of heart disease. Substances with two or more double bonds are easily affected by oxidation. Oxidation of lipids is a common issue in fish food. It can lead to nutritional problems by destroying important fatty acids, reducing antioxidants in tissues, and making harmful substances. The use of high-energy feeds, which are high in fats, is becoming more common in salmon farming. Because of this, there is a lot of worry about the oxidation of fats. Before talking about what lipids fish need, we need to explain the words we use to describe the types of fat. These compounds have chains of carbon atoms that are connected to hydrogen atoms. The chain can have anywhere from one to six double bonds. The individual chain is described by using two numbers. The first number tells how many carbon atoms are in the chain and the second number tells how many double bonds there are. The double bonds in fatty acids have a big impact on their physical and nutritional properties. The ω designation shows where the closest double bond is located to the methyl group. So, the code 18:3 ω - 9 means there is a fatty acid with 18 carbon atoms and three double bonds. The closest double bond to the methyl group is nine carbon atoms away. The body makes fatty acids longer by adding on to one end of the molecule. This process makes different types of fatty acids have similar effects in the body.

Fish can make certain types of fatty acids, but they are not able to make two specific types called linoleic and linolenic. These things are important for fishes and mammals. If there isn't enough of them or the longer versions of them in their diet, they can have health problems.

Longer chain members of the omega-3 series, known as linolenic, are very important for normal growth. We need to have about 1. 5% of our diet consist of these fatty acids. Different species have different abilities to lengthen the unsaturated linolenic acid (18:3 ω - 3). Salmon fish can change certain fats they eat into another type of fat called arachidonate. In the same way, they can change linolinate to eicosapentenoic and docosahexanoic acids, but not enough to support growth. Cowey and his colleagues. In 1976, researchers found little proof that turbot fish can convert linoleate to arachidonate or linolenic to docosahexanoate when they were given diets rich in these fats. In these situations, the liver and the tissue that stores fat experienced significant changes. When the body doesn't get enough essential fatty acids from food, it stores a particular type of fatty acid called 20:1 ω - 9 in its tissues. Usually, marine fish cannot change linolenate into EPA or DHA, but freshwater fish can do it.

This is probably because EPA and DHA are found in large quantities in marine food. If you don't have enough essential fatty acids, your liver can get swollen because it has too much fat in it. There is a constant condition called anaemia, which happens when the liver doesn't make enough haemopoietin. Many people die from this condition. In 1983, a group of researchers called Bell and others. Lipoid liver degeneration is a big issue when it comes to giving farmed fish the fat they need. The main problem is stopping the high levels of fatty acids in their diet from getting damaged by oxygen in the air. This includes important omega-3 and omega-6 fatty acids. Auto-oxidation is bad because it decreases the amount of fatty acids that the body can use. It also creates harmful substances that can hurt fish and react with other things we eat. substances that protect cells from damage caused by harmful molecules, such as vitamin C and vitamin E, play an important role in maintaining the health of tissues and membranes in our body. These antioxidants help to neutralize the harmful effects of free radicals, which are unstable molecules that can damage cells and lead to various health problems. By protecting our cells, tissues, and membranes from damage, antioxidants help to prevent diseases and promote overall well-being. The levels of tocopherol and vitamin C decrease when feeds with oxidizing fat are given. This leads to changes in the biomembrane, particularly in how easily substances can pass through and how easily it can be damaged.

The biggest problem caused by rancidity is a liver disease called lipoid liver disease. This usually happens when feeds are stored for a long time at high temperatures, which makes the antioxidants run out faster. Because of this, fish raised on farms often have a lot of vitamin E added to their diets to act as an antioxidant. The special type of tocopherol called α-tocopheryl acetate is added to fish feeds as a source of vitamin E. It doesn't work as an antioxidant in the feeds, but it is active in the body and helps protect the tissues. Fish oils and some plant oils contain a substance called α - tocopherol, which is good for your body. These oils also have other forms of tocopherol (beta, delta, and gamma), which are not very helpful in your body, but they are really good at protecting the oils from damage. substances called antioxidants help reduce the damage caused by unstable molecules in our bodies called free radicals. These unstable molecules can harm our cells and contribute to diseases like cancer and heart disease.

Antioxidants prevent this damage by stabilizing the free radicals and preventing them from causing harm. They can be found in many different foods and can also be added to processed foods to help protect our health. Ascorbic acid or EDTA help stop oxidation by getting rid of metal cations that are involved in making free radicals. Ethoxyquin is a man-made substance added to fish oils that are used in fish feeds to prevent spoilage. Old or rotten fats are harmful on their own. They also combine with protein, making it less helpful, and negatively affect other vitamins like A and C. Therefore, the characteristics of lipoid liver disease can change from one occurrence to another, based on how much each component contributes to the

deterioration. Fish with lipoid liver disease have severe anemia, which can be seen as pale gills and fragile red blood cells. They also have a rounded heart that looks bronze, and their liver is swollen with rounded edges. In simpler terms, the main thing we see under a microscope is a lot of fat inside liver cells. This fat makes the cells lose their natural color and shape. The spleen and kidneys are not functioning properly, and there are lots of light-colored pigment in certain cells. There is also sometimes extra blood cell production in the tissues near the outside of the heart and around certain areas.

The amount of liver damage caused by certain cells called macrophages containing a pigment called ceroid can vary depending on how long the disease has been present, how much oxidation has occurred, and the type of fat in the diet. This pigment is a result of the breakdown of a substance called phospholipid. All types of salmon are at risk of developing a liver disease called lipoid liver degeneration. However, rainbow trout farming is especially affected by this problem. Lots of fish, like gadoids, store fat in their liver. The way their liver looks can change depending on the time of year and how much food they have. This can make your lips look bad in extreme cases but it's actually normal. When salmon are only a little bit affected, they can usually fully recover. However, if they have severe anaemia and hepatic ceroidosis, they often cannot recover well and eat like they used to. Other problems that can occur when animals eat rancid fats include bulging eyes, inflammation of the fat tissues, darkening of certain organs, excess iron in the spleen, and muscle weakness.

The calciferols are a group of substances that can withstand heat and are important for stopping rickets in mammals. Ergocalciferol (D2) comes from plants, while cholecalciferol comes from animals. In simple terms, cholecalciferol (D 3) has three times more vitamin D activity than ergocalciferol for rainbow trout. Deficiency has been shown in fish during experiments with salmon and channel catfish. Scientists conducted experiments to study hypervitaminosis by feeding brook trout a diet containing 3,750,000 IU of cholecalciferol per kilogram. This caused the trout to have higher levels of calcium in their blood and increased haematocrit. However, when rainbow trout were fed a diet containing 1,000,000 IU/kg, hypervitaminosis was not observed. Adding extra Vitamin D improved the immune system of gilthead seabream fish. Tocopherols are a bunch of similar substances that have different effects on the body and help prevent damage from oxidation. The most bioactive form is alpha-tocopherol. The way the body uses tocopherols (a type of vitamin E) is connected to how it uses selenium. Usually, there is more than enough tocopherols in our diets because they have antioxidant properties. However, if a diet has already been partially oxidized before eating, there may not be enough tocopherols left.

This can lead to a deficiency unless there are sufficient levels of tocopherols to both act as antioxidants and support metabolism. To make sure enough tocopherol reaches the fish, vitamin mixes contain a protected form that stays fresh in the food storage. One of the main purposes of vitamin E in the body and food appears to be to protect against the harmful effects of free radicals. Tocopherol helps protect our body by giving away protons to harmful free radicals, which makes them turn into safe and harmless compounds. In living things, tocopherol can be made again with the help of selenium. When fish are given diets with oxidizing fat, the rate of regeneration of tocopherol cannot keep up with the rate of tocopherol oxidation. This leads to a decrease in levels of tocopherol in the fish's cells and membranes, and the emergence of signs indicating a lack of tocopherol. Another important role seems to be controlling the structure of biological membranes. So, if a fish doesn't have enough vitamin E, it will show symptoms and characteristics of both roles. This is made more difficult by the process of regenerating oxidized tocol through the help of selenium. If you eat a lot of vitamin E or selenium, you don't need as much of the other in grouper fish.

Another difficulty in understanding the relationship between the types and amounts of fats in fish diets, vitamin E, selenium, and the environment is that the effect of temperature on the type of negative response is stronger at lower temperatures. Similarly to other animals, there is evidence to suggest that not having enough vitamin E in the body can be linked to exercise. This adds another factor to an already complicated situation. Many different health problems have been linked to not having enough vitamin E. One of these is muscular dystrophy. A study found that a high level of certain vitamins in fish oils can lead to a disease called yellow fat disease in cats.It is difficult to determine the exact role of vitamin E in pancreas disease and heart muscle disease in Atlantic salmon. Pancreas disease and CMS are viruses that make fast-growing Atlantic salmon sick when they are in the sea. This happens during the stage of their life cycle where they are growing quickly in the ocean. Usually, their vitamin levels are higher during this stage compared to when they are in freshwater. PD is more common in the first year of being at sea, and CMS usually happens in older fish. Both conditions are caused by viruses, but they are defined by having weak muscles and a significant decrease in the amount of vitamin E in the blood. The reason could be that the type of Vitamin E used in food is not effective unless it is activated by certain substances produced by the pancreas.

So, if a fish has a problem with its pancreas, it won't be able to absorb the active form of Vitamin E from its stomach and intestines. The fish that are affected are a darker color than usual and have no appetite. They also have smaller muscles in their abdomen. They have a low blood count and can't easily swallow. Even though a lot of people may seem sick and the economy may be really affected by the lack of growth, not many people actually die from it, and when they do, it's usually because they get other infections.Water-soluble vitamins are usually found in many foods, just like fat-soluble vitamins. Because of this, the chances of having a deficiency in a single water-soluble vitamin are very rare. In simpler terms, when researchers have studied specific deficiencies of water-soluble vitamins, they have learned a lot about the particular signs and symptoms associated with those deficiencies. However, in real life, the common signs of water-soluble vitamin deficiencies are slow growth and a change in skin color. Some vitamins can dissolve in water. When a person does not have enough of these vitamins, specific signs of a deficiency are observed. Furthermore, there are variations between water-soluble vitamins in how quickly a deficiency can occur. Some vitamins can cause a deficiency quickly when a diet lacking in them is consumed, while others may take months to cause deficiencies. Another way to describe water-soluble vitamin deficiencies is that they take longer to happen in big fish compared to young fish, because young fish have less vitamin storage and grow faster.

CONCLUSION

The health of fish is affected by what they eat and how the food is made. This includes the type of nutrients in their diet, how balanced it is, and how they are fed. Diets can cause health problems not just because they lack certain nutrients but also because they have harmful substances in them. These substances can change how the animal's body functions. The temperature and food we eat affect how we grow and how our body repairs itself. They also influence our immune system. This means that our diet and the temperature around us can affect how and how quickly our body develops any health problems.Algal toxins are produced by the overgrowth of algae in water, which kills fish by reducing the oxygen levels. Some types of freshwater algae, like Mycocystisaeruginosa and certain non-toxic anabaena, have been found to be toxic to humans and animals. Sekoke disease has been observed in carp in Japan when they are fed silk worm pupae in their diet, causing lipid buildup in organs, cataracts, and degenerative changes in their eyes. Starvation in fish can happen for reasons

other than not getting enough food, such as incorrectly estimating the amount of food given. This means that sometimes fish can't eat certain things because they are too big or too heavy and sink too fast. The signs of starvation are easy to see and include being very skinny, losing weight, and not being able to have babies.

There might be more cannibalism happening, like when fish bite each other's fins or try to eat smaller fish, especially the really young ones. To make a clear diagnosis, it is necessary to identify a specific lack of nutrients in the food we eat. Treating and controlling disease caused by poor nutrition involves giving fish the correct type and amount of food based on identifying the specific nutrient deficiencies.

To make sure that all the necessary nutrients are available, it is important to follow a specific plan for feeding fish. This plan includes creating a balance of nutrients, preparing the food, analyzing it, and actually giving it to the fish. It is important to prepare the fish's food in a way that they can eat and digest it.

We must think about how each type of fish will like the food we give them. Fish have a strong ability to taste things, so the food they eat needs to taste good to them. When given to the fish for them to eat it all the time.

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CHAPTER 11

FISH INFECTIONS: UNREAVELING NON-INFECTIOUS DISEASES IN FISH HEALTH

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ABSTRACT:

There are a lot of illnesses and abnormalities in fish that don't fit neatly into any of the larger groups we talked about before. There are different types of diseases that are not caused by germs and are related to changes in the water or chemicals. There are also diseases that are caused by genetic problems and diseases that we know the cause of but don't fit into a specific category. Additionally, there are some conditions that we don't fully understand the cause of yet. These diseases are not similar to each other or to other types of diseases, so they are talked about here as "Miscellaneous non-infectious diseases.In fish tanks and fish farms, the problem can be caused by water leaking from pumps or valves or by sudden changes in temperature. It has been linked to changes in altitude for fish that are being transported by air. Because more and more tropical aquarium fish are being transported by air and helicopters are being used to transport live salmon eggs, this is something that we should still be worried about. In nature, when there is too much algae in the water, it can create high levels of gas. This can be harmful to fish, similar to a health condition called the "diver's bends" in humans. However, scientists still don't fully understand how this happens, even though it is important for fish farming. The biggest chance for sudden serious outbreaks happens in fish farming systems. With the use of water recirculation and injecting air and oxygen, production levels have gone up. However, it has been discovered that injecting only oxygen can lead to a disease caused by too much oxygen in the water.

KEYWORDS:

Fish, Infectious Disease, Non infectious, Populations, Water.

INTRODUCTION

The amount of supersaturation is very important for how the patient looks and what happens in the end. However, how long the person is exposed and how they are treated after also impact how well they survive. Sometimes fish die from gas bubble disease without showing any obvious signs, and the rate at which they die varies depending on their age and species. In baby fish, there are gas bubbles that cause problems. These bubbles are most noticeable under the skin and in the yolk sac. In baby flatfish, the edges of their fins are more likely to get gas bubbles. Bubbles are often seen in different parts of the fish's body, like the eyes, skin, gills, and mouth. When the fish is examined after it has died, gas can also be found in the swim-bladder and organ lining. Fish that have bubbles in their eyes are typically unable to see and are therefore darker in color. Sometimes, when gas bubbles in the eye get bigger, they can cause damage and lead to blindness and eventually phthisis. The way the condition affects the cells and tissues of a small number of chinook salmon. The current description is mainly based on this limited study. The main thing we see is swelling in the parts of the gills, with damage to the cells covering them. When air bubbles enter the bloodstream, they can block important blood vessels in the gills, which can cause sudden death. Other injuries, such as swelling and blistering of the inner cheeks and intestines, and damage to the kidney cells were observed as part of a overall syndrome that also affected the liver and muscles. We don't

know for sure how the disease affects the future performance of fish that get better after an outbreak. The size and type of fish, the amount and length of time in supersaturation, and the water temperature play a big role in how well the fish will do[1], [2].

We have already talked about how cold water temperatures are related to bacterial diseases in Chapter 8. However, in the farming of salmon and flatfish, there may be cases of excessive growth of the skin without any signs of bacterial infection, except for a bacteria found after the fish has died. In Scotland, there is a condition called plaice where the fins and tail grow too much and lots of fish die when the water is cold. 2-year-old Atlantic salmon developed a growth problem in their gills when the water temperature was below 3°C. Excessive sensitivity to ammonia in cold temperatures and lacking an appetite due to a deficiency in pantothenic acid were thought to be possible reasons, but this hasn't been proven yet. The illness seemed to go through two stages. The first stage had a low death rate and thickening of the gill tissue. After 2 to 6 weeks, the second stage began and caused a 20-30% death rate. Fish affected by this stage had their gill tissue fused together. A big problem with cold water is that fish can get something called water-belly. This is when the stomach fills up with fluid and happens often to salmon and trout in colder areas. The stomach is very big and full of sea water. The stomach and what it contains can sometimes make up 40% of a person's total body weight[3], [4].

The main reason for this is because of stress caused by the body trying to adjust to low temperature and high saltiness. Trout struggle more than other fish in dealing with the challenges of living in saltwater. They are often affected by it. However, a few salmon can also have issues, especially if they are moved to a colder environment.Every type of fish has a preferred range of water pH levels. The importance of these ranges and the things that affect them have already been talked about in Chapter 1. But it is important to repeat and explain that many things that make pH change quickly are also bad for the gill for other reasons. Certain substances like cement dust or silt, and ammonia, can harm the gills and this damage may not be easy to see right away. The reason for this is that when the gills are irritated, they usually grow more and this takes some time. However, when the water is cold and has a lot of oxygen, the fish can still breathe well because it has enough capacity to do so. The clinical effects only become noticeable when there are high temperatures and low levels of oxygen. They found a different type of disease in rainbow trout called nodular gill disease. They think it might be caused by environmental factors or parasites. Instead of being spread out, the growths caused by gill disease are bumpy and can connect multiple parts of the gills together. This is different from other types of gill diseases caused by parasites or bacteria. They mainly consist of malpighian cells that form large abnormal growths[5].

Dramatic gill hyperplasia has been observed in certain fish species kept in recirculation aquaculture facilities when the amount of ammonia in the water is more than 30 mg/1, according to Rodger's unpublished work. It is not known for sure whether this condition is caused by high levels of ammonia or other bad environmental factors.The different colors in fish are often caused by genetics, and they are sometimes used to create decorative varieties or groups of fish. In this chapter, we talk about these things. Pseudo-albinism, which is commonly found in fish that are raised in controlled environments, seems to be a development issue caused by how they are taken care of. Many hatcheries have partially pigmented or reverse-pigmented individuals to a significant extent. We don't know the exact cause. The sore is believed to form when babies are young and exposed to very bright lights in their tanks, used to keep the live food they eat alive. It could also be caused by not getting enough of an important nutrient in their food when they first start eating. Once it starts, the abnormal pattern is kept the same for the rest of a person's life[6], [7].

DISCUSSION

Physical deformities can happen for many different reasons. Birth defects, which are common in closely related populations, can affect the jaw or skull, gills or spine, or more commonly result in extra fins or shortened gill covers. Other reasons include when eggs or larvae are kept too warm, when there are not enough minerals in the food for larvae, when harmful substances are present in the food or surroundings, and when hormones are used to control growth. What you eat and how you take care of yourself can impact the growth of your spine. This can cause conditions like scoliosis, lordosis, or sometimes problems with the mouth and jaw. In simple words, it means that certain problems related to genes, temperature, or hormones can be seen very early on in the hatchery. On the other hand, problems caused by how the fish are taken care of or what they eat can appear at any time during their growth. These problems can affect many fish in the group. Besides the bone problems related to food discussed in this chapter and in Chapters 3 and 10, different groups of fish can also experience various other health issues due to genetics. The sickness called malignant melanoma in the platy swordtail fish hybrid has already been talked about in Chapter 5 about tumors. This is the only well-documented case of a genetic condition directly caused by a gene in teleosts so far. However, there are other abnormal development conditions that are believed to be caused by genes.

This means that in some salmon, there is a common birth defect where two fish are joined together. There are also many other problems with the fish's body, like having an overbite or underbite, abnormal fins, and short gill covers. Many eye problems are common in unborn babies, especially smaller-than-normal eyes and missing eyes. These problems often happen when specific parents reproduce. Another condition that a person is born with is called albinisticophthalmia. It is believed to be caused by genes and it affects Atlantic salmon. This condition is characterized by the occurrence of fry that look like they are albino, but they are not completely albino. It happens more often in specific genetic groups. These fish are mostly orange, not white, in color which suggests they still have xanthophore and iridophore presence. It can be confirmed through histological examination. They usually have bulging eyes with dark pigment and commonly have bleeding, eye movement, and eye socket dislocation due to injuries. Even though the number of fish from each mating is not large, some salmon farms and hatcheries connected to the conservation of rivers have a habit of keeping smaller gene pools. This makes it difficult to prevent siblings from mating with each other. Therefore, it is crucial to avoid breeding fish that are related to those who are affected by such conditions[8], [9].

People are becoming more worried about inbreeding because they have realized that the MHC genes are very important for the immune system of fish. When closely related animals mate with each other, and as a result, the genes in this small group become less diverse, it can have a big impact on how well the group can survive in the long run. This is important not only for raising fish for food on farms, but also for helping endangered salmon and other species grow in numbers before releasing them into the wild. We can do this by using a small number of parent fish from small and isolated populations.In their natural habitat, fish stay away from harmful radiation from the sun by going to deeper parts of the water or finding shaded areas. In fish farms, fish are often kept in shallow water without shade and in large numbers. This can expose them to more sunlight than they would experience in their natural habitat. The problem is worse at higher altitudes, especially in the Southern hemisphere. In these areas, the ozone layer is thinner, causing higher levels of harmful ultraviolet rays from the sun during the summer compared to similar areas in the North. Only about 3% of the solar ultraviolet (light radiation with a wavelength between 100 and 400 nanometers) that is

emitted reaches the Earth's surface. The UV spectrum is typically split into three parts for convenience. UV A stimulates the melanin pigment cells. UV B causes sunburn. UV C fights against microbes. Many people believe that UV B cannot pass through more than a few millimeters of water, but this is not true. This is true for water that has a lot of particles or humic substances, but in clean water it can go down to almost 1 meter. Experiments have shown that fish can get sunburn if they are deeper than 0. 5 meter Fish skin doesn't have a protective outer layer made of keratin, and all layers of fish skin have cells that are constantly dividing. Because of this, fish skin is easily damaged by UV-B radiation. This is made worse by the fact that fish skin usually does not have protective cells called melanin. When fish that are raised on farms are exposed to UV-B rays in clear water, their outer skin changes in a way that is very similar to what happens in scientific experiments. Sores usually occur on the parts of the body that are most often exposed, like the head, back fin, side fins, back, and tail. In simpler terms, when looking at the cells under a microscope, early stage sores are known for having a specific swollen cell with a big clear circle around the small, shriveled center. Other cells in the body are damaged and dying, with the nucleus breaking apart and swelling of the layers beneath the skin. This eventually leads to the death of the swollen tissue. In fish like plaice, there are special cells in the skin called eosinophilic granule cells.

These cells move towards the surface and break open at an early stage. Once the skin gets damaged, it becomes easier for harmful bacteria or other organisms to invade and cause infections. Normally, this happens when there are bacteria and parasites, but it is when oomycetes like Saprolegnia or Achlya are present that very high numbers of deaths can occur. Sunburn cells can be seen in farmed salmon that have the summer lesion syndrome in Ireland, which is a disease condition with multiple causes. Another type of reaction to UV rays in the skin of fishes is called photosensitization. In this situation, cells that are usually not affected by weak levels of visible light or UV-A are made to absorb them, which has harmful effects. This happens because there are certain harmful substances found in the fish's body that come from plants, animals, or human activities. The fish can accidentally eat these chemicals, or they can be intentionally used for treatment. Phenothiazine, a type of medicine used to kill worms, is known to cause a condition called 'back - peel' in fish. Scientists have recently discovered that this toxic effect is actually caused by the fish becoming more sensitive to light. The first sign of damage in the skin that has been exposed to light and a certain chemical is a strange kind of blister. This blister is not commonly seen in fish, except in a disease called ulcerative dermal necrosis (UDN), which will be explained in another part of this chapter. These porphyrins are found in many marine animals and can cause sensitivity to light[10], [11].

Sometimes, certain types of fish, like tilapias or carps, can get very sick if they eat a lot of food with lots of protein. After eating, many people quickly become very stiff and their fins stand up straight. Their bodies become extremely rigid and start shaking. These fish are easy to take out of the water, and their fins stay standing up. If they rest quietly, they usually feel better until it's time to eat again. In simple words: We can stop the reaction in allergy-prone individuals by giving them medicine before exposing them to allergens. However, we do not know what specifically causes the allergic reaction. We really need to take care of the health of fish, whether they are in fish farms or in rivers and oceans. This is important because if fish are not healthy, there won't be enough of them and we won't be able to catch them anymore. Infectious diseases in fish have been studied and managed for a long time, but non-infectious diseases are just as significant, even though they are not given as much attention. This discussion explores the complicated topic of diseases that are not caused by infections in fish. It reveals different things that can harm their health and happiness.

Eating the right food is very important for fish to stay healthy, grow, and reproduce. Fish can have problems with their health if they don't eat a balanced diet. This can cause a variety of health issues. Malnutrition happens when fish don't get enough nutrients or are fed a diet that is not balanced. Common signs of malnutrition include slower growth, difficulty having babies, and weaker ability to fight off illnesses. In fish farming, it is very important to feed the fish properly so that they can grow well and stay healthy. Fish need vitamins to help their bodies function properly. Lack of vitamins like vitamin C or D can cause problems like curved spine, weak bones, and slow wound healing. These problems can happen when you don't eat enough food or when the vitamins in the food are not easily absorbed by your body.Fish need minerals like calcium and phosphorus to grow strong bones. If the levels of these minerals are not right, it can cause problems with bones. This can make it harder for some animals to swim and easier for predators to catch them. Sometimes, fish can have problems when the water they live in doesn't have enough minerals. Substances like mycotoxins or heavy metals that are in the food fish eat can make them sick.

Harmful substances produced by fungi in animal food can harm organs, and when fish have high levels of heavy metals in their bodies, it can be dangerous for people who eat them. Fish are very affected by what is around them, and if they experience different things that cause them stress, it can make them sick without getting infected. Having clean water is really important for keeping fish healthy. When there is dirty or unhealthy water for fish, it can make them sick and cause problems like damage to their gills, slow growth, and make them more likely to get infections. Habitat degradation, which happens when humans pollute or destroy habitats, can harm fish populations. Loss of places where fish lay their eggs, changes in how water moves, and the arrival of harmful species can upset fish life stages and cause fewer fish to exist. Climate change is changing the way water ecosystems around the world function. Increasing temperatures, acidic oceans, and altering rainfall patterns can impact how fish behave, function, and spread. Fish may have problems handling high temperatures, they might change their migration habits, and they may have trouble having babies.

Noise pollution underwater occurs when humans engage in activities like shipping and construction. This noise can disrupt the behavior and communication of fish. This disturbance can cause more stress, make it harder to eat, and make it difficult to reproduce. Genetic factors are also important in non-infectious diseases in fish. Genetic disorders can happen when close relatives have children together or when there are changes in genes, which can cause various health issues. Inbreeding is when closely related individuals have babies, and this can cause harmful genes to show up in the babies. This can lead to being less healthy, more likely to get sick, and have a higher chance of not surviving. Changes in fish genes can happen suddenly. Certain changes in genetic material can cause problems, like odd fin growth or difficulty swimming. Over time, these changes in genes can add up and affect the overall well-being of a group of organisms. Fish can get sores and physical abnormalities that are not caused by harmful parasites. Fish, like other animals, can get lumps and growths called tumors. These strange growths can disrupt how organs work and the overall health of the fish. The tumors can happen because of different factors, like genes you were born with and things in the environment that can cause cancer.

Problems with the skin and scales, like changes in color or wounds, can happen because of different things. These include bad water, getting hurt, or being in contact with things that bother the body. These conditions can weaken the fish's defense system and make them more likely to get infections. It is important to prevent and control non-infectious diseases in fish. This is necessary for protecting natural habitats and for the success of fish farming. In fish farming, it is important to make sure that fish are given the right kind of food in order to keep

them healthy and prevent problems with their nutrition. Regularly checking the quality of the fish's food, giving them extra vitamins and minerals, and changing their diet depending on their stage of life are all very important strategies. Regularly checking the water quality in fish farms is important to avoid diseases caused by stress. Using the right methods to treat and manage water can keep fish in the best conditions. In nature, fixing damaged habitats can help protect fish populations from harm. By fixing places where fish produce offspring, making water cleaner, and managing non-native species, we can make fish homes better and help them have more babies. It is extremely important to protect the variety of genes in fish populations to avoid the problems that can come from interbreeding. Breeding programs that carefully choose specific traits and bringing in different individuals with varied genes can help keep populations in good health.

The fish rubs against things quickly, has a slimy substance on its gills or body, its gills or fins might get worn away, and its skin could turn red. Flukes come in multiple variations, characterized by their slim body shape, reaching a length of roughly 1 mm, with a small number of discernible symptoms. They invade the gills and skin similar to Ich, but you can distinguish the difference by using a hand lens. The best way to treat something is by taking a bath for 10 to 30 minutes. In the bathwater, there should be 10 milligrams of potassium permanganate for every liter of water. Alternatively, you can add 2 milligrams of the treatment to every liter of water in the tank. However, this approach can be untidy and may cause the water to become stained. Worms are hanging out of the butt. Nematodes, also known as threadworms, can infect different parts of the body but are only visible when they come out of the anus. When there are a lot of pests, it can make people hungry because they don't have enough food. Two options have been proposed. First step: put the food in a solution with para-chloro-meta-xylenol and then wash the fish or put 10 ml of the solution in every liter of water in the aquarium. You need to take a bath for a few days. Second treatment: Look for special food that has thiabendazole to help get rid of threadworms in fish. We hope the fish will eat this food and get better.

Leeches can be seen on the fish's body. Leeches are bugs that stick to fish and live on their bodies, fins, or gills. Normally, they look like worms in the shape of a heart and are connected to the fish. When leeches attach themselves to fish and dig into their skin, using forceps to remove them can seriously harm or even kill the fish. If you put the fish in water with a little bit of salt for a short time, the leeches will likely come off. Those who do not cooperate will have to be removed forcefully with small tools without causing much harm. Another way to treat is by adding Trichlorofon at a concentration of 0. 25 milligrams per liter. This is a very uncommon disease caused by tiny organisms that makes the skin appear cloudy. The most effective treatment is using a small amount of copper, specifically 0. 2 milligrams per liter (0. 2 parts per million). This treatment may need to be done again after a few days, if it is needed. Instead of using acriflavine (also known as trypaflavine), you can use a 0. 2% solution by adding 1 milliliter of it to every liter. Since acriflavine could possibly make fish sterile and copper can cause poisoning, it's important to slowly change the water after treating them.

This is when tiny organisms in the intestines attack the lower part of the intestines. This sickness affects the Digestive System and makes people not want to eat. Metronidazole is a helpful medicine. You should use a treatment for both the fish food and the water. For the fish food, use 1% of the treatment, meaning if you have 100 grams of food, use 1 gram of treatment. For the water, use 12 milligrams of the treatment for every liter of water. Do the water treatment every other day for a total of three times. Small white dots on the fins of the body. Too much slimy substance. Difficulties in breathing, fins held tightly together, not

wanting to eat. I, a disease called white spot, regardless of its name, is the most common health problem in home aquariums. Thankfully, if this illness is detected early, it can be treated without difficulty. Ich is a kind of tiny organism called Ichthyophthiriousmultifiliis. These protozoa go through three different stages in their life cycle. Usually, to someone who is new to keeping fish as pets, the process of how a fish grows and reproduces is not seen as significant. However, because Ich can only be treated at one stage of its life cycle, it is important to understand the different stages of its life. It is stuck on the fish's skin or gills, which makes the fish irritated and have small white bumps. As the parasite gets bigger, it eats red blood cells and skin cells. After a few days, the fish gets tired of it and the thing/fish falls down to the bottom of the fish tank. After reaching the lowest point, the grown-up parasite becomes a cyst and quickly divides its cells.

After the cyst phase, around 1000 young ones who can swim freely start swimming upwards in search of a host. If a living thing that feeds off another living thing cannot locate its host in 2 to 3 days, it will perish. Once a host is discovered, the entire process starts over again. The preferred medication is quinine hydrochloride, which should be taken at a dose of 30 milligrams for every liter of solution, with a concentration ratio of 1 in 30000. If you can't find the hydrochloride, you can use quinine sulphate instead. The water may become blurry but it will become clear again. By shortening the time and increasing the temperature, you can effectively deal with the free swimming phase. Most commercial remedies have malachite green and/or copper, which work well.White patches inside the flesh of the fish. Loss of muscle causing strange swimming movements. It is called that way because it was first identified on a fish. It is caused by a tiny organism called Plistophorahyphessobryconis. Even though it is called Neon Tetras, it can also be found on other types of fish. White spots seem to be right under the skin. In Neon Tetras, it gets rid of the pretty blue-green neon stripe. The living things create small protective sacs that break open and let out tiny seeds. The small cells go deeper inside and create more sacs. In the end, the spores move to the water and get eaten by other fish as food. These tiny particles move into the stomach and intestines, then the muscles, where a new illness begins.

There is currently no cure. It's better to get rid of the sick fish and clean the fish tank. Like immune cells in our body, fish can develop small raised white bumps on their fins or body. Glugea and Hnneguya are small organisms that create big cysts on a fish's body and then release spores. Fortunately, these illnesses do not happen often. The fish swell up and get lumps that look like tumors, and eventually they die. There is no cure yet. It is better to kill the sick fish before the spores move around. The colors become less intense because there is too much slime. The fins get burned and become weak. The gills get hurt. This sickness makes the skin look cloudy and bluish-white and affects the gills. Afterwards, the skin might start to break and the gills could get damaged. The fish might act like they are annoyed. Acriflaving, also known as trypaflaving, can be used in a 1% solution. This means that you would add 5 ml of acriflaving for every litre of liquid. When acriflavine is used to sterilize fish, the water needs to be changed slowly after the treatment is done. Increasing the temperature to around 80 degrees Fahrenheit also helps. It is a disease caused by a type of protozoa called Myxosomacerebralis. Common symptoms include a darkening of the tail, a band on the back end of the body, and a deformity in the area around the anus. Cancer can be caused by a virus or genetics, but usually it is genetic. Genetic tumors can happen when there is excessive mixing of different types of plants or animals, which is something that often happens with professional breeders. Almost all cancers cannot be treated. If the fish is very sick or suffering, it needs to be killed.

Abnormalities often happen when breeders who are experts in their field are trying to get specific traits in certain breeds. Just like humans, fish can also have accidents in their lives. If you can easily see why the injury happened, it should be fixed. Then the harm or damage should be taken care of. Then, apply 2% mercurochrome, which can be bought in stores, to the injury. Also, if the fish can handle it, keeping it in slightly acidic water with a pH of 6. 6 could help it recover faster. If the water is clean and safe, small injuries will likely get better on their own. Some fish are more likely to get constipated than others. Usually fish that have bodies that are more squished or flattened, like angelfish and silver dollars. The signs are not being hungry and the body getting bigger. The reason behind something is usually related to what we eat. Normally, when you change what you eat, the condition gets better on its own. If other methods don't work, you can try using dry food that has been soaked in special oil to help with stubborn cases. We can also use glycerol or castor oil. If you change your diet regularly and sometimes eat fresh foods, this condition might not happen. India needs more knowledge, research facilities, and expertise on fish diseases and fish health protection to improve and expand freshwater aquaculture in the country. This starts as tiny holes on the head and face, usually right over the eye. If not treated, these become big holes in your teeth and then the illness moves along the side line. Head and Lateral Line Disease is caused by not having enough of certain vitamins and minerals like vitamin C, vitamin D, calcium, and phosphorous in your body. Experts believe that a bad diet or not having enough types of food, not changing water often enough, or using too many chemical filters like activated carbon can cause this problem.

CONCLUSION

In summary, this chapter has given us information about diseases in fish that are not caused by germs. We have looked at different things that can harm fish health, such as problems with their diet, things in their environment that stress them out, and genes that make them more likely to get sick. It is really important to understand these diseases that cannot be passed from one fish to another. This knowledge helps us manage fish populations in a way that is good for the environment and will last for a long time, whether the fish are being farmed or live in the wild. We can improve the fish's health and help protect them by identifying and reducing these factors. This will also help us conserve and use this important aquatic resource responsibly. We need to keep studying this field to find out about new non-infectious diseases and come up with ways to prevent and treat them.Non-infectious diseases in fish are complex and often ignored health problems that they can have. Things like food, things in the environment, genetic problems, and bugs that harm the fish can really affect the number of fish in rivers, lakes, and fish farms. Understanding and treating these diseases that are not caused by infections is very important for making sure fish populations stay healthy, farmed fish are well taken care of, and the variety of fish species in water environments are protected.

Ongoing research and proactive management are important to reduce the impact of diseases that are not caused by infections and to protect the health and strength of fish populations in a constantly changing environment.

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CHAPTER 12

FISH PHYSIOLOGY: UNDERSTANDING TECHNIQUES AND METHODS IN THE LABORATORY

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ABSTRACT:

Fish are usually checked by experts to find out if they are healthy or have any diseases. This is done either to diagnose any problems or to make sure they meet certain health requirements. More and more people are worried about the risks of potential harmful germs spreading from one place to another. When live fish move, they pose the biggest danger in terms of transferring something harmful. However, moving eggs or milt, which are parts needed for reproduction, also poses a smaller risk.In the past twenty years, there has been a huge increase in the use of biochemical and physiological methods to study the effects of toxins on fish. This chapter gives some information about using a physiological approach to find out how fish react to harmful substances early on, even if the reactions are not immediately deadly. We have talked about the findings from our studies in the field and in the laboratory. We have also talked about the benefits and issues linked to different methods that we tested.

KEYWORDS:

Bacteria, Fish, People, Quality, Smell Taste.

INTRODUCTION

Many countries that have big fish farms or fishing industries have strict laws about bringing fish and fish products from other countries. Normally, for no apparent reason, these rules do not apply to the movements of fish in aquariums. This is strange because it could lead to the spread of serious diseases that could affect many more fish. Different countries have different rules, but most of them are based on the principles of the Organisation des Epizootics in Paris. This organization is in charge of controlling diseases in animals. The rules for testing and certifying fish that are to be imported into the US and Canada are written in the 'Blue Books'. These books provide specific guidelines for the process. The rules in most other countries also have certain aspects of these requirements. The amount of fish that need to be tested to get health certification will vary based on the size of the group of fish being checked. However, testing every single fish in a group is usually not possible because it would involve killing all of them, which is not a practical option. To make sure the sample is representative, we use valid sampling techniques when there are low levels of the thing we are studying. Testing is usually done to try and find at least one carrier fish in a group of fish. We aim to be 95% certain in our results[1], [2].

We assume that 2%, 5%, or 10% of the fish are carriers. It is very important to understand that if we cannot find a specific germ in a group of people, even if we test a lot of people or assume that the germ is not common, it does not mean that the germ is not there. Because there are dangers with virus diseases like IPN that can be passed from one fish to another through eggs or sperm, and because it can be hard to detect the virus when fish aren't spawning, Roberts and Frerichs came up with the idea in 1978 to test all broodstock in commercial aquaculture for the virus. Originally created to identify a disease called IPN in

fish eggs that were being sent from Scotland to Canada, this method is now used by several countries to make sure that salmon eggs being imported are disease-free. Fish to be tested are prepared and killed, and eggs and milt from each pair are combined to create fertilized eggs. Each group is kept separate and supplied with spring water. The group is isolated until the parent fish, which are tested for different conditions, are confirmed to be healthy. Good things are destroyed.

This chapter does not cover all areas of pathology laboratory technology. There are already several medical and veterinary textbooks available for this. However, a lot of the usual methods need adjustments to be used in fish diseases and these adjustments, along with the most useful normal methods, are provided for each of the main diagnostic areas. Histopathology is the study of the cells and tissues in our body. It has been used for diagnosing medical and veterinary conditions since the mid-nineteenth century. Since then, many new and advanced techniques have been developed in cellular biology. This means that fish histopathologists now have access to a variety of recently created techniques that were originally designed for mammalian histologists. Before we can create good histological sections from biological material, we need to make sure it is prepared correctly. Fish tissues decay quickly compared to the tissues of warm-blooded animals. Because of this, fish must be handled quickly to avoid damage to the sample. If they are not handled in a timely manner, it becomes difficult or even impossible to make an accurate diagnosis. The way we collect samples for histological preparations is by using fish that have just been killed or are very close to dying[3].

External wounds or sores on a fish's body need to be treated carefully after it is caught because the the fish's skin can easily be damaged. To get ready, fish need to be taken out of the water using hooks or nets with small holes. Then, they should be put into a container with appropriate medicine to make them fall asleep, or their heads can be cut off. The fish should be handled using a tool called forceps. If the fish is too big, you can hold it by the tail or fins, unless those parts are being studied. Lesions should be cut out or, if the whole specimen is being saved, make several long cuts from the nose to the tail. These cuts should be parallel and allow the fixative to reach the lesion quickly. Taking some extra precautions and being mindful now will result in better information in the end. If there are sores inside the fish and you want to keep the whole fish intact, you need to cut open the entire body cavity by slicing down the middle of its belly. The inner organs and swim-bladder should be moved carefully and cut at least once to allow the fixative to soak in properly. In an ideal situation, the part of the body being studied should be carefully removed from the body, cut into small pieces, and placed in a liquid that preserves it. The liquid should be at least 20 times bigger than the tissue. There are many different substances that can be used to preserve tissue in fish. Each one has its own strengths and weaknesses[3], [4].

Making sure things are properly set is really important for getting the tissue ready and it's really, really important. If the fixing is not good enough, the final product will clearly show it. The main goal of fixation is to protect the shape of the tissue and keep it in a condition that is as similar as possible to how it was when the organism was alive. This assumes that both the breaking down of tissues by enzymes released from cells after death and the decay caused by bacteria are prevented. In hot weather, it is important to keep things cool. In fish pathology, a commonly used substance to preserve tissues is formaldehyde. It is a gas that can dissolve in water and is sold in a concentrated form of 40% by weight. In a strong solution, formaldehyde often becomes cloudy when stored because it turns into paraformaldehyde. If you warm the solution or add a little bit of NaOH, it will help break down the paraformaldehyde. Or it could be taken out by passing it through a filter.

Formaldehyde is not good for fixing things on its own, but it is used in different fixing solutions along with other substances like water or salt solution. The biggest problem with using formaldehyde as a fixing agent is not how it affects the tissue, but rather the strong, irritating smell that it gives off. Breathing in this vapour can cause extreme discomfort in the nose, throat, and eyes. Moreover, it can make the skin more sensitive and cause "formalin dermatitis". Therefore, it is important to take proper precautions to protect the hands and face when working with this substance. All kinds of formaldehyde, no matter how pure, will be acidic when you buy them, usually with a pH level between 3 and 5. Make sure to check the final pH of any formalin-based fixative[5], [6].

DISCUSSION

Most of the time, quality means how good the fish looks and how fresh or spoiled it is. It may also mean being safe from harmful things like bacteria, parasites, or chemicals. It is necessary to keep in mind that the word quality means different things to different people and needs to be defined based on the specific product. For instance, some people believe that fish taste the best when eaten shortly after they have died. However, it is hard to cut and remove the skin from very fresh fish that are still stiff after death, so they are usually not suitable for smoking. So, for the machine, it is better to use fish that are a bit older and have already gone through the cleaning process. There are two main ways to evaluate the quality of fresh fish: sensory evaluation and instrumental evaluation. Because the consumer is the one who determines the quality, most chemical or instrumental methods need to be compared with sensory evaluation before being used in the laboratory. However, sensory methods need to be done scientifically in controlled conditions to lessen the impact of factors like test surroundings and personal biases. Sensory evaluation means using science to understand and study how people react to the way food looks, smells, tastes, feels, and sounds. Most things that we can perceive with our senses can only be accurately measured by people. However, progress is being made in creating tools that can measure changes in the quality of individual things.

We use instruments like the Instron and Bohlin Rheometer to measure the different properties of things we can sense, like texture. We use powerful microscopes and special software to study how things change on a very tiny scale. We also have a machine called "the artificial nose" that helps us understand different smells. In sensory analysis, we use our human senses to assess how things look, smell, taste, and feel. In simple words, the process can be split into three parts. The human sense organs detect a stimulus. Then, the brain evaluates and interprets the stimulus. Finally, the person responds to the stimulus. Differences in how people react to the same thing can vary and can make it hard to get a definite answer from a test. Some people may react differently to colors. They may also have different sensitivities to chemicals that they can smell or taste. Some people can't taste bad flavors, and some don't feel cold flavors very strongly. It is very important to understand these differences when choosing and teaching judges for sensory analysis. Understanding and analyzing the signals and actions of the fish requires careful training to obtain unbiased observations that accurately describe its characteristics. It is simple to tell if the fish is completely stiff, but it takes more practice to determine if the fish is post or pre-rigor. Subjective assessment is when someone judges a product based on their personal preference. It is used in market research and product development to understand how consumers react to a product. In quality control, assessment needs to be based on facts and not influenced by personal opinions or biases[7], [8].

The quality control test that analyzes products can be separated into two groups: tests that identify differences between products and tests that describe the characteristics of products. The purpose of discriminative testing is to establish whether there is variation among

different samples.Examples of this are triangle tests and ranking tests. Descriptive tests are used to find out how different things. The subjective test is a test that measures how much someone likes or accepts something. QIM is a system that uses various factors to judge the quality of raw fish. The factors are given points from 0 to 4, with higher points indicating lower quality. One study by Jonsdottir in 1992 came up with this system. QIM is using a helpful rating system, where the fish is checked and any problems are noted. After adding up the scores for each characteristic, we get a final score called the quality index. QIM gives a score of zero for really fresh fish. The score gets bigger as the fish gets worse. The explanation of how each measure is assessed is written in a guide. For instance, if a herring has 0 demerit points for its skin appearance, it means that the skin is very bright and is only found in herring that have been caught recently. When the skin is decaying, it becomes less shiny and vibrant, which results in receiving 2 negative points. Most of the choices made are the same as many other plans. After describing something in literal terms, the scores are given for each aspect on a scale of 0 to 1, 0 to 2, 0 to 3, or 0 to 4. Parameters that are not seen as very important are given lower scores. The scores of each person are always less than or equal to 4, so no factor can greatly change the score.

There is a connection between how good something tastes and how long it can be kept in the freezer. This connection helps us know how much longer it can stay frozen. The theoretical demerit curve has a fixed point at (0,0) and its highest point is determined by when the fish is rejected after being evaluated by our senses or by a set time limit. To predict how long fish will last, a trained group of people needs to taste and evaluate it. They only need to do this during the planning stage. After that, they won't have to taste the cooked fish again to know how long it will stay good. QIM does not follow the usual pattern of fish quality decline during storage. The goal is to have a clear way of telling the difference between fish that are freshly caught and fish that have been stored for a while. If a fish merchant keeps the fish on ice right away, they might want to know how long the fish will still be good to sell. A person buying fish at a market might want to know how long the fish have been stored on ice and how much time is left before they cannot be sold anymore. We can use the quality index method to find condition indicators for a fish sample. These indicators show how the demerit points are changing for the fish.

By employing a systematic scaling approach, descriptive testing can be utilized to assess both the durability and quality of a product. Structured scaling helps the panelist see a scale that has different levels of intensity. Sometimes, a group of experts who have been trained well in describing things pick a few specific characteristics. The words we use to describe things need to be chosen carefully, and the people who make decisions need to be taught so that they all understand and agree on the words. Using objective terms is better than using subjective terms. If we can, we include standards at different points on the scale. This can be done easily by using different amounts of salt, but it could be harder if the food is spoiled. The easiest way can be 1. No bad smell or taste, 2. A small unpleasant smell/taste and three. The smell or taste is really bad, but it's considered okay if it's between 2 and 3. This has been improved to a test that combines cooked fish fillets from lean and fatty fish. Training is needed for people who assess things using their senses in almost all methods that involve using your senses. The level of training needed is based on how hard and intricate the assessment is. For instance, in order to correctly define the characteristics and use the scoring system, you need to train extensively with a wide variety of examples. The triangle test usually doesn't need much training. Sensory quality control is usually carried out by a small number of people either at the fish market when purchasing fish or during quality inspection[9], [10].

These people have a lot of knowledge, so they can determine the quality of the fish. When you begin working as a fish inspector, you don't need to know all the different ways to test the senses described in textbooks. However, you should know some basic principles. The person evaluating must have training in basic tastes, the most common fish flavor, and be able to distinguish between unpleasant flavors and contaminations. You can learn this information in a 2-day training course. In larger companies and for experimental work, it is important to provide additional training to a group of people who evaluate sensory factors. This training helps to ensure that the evaluations are unbiased and fair. A group of 8-10 people is needed for a laboratory panel. The panel members need to go through training and testing regularly. People like using biochemical and chemical methods to check seafood quality because these methods can measure how good or bad the seafood is. Setting tolerance levels for chemical spoilage indicators would remove the necessity of relying on personal opinions to judge the quality of a product. Of course, in most situations, our senses are helpful in determining if products are really good or really bad. So, using biochemical/chemical methods might be the best way to solve problems with products that are not very good. Furthermore, scientists have found alternative ways to measure certain substances using chemicals instead of relying on microbes, which takes less time. However, these factual ways of measuring should align with how good something tastes and the specific chemicals being tested should go up or down depending on how much it's gone bad or decayed. It's also important that the chemicals being measured aren't changed during processing, like when amines or nucleotides break down due to high temperatures in canning.

Total volatile basic amines (TVB) is a common way to measure how fresh seafood is. This term refers to measuring certain substances that are produced during the spoiling of seafood. These substances include trimethylamine, which is made by bacteria that spoil the food, dimethylamine, which is made by enzymes when the food is frozen, ammonia, which is made when certain chemicals in the food break down, and other smelly compounds. Although TVB analyses are easy to do, they usually only show spoilage that has already happened and are not dependable for measuring spoilage during the first ten days of keeping cod and other species in cold storage. They are very helpful in measuring the quality of cephalopods like squid, fish for meals, and crustaceans. However, it is important to remember that TVB values do not show how the food is spoiled (by bacteria or by natural breakdown), and the results can vary a lot depending on how the analysis is done. Six different TVB procedures were not in good agreement Most people use either steam distillation or microdiffusion to extract volatile amines. Microdiffusion is the preferred method. Ammonia is produced when bacteria break down proteins, peptides, and amino acids. It is also made when adenosine monophosphate breaks down in chilled seafood.

Ammonia is found in spoiling fish, but there haven't been many studies that measured how much of it is present because it's hard to figure out how much it adds to the overall increase in smelly compounds. Recently, two easy ways to recognize ammonia have been made accessible. The first thing requires using three things: an enzyme called glutamate dehydrogenase, a molecule called NADH, and another molecule called alpha-ketoglutarate. In simpler terms, when ammonia is reduced in a fish extract, it produces one mole of glutamic acid and NAD, which can be easily measured by checking the absorbance at 340 nm. Test kits for ammonia are now for sale from Sigma. They use glutamate dehydrogenase. Louis, Missouri in the United States of America and Mannheim, Germany are the locations of two companies named Louis and Boehringer Mannheim. There is another kind of ammonia test kit that has a strip. When this strip comes into contact with liquid containing ammonia, it changes color. LeBlanc and his team changed a procedure called glutamate dehydrogenase to measure ammonia levels in a rough estimation without a machine called a spectrophotometer.

They used a special dye called formazan which changed color to show the amount of ammonia present. TMA analysis is better than counting bacterial numbers because it is faster and more accurately indicates the level of spoilage compared to counting bacteria. For instance, if you use a dirty knife to cut even good quality pieces of fish, there might be a lot of bacteria on them. However, if the bacteria have not had a chance to spoil the food, the levels of TMA will be low. The main problems with TMA analyses are that they don't show the beginning stages of decay and can only be trusted for specific kinds of fish. Be careful when preparing fish samples for amine analysis. TMA and many other chemicals become easily evaporated at high pH levels. Many methods currently used start by removing the protein from a sample. This is done by using perchloric or trichloroacetic acids to break down the proteins. The substances called amines can evaporate from samples that are being stored. This can cause big mistakes in the analysis of those samples. So, samples need to be made neutral (pH 7) before testing. If they need to be stored for a long time before testing, they should be kept in sealed containers in their acidic form. It is important to wear gloves and goggles when handling perchloric and/or trichloroacetic acids. Furthermore, perchloric acid can cause fires if it comes into contact with organic material. Spills should be cleaned with lots of water.This means that when fish in the cod family, like cod itself, are frozen, a substance called DMA is created along with another substance called FA.

These substances cause the proteins in the fish to become harder. The more FA/DMA produced, the more protein denaturation occurs. Usually, DMA is measured, rather than FA, to check the quality of frozen gadoid fish. Most of the FA sticks to the tissue and cannot be easily removed or measured accurately. The most common way to analyze DMA is by using a color measurement of the DMA in fish extracts with the proteins removed. Unfortunately, a lot of color-based tests that have been suggested so far do not work well when there are different types of amines mixed together in a sample. The methods of chromatography, such as gas-liquid chromatography and high performance liquid chromatography, are more specific and less likely to be affected by outside factors compared to spectrophotometric methods. In simpler terms: Moreover, most of the techniques suggested so far for studying amines destroy the samples and are not suitable for analyzing a large quantity of them. Scientists have suggested using gas chromatography to analyze the vapors released from a sample without damaging it, instead of traditional methods for measuring amines. Unfortunately, all the methods suggested so far have significant practical problems.

During the time when something is stored in a frozen state, a substance called dimethylamine is made by itself. For fish like hake, it has been discovered that FA-induced toughening can be determined by it. Its production is increased when muscle tissue is treated roughly and when there are changes in temperature in the cold storage.

Dimethylamine does not really change the taste or feel of the fish itself. However, it can indicate if the protein has been damaged, which can happen if the fish was not handled correctly before or during freezing.Fish muscle can help bacteria make many different chemicals called amines. These amines come from changing amino-acids. Spoilage bacteria that have decarboxylase activity are able to raise the pH of their environment by producing amines. They do this in response to acidic conditions. Histamine, putrescine, cadaverine, and tyramine are made when histidine, ornithine, lysine, and tyrosine are changed. Histamine has gotten a lot of attention because it has been linked to scombroid poisoning when people eat tuna, mackerel, and mahi-mahi a type of fish from Hawaii. However, just because scombroid fish like tuna and mackerel do not have histamine does not mean they are safe to eat. This is because when these fish are stored at cold temperatures, they can still spoil even without histamine forming.

The process of diagnosing bacterial infections in fish is similar to that of other animals. However, the types of bacteria that can cause these infections are often unfamiliar to veterinarians and medical microbiologists. The process of isolating and understanding results in water can be difficult because the water itself contains a lot of bacteria, and the way a cold-blooded animal interacts with its surroundings is closely connected. Many fish can get sick from bacteria that are already inside their bodies or on their skin. These bacteria only cause harm when the environment changes suddenly, like when there's a big temperature change, pollution, or when the fish is under stress from its diet or hormones. Therefore, paying careful attention to a person's medical background is absolutely necessary for logical diagnosis. Dead fish should not be used to diagnose bacteria because after death or even just before death, the tissues are quickly invaded by other organisms, which can hide the bacteria that caused the problem in the first place. It's best to look at multiple examples of sick fish, including ones that are still in the early stages of the disease and ones that are close to dying. Fish can be killed either by cutting off their heads or by giving them too much anesthesia. If a person needs to check for bacteria inside their body, a doctor will make a cut on the stomach with a clean knife and take out a piece of the stomach without letting any germs get in.

The best way to collect samples for culture is to burn the surface of the organ being studied with a hot scalpel blade. A clean loop or pipette is placed through the cleaned area, and the sample is spread onto the necessary substance. The temperature needed for incubating microorganisms can be different for each one. If it's not clear which microorganism is present based on the symptoms or smears, incubating them at different temperatures and on different types of media may be necessary. For diseases caused by bacteria in the bloodstream, doctors usually focus on testing the heart and kidney to diagnose the problem. However, it's also important to test other organs to increase the chances of finding any bacteria that might be causing the disease and improving the recovery process. It is very hard to take samples of external skin problems because they are always affected by other types of bacteria or fungi. These could hide the original harmful germ or replace it entirely. Along with studying culture, it is important to also make smears from visible sores. Since many conditions are related to infections in the blood, it's crucial to also obtain impression smears from the tissue of the kidneys or spleen. You should use Gram's method to stain these, and if there are lumps or lesions that could be from granulomas or tuberculosis, use Ziehl-Neelsen's method as well.

Looking closely at these smears is really helpful in figuring out if the condition is caused by bacteria. Sometimes, it is difficult to isolate organisms like the kidney disease organism Renibacteriumsalmoninarum. In those cases, it can be helpful to inject the suspect material under the skin of another species that is capable of getting the disease. This can help remove other unwanted things and hopefully create a pure culture of the original harmful organism. A helpful guide on how to isolate and identify bacteria that cause diseases in fish. After we determine the structure and staining characteristics of bacteria in a sore, we should be able to separate and identify them in a logical way. These tests check for specific enzymes in fish bacteria. There is a simple chart for the most commonly seen types of fish bacteria that these tests are used for.

The type of material and the way it looks can determine what media is used for isolation. A nonselective approach means using media that can support the growth of many different types of bacteria. This makes sure that most bacteria will be able to grow, but some bacteria that aren't really important for medical purposes may grow especially well and crowd out the more delicate yet potentially more important ones. Selective media have certain substances that can stop the growth of specific groups of organisms and only allow certain target groups to grow. These types of media are very helpful in checking for bacteria like

Aeromonashydrophila or Pseudomonas sp. Cetrimide agar is a type of substance used in experiments that helps identify and grow bacteria. It is made up of cetrimide, which is a chemical that kills certain types of bacteria, and agar, which provides the right environment for bacteria to grow.

CONCLUSION

In brief, this chapter has extensively covered the laboratory methods and techniques employed in the study of fish physiology. We looked at many different ways to study the body, like measuring things like how much oxygen we use and how fast our bodies work, studying how hormones work, and examining genes. These methods are important for helping us learn more about how fish work in different places, like fish farms and natural environments.Using these laboratory techniques, scientists can learn important information about how fish adapt to their environment, how they react when faced with challenges, and how healthy they are overall. This information is very important for taking care of fish, improving fish farming, and protecting fish species in a world that is changing quickly.As technology gets better, scientists will find better ways to study how fish bodies work in laboratories. Scientists and experts in the field need to keep up with these changes to make sure that their work stays ahead in fish physiology research.To put it simply, studying how fish bodies work in a lab is always changing, and the ways we talk about it in this chapter are really important for us to understand these cool water-dwelling creatures. We can learn more about fish bodies to help protect them and manage their populations.

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