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"FISH: THEIR PRIZE AND PAIN"

By

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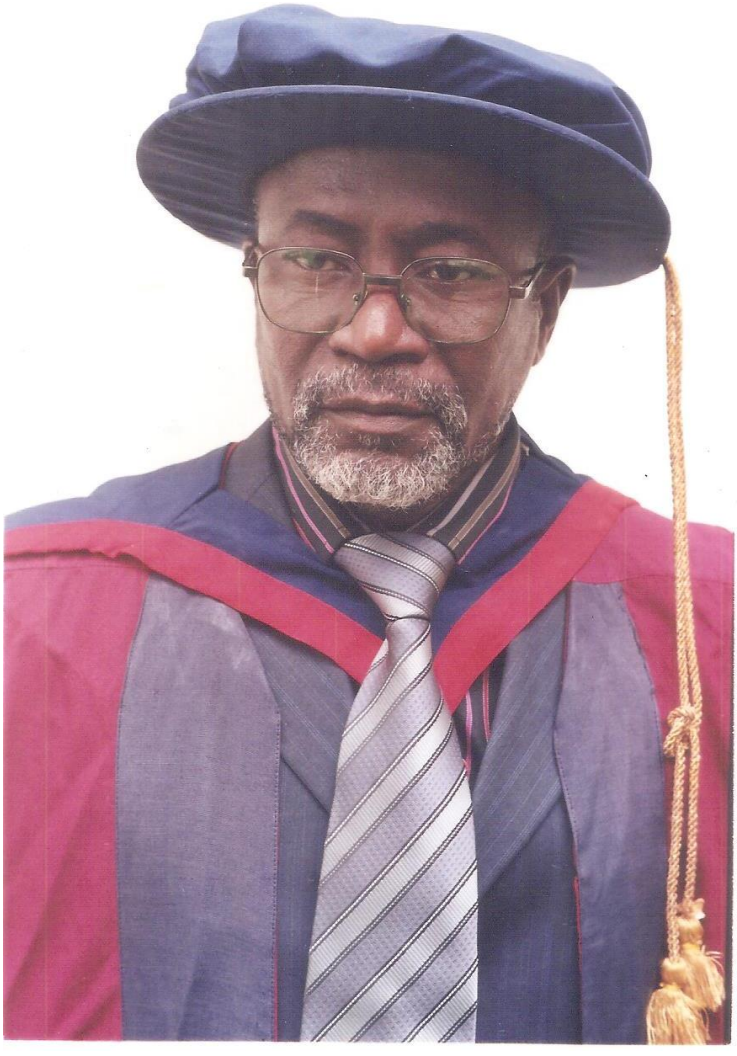

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My Lords Spiritual and Temporal,
Distinguished invited guests,
Gentlemen of the mass media,
Great Unilorin Students,
Ladies and Gentlemen.

Preamble

To you alone, El-shadai, Jehovah Rohi, Jehovah Jireh, I ascribe gratitude for granting me the grace to witness this day to present the 174th series of Inaugural lectures of this great University, because "The race is not to the swift, nor the battle to the strong, nor bread to the wise, nor riches to the intelligent, nor favour to those with knowledge, but time and chance happen to them all" (Ecclesiastes 9:11).

My advent into the fish and fisheries discipline forty-two (42) years ago was prompted by one of my

undergraduate lecturers Dr. R.A. Shotter, who invited me, out of a class of seven (7) students studying Zoology at Ahmadu Bello University, Zaria, and said, "James, I am giving you a project topic on fish. Will you like it?" My immediate response was No, because I did not know how to swim, and I had a strong phobia for water. He allayed my fears and reminded me I was in the University to learn. These words of encouragement and assurance made me drop my initial plan to study insect, i.e Entomology instantly, and kindled the light of interest in the study of fish i.e. Ichthyology, and finally culminating in the inaugural lecture delivery of today.

What are Fishes?

Fish is any of more than 30,000 species of cold-blooded vertebrate animals (Phylum Chordata) found in the fresh and salt waters of the world. Living species range from the Primitive, Jawless Lampreys and Hagfishes (Plate 1) to the Cartilaginous Sharks (Plate 2), Skates and Rays (Plate 3) to the abundant and diverse bony fishes (Plate 4).

Plate 1: Pacific Lamprey *Petromyzon marinus* (Keefer *et al*., 2009)

Plate 2: Great white shark *Carcharodon carcharias*
Source: Burgess *et al., (*2014)

Plate 3: Skate *Dipturus batis*
Source: Burgess *et al., (*2014)

Plate 4: Bony Fish- *Cyprinus carpio*
Source: Olden *et al*., (2010)

Ichthyology, is of broad importance. Fishes are of interest to humans for many reasons, the most important being their relationship with and dependence on the environment. A more obvious reason for interest in fishes is their role as a moderate but important part of the world's food supply. This resource thought unlimited is now realised to be finite and in delicate balance with the biological, chemical and physical factors of the aquatic environment. Over fishing, pollution and alteration of the environment are the chief enemies of fish and fisheries management, both in fresh water and in the ocean.

Fishes have been in existence for more than 450 million years, during which time they have evolved to fit into almost every conceivable type of aquatic habitat. In a sense, land vertebrates are simply highly modified fishes: when fishes colonised the land habitat they became tetrapod, (Four Legged) land vertebrates, man inclusive. The popular conception of a fish as slippery, streamlined, aquatic animal that possesses fins and breathes by gills applies to many fishes but far more fishes deviate from that conception than conform to it. For example the body is elongated in many forms and greatly shortened in others; the body is flattened in some (bottom-dwelling fishes) and laterally compressed in many others; the fins may be elaborately extended, forming intricate shapes, or they may be reduced or even lost; and the position of the mouth, eyes, nostrils and gill openings vary widely. Air breathers have appeared in several evolutionary lines.

Fishes range in adult length from less than 10mm to more than 20 metres and in weight from about 1.5 grams to many thousands of grams. Some live in shallow thermal springs at temperatures slightly above 42 ^{o}C others in cold

Arctic seas of few degrees below $0^{o}C$ or in cold deep waters more than 10,000 meters beneath the ocean surface. The structural and especially, the physiological adaptations for life at such extremes are relatively poorly known and provide the scientifically curious mind with great incentives for study.

Does fish feel pain?

The idea that animals might not feel pain as human beings feel it, dates back to the 17^{th} century. French philosopher, Rene Descartes argued that animals do not experience pain and suffering because they lack consciousness (Radner & Radner 1989, Carbone, 2004).

Bernard Rollin of Colorado State University, the principal author of two U.S Federal laws regulating pain relief for animals wrote that researchers remained unsure into the 1980s as to whether animals experience pain, and veterinarians trained in the U.S before 1989 were simply taught to ignore animal pain (Bentham 1879).

Subsequently several authors have published research work which claimed that fish do feel pain and their reactions to pain are much like those of humans (Mans 2012, Mosley 2005, Sladky & Mans 2012).

For years anglers have claimed hooking fish out of water (Plate 5) and tossing them back in, does not hurt.

Plate 5: Fish pierced and carried by a rod (Mosley, 2005)

Tagging and marking of fish even for research purposes, if improperly done might also cause pain and discomfort for fish and must be avoided (Plate 6). Research involving living animals including fishes must be based on experimental designs that can lead to scientifically valid results while also taking the welfare of the test animals into consideration. Researchers need to take great care to avoid inducing stress in experimental subjects (especially on prolonged bases) because it can evoke physiological and behavioural changes. Ethical standards mandate a respect for all life forms and processes (Barton & Iwama 1991).

Plate 6: Fish tagging (Thorsteinn *et al.*, 2006)

Fish Stress

Stress is a critical factor in fish health. It is so important, that scientists have studied it in detail both in the wild and captive fish.

Common fish life stressors in captivity include overcrowding, handling, poor environment, and inappropriate or aggressive fish sharing the same tank. Stress causing factors in the wild include predators, decayed aquatic weeds after treatment with a herbicide or a large algae bloom, and the turnover of oxygen-poor bottom waters following a thunder storm, the runoff of livestock waste and other organics after a heavy rain, oxygen depletion, and pesticides like chlorine, gasoline, fuel oil, ammonia, fertilizer, acids and other toxic chemicals. Slow death as a result of disease and parasites can equally be stressful for the fish. Fishes have evolved and live in a relatively stable environment. They are consequently better at handling short-term trouble and are not as well-suited to long-term environmental stressors.

Short-term Stress Responses

For short-term stress, the most common reaction is to flee from danger. When a fish senses any danger, it triggers a short-term alarm reaction by releasing hormones, including adrenalin for its locomotory muscles. This will give it a sort of energy to escape quickly, the fish also releases cortisol.

The adrenalin disturbs the fish's natural osmoregulation (balance of salt and water in its body) and the cortisol affects white blood cells and reduces the effectiveness of the immune system. Once the panic has passed, the fish must also regain its natural balance. This can take hours or days after only a short period of stress.

Long-term Stress Responses

Long-term changes such as an unsuitable environment are handled with the same initial response: an alarm message to escape. However if escape is impossible, it begins to adapt to the new environment as best as it can.

Throughout the period of adaptation, the fish still prioritises reacting to the new environment and remains stressed, so its immune system suffers and it is prone to disease. Adaptation normally lasts from four to six weeks. However, if the fish continues to be in stressful conditions, such as a constantly deteriorating environment or endless bullying from an aggressor, it continues to try to adapt and extends all the bodily responses as long as necessary. This reduces its chance of survival, and in the worst situation, where adaptation is impossible the fish will exhaust itself to death.

Economic Value of Fish

One of the most important groups of vertebrates to man are fishes. They form a rich source of food and provide a means to tide over the nutritional difficulties of millions of human beings. Fishes are valuable laboratory animals in many aspects of medical and biological research. They have been especially important in the study of animal behaviour where research on fishes has provided a broad base for the understanding of the more flexible behaviour of the higher vertebrates e.g *Capra hircus* (Goat).

The zebra fish (*Danio rerio*) is used as a model in studies of gene expression.

Fish as Human Food

Fish have formed a significant item of human diet from time immemorial, and are primarily captured for this purpose. Fish is known to be one of the cheapest sources of animal protein, minerals and other essential nutrients required in human diets (Sadiku and Oladimeji, 1991). The most important mineral salts are calcium, sodium, potassium, phosphorus, iron and chlorine, while many others are needed in trace amounts. The deficiency of the principal mineral elements induce a lot of malfunctioning as it reduces productivity and causes disease, such as inability of blood to clot, osteoporosis and anemia (Mills, 1980).

Lipids from fish are well known as a rich source of long-chain n-3 polyunsaturated fatty acids (n-3 PUFA) which has been reported to have preventive and/or curative effects for several diseases including arterial hypertension, cancer and inflammatory diseases (Turkmen et al., 2005). It may also aid in lowering the risk of dementia, alzheimer's diseases (Grant, 1997) and prevent cardiovascular diseases

(Cahu et al., 2004). The beneficial health effect of Omega-3 PUFA are well demonstrated and include the prevention of a number of diseases such as, coronary heart diseases, hypotrigly ceridemic effect, allergies, hypertension, arthritis, autoimmune disorders and cancer (Von-Schacky and Harries, 2007).

Plate 7: Fish and chips delicacy
(Akihiko and Wimberly, 2010)

Table 1: Fish with good source of omega-3 fatty acids

COMMON NAME	SCIENTIFIC NAME
Salmon	*Salmo salar*
Tuna	*Thunnus alalunga*
Sardines	*Sardinella longiceps*
Herring	*Clupea harengus*
Mackerel	*Scomber scombrus*
Black Bass	*Micropterus dolomieu*
Carp	*Cyprinus carpio*
Channel cat fish	*Ictalurus punctatus*
Pompano	*Trachinotus africanus*

Fish Oil

The most important fishery by-product is that of the fish oil, which is of two kinds, liver oil and body oil. The oil extracted from the whole body of the fish is called fish body oil, while that obtained from the liver of certain fish (e.g. Cod fish, albacore tuna etc) is called the fish liver oil. Liver oil contains vitamins A and D, 55-75% fat, 5-10% protein, the rest water, and is of considerable medicinal value. The body oil from fish has many uses in painting, varnishing soap, candle, leather and steel industries (Plate 8).

Plate 8: Fish liver oil capsule (Baocheng *et al*., 2015)

Fish Skin

The skin of sharks (*Scoliodon* sp.) and Rays (*Dasyatis* sp.) and several other fish species are used for making polishing and smoothing materials. The dried and treated skin is also used for preparing ladies shoes, money bags, suitcases and belts (Plate 9, a, b & c).

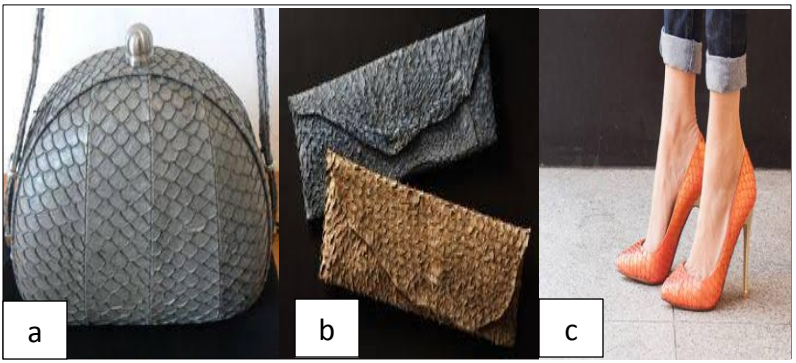

Plate 9: (a,b and c): Some fish leather products
Source: Nagarajan *et al*., (2013)

Fish flour

Fish flour is superior quality of fish meals which is used for human consumption. It can be mixed with wheat flour (10% fish flour and 90% wheat flour) and is used for enriching nutritive value of bread, biscuits, cakes, etc.

Biological control

During the past several years, Dichlorodiphenyl-trichloroethane (DDT) and other insecticides have been used in increasing quantity to control the mosquito menace with their attendant negative effects on other aquatic animals including humans. Fish is a natural enemy of mosquito eggs and larvae, and biological control of mosquitoes with the help of suitable larvivorous species is the most practical, safe and cheapest method. There are several indigenous species, some of which are very effective in destroying mosquito larvae (e.g. *Notopterus notopterus*, *Barilius* sp, *Oxygaster* sp, *Oryziac* sp. *Mugi* sp,

Glossogobius sp. etc. Exotic species include *Carassius auratus, Lebistes* sp and *Gambusia affinis* (Plate 10).

Plate 10: Feeding on Mosquito larvae (Hay *et al*., 2005)

Aquarium trade

Keeping of ornamental fish is a long practice in Nigeria. In some villages electric fish was sometimes kept in drinking water clay pots in order to "cleanse" the water. In recent times, the advent of modern technology has introduced the glass-aquarium, used for ornamental fish keeping in Nigerian homes. Many species of beautifully coloured fishes are kept in aquaria and ponds for ornamentation. They are bred and maintained by stockists who offer numerous varieties for aesthetic purposes (Plate 11).

Plate 11: Freshwater Aquarium (Duggan, 2010)

Table 2: Fish species commonly used in the aquarium

Common name	**Scientific name**
Two-spot barb	*Pontius ticto*
Giant gourami	*Colisa Faciatus*
Siamese fighting fish	*Betta splendens*
Black molly	*Poecilia sphenops*
Black ruby	*Poecilia maxicana*
Gold fish	*Carassius auratus*
Kissing gourami	*Helostoma temmincki*
Indian flying barb	*Esomus danricus*
Zebra fish	*Barbus fasciatus*
Angel fish	*Pteryphllum* sp
Red or Jewel cichlids	*Hemichromis bimaculatus*
Penchax	*Epiplatys senegalensis*
Glass catfish	*Physalia pellucid*
Sail fish	*Calanuichthys calabaricus*
Elephant snout	*Gymnarchus niloticus*
Shortnose trunkfish	*Marcusenius* sp
Electric fish	*Malapterurus electricus*
Spiny eel	*Mastacembelus loembergi*
Butterfly (flying) fish	*Panthodon bucholzi*
Feather back	*Papyrocranus afer*
Sail fin of Birchers	*Polypterus senegalus*
Spotted catfish	*Synodontis nigrita*

Therapeutic Value of Fish

Drugs have been employed in combating health challenges and for long has their therapeutic abilities been proved. However, these drugs also have side effects. These side effects have led to serious health issues, hence an alternative to these drugs becomes imperative (Thomas, 2003). In this respect, fish has played a significant role.

Cardiovascular Diseases

It has been found that regular fish consumption and intake of n-3 PUFA play an important role in the primary and secondary prevention of coronary heart diseases and stroke (Sidhu, 2003). The possible mechanism for this action relates mainly to their anti-arrhythmic, anti-inflammatory, anti-thrombotic and anti-atherogenic effects (Mohanty et al., 2011).

Skin Diseases

Ichthyotherapy is the treatment of skin wounds/conditions with fish (Plate 12). The fish is maintained in hygienic pools and sparsely fed. The fish feed or nibbles on the affected skin, removing the dead skin and avoiding the healthy skin (Mohanty et al., 2011). The most commonly used fish for this is *Garra ruta*, popularly known as the 'doctor fish', 'nibble fish' or 'kangal fish' (Mossman, 2007).

They are employed in treating patients suffering from various skin disorders, including psoriasis and eczema. Species of *Barbus callipterus* and *Barbus occidentalis* could be experimented locally in same regard.

Mr. Vice Chancellor Sir, there is very little scientific backup to claim that the saliva of *Garra ruta* fish leaves a

potent enzyme that, with repeated treatments, can cure psoriasis and eczema, but by peeling away ordinary callouses and the thick lesions of psoriasis, the fish do leave the feet feeling softer and prettier (Cunningham, 2009).

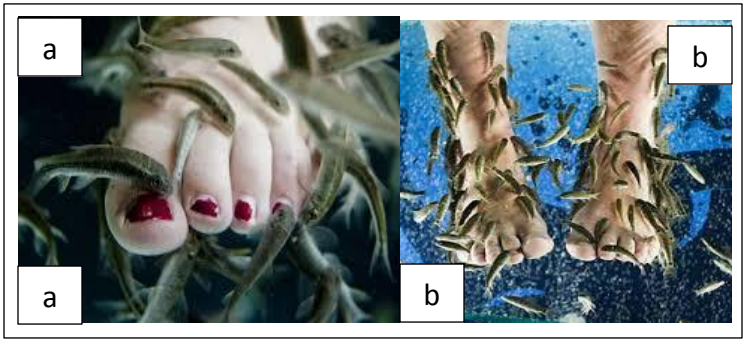

Plate 12: (a & b): Treatment of skin disease with life fish (Mossman, 2007).

Other ailments

Cod liver oil, which is a supplement derived from liver of cod fish is widely taken to ease the symptoms of arthritis. Because of the high level of vitamin D in cod liver oil, it is given to children to prevent rickets and other symptoms of hypovitaminosis D. (Rajakumar, 2003).

Regular fish consumption can improve the development of bones owing to the content of vitamin D in fish (Mohanty et al., 2011).

Table 3: Fish with established therapeutic value

Fish	Disease/Ailment	Locality
Channa striatus	Consumption induces wound healing in post-delivery and post-operation especially among caesarean mothers (Sabot 1998)	Asian countries
Scoliodon sorrakowah (Shark)	Shark liver oil, general health, heals wounds, sores, irritations of the respiratory tract and alimentary canal. (Mohanty et al., 2011)	Asia
Gadus marhua (Cod fish)	To ease symptoms of Arthritis, prevent rickets and other symptoms of hypovitaminosis D in Children. (Rajakumar, 2003)	Asia
Belaya sp	To cure Asthma, Arthritis, and joint pain (Prabhakar and Roy, 2009)	People of Kosi River Basin India
Lamelliadiens sp	To cure Cardiac ailment	
Macrobranchium sp	To cure Anemia (Prabhakar and Roy, 2009)	People of Kosi River Basin India
Clarias batradus and *Heteropneustes* fossils	To cure infections, reduce pains (recuperating patient from operation, injuries and wounds (Mohanty et al., 2011)	India
Trachelyopterus galeatus	To cure umbilical hernia, asthma and sexual impotence (Alves, 2009)	India

Urotrygon microphthalmum	To cure Asthma (Alves, 2009)	India
Colomesus psittocus and *Sphoeroides testudineus*	Reduces breast cancer, backache, warts and rheumatism. (Alves, 2009)	India
Synbranchus marmoratus	To cure bronchitis. (Alves, 2009)	India
Narcine brasiliensis	To cure tooth ache. (Alves, 2009)	India

Mohanty *et al.*, 2011

Fish in Indigenous Healing Practice

The use of plant and animal resources in natural healing practices is wide spread in Nigeria before the advent of orthodox medicine. Natural healing practitioners are usually the first sources of intervention for health-related problems in an overwhelming proportion of the population (Ehinmore and Ogunode, 2013). The premium on the use of fish and their derivatives in treatment, is evident in the range of available literature on diversity, uses, trade and implication for conservation. Studies have shown that science of natural healing using fish derivatives with fusion of herbs and other natural ingredients have been an age long practice in Nigeria. Medicinal uses of fish in Nigeria are legion without adequate record, and the list of fishes of medicinal value is by no means exhaustive. It varies from one locality to another. From interviews with traditional medicine experts and through very few literatures available, the following fishes have been listed for having medicinal value.

Table 4: Fresh water fishes with medicinal value

Yoruba	**English**	**Scientific name**
Ojiji	Electric Fish	*Malapterurus electricus*
Aro	Mud Fish	*Clarias sp. / Heterobranchus sp*
Epiya	Tilapia	*Tilipia sp. / Sarotherodon sp Oreochromis sp.*
Agbadarigi	African bonny tongue	*Heterotis niloticus*
Osan	Mormyrid	*Gymnarchus niloticus*

(Ehinmore and Ogunode, 2013)

Table 5: Marine fishes with medicinal value

English	***Scientific name***
Shiny nose	*Polydactylus quadrifilis*
Cuttle fish	*Sepia officinalis*
Sting – ray	*Dasyatis pastinaca*
Sword fish	*Xiphias gladius*
Shark	*Carcharlinus amblyrhynochos*
Silver Cat fish	*Bagrus filamentosus*
Red snapper	*Lutjanus campechanus*
Spade fish	*Chaetodipterus faber*

(Ehinmore and Ogunode, 2013)

Pregnancy

To enhance strong kick of pregnancy, fresh electric fish is combined with gun powder and alligator pepper (Atare) burnt together, ground into powder and chewed periodically by pregnant women. Similarly, fresh tilapia is cut alive, mixed with water lily (*Nymphaea lotus*), native seasoning (iru) and pepper, and then cooked as a concoction for eating by pregnant women for energising weak pregnancy (Ehinmore and Ogunode, 2013).

Irregular menstrual cycle

Dried leaves of plant "Agboki" (Yoruba) with catfish (*Clarias* sp) are grounded into powder. A teaspoon full is taken with warm water daily (Ehinmore and Ogunode, 2013).

Strong erection in men

Electric fish is combined with parts of gorilla and he-goat penises and alligator pepper, burnt together and mixed with honey for periodic licking. Electric fish is also used in many other ways such as brain stimulation (Isoye), infertility, stroke, etc (Ehinmore and Ogunode, 2013).

Abdominal Problems

Mud fish is used in a complex and vast regimen. It is mixed with other ingredients to prepare medicinal concoctions (Aheje, Aloje) to treat various ailments such as abdominal problems, restoration of womb tranquility (Eda), worm attack, overheating of the womb, etc (Ehinmore and Ogunode, 2013).

Anaemia

Mud fish (*Clarias* sp/*Heterobranchus* sp) is grinded with the leaves of "Omisinmisin" (Yoruba) plant with little salt mixed with palm oil. It is a blood tonic that has proved potent for the treatment of anaemic condition. Fat extracted from large fishes such as sting-ray, shark and sword fish are used in various ways for body treatment. It is used to massage swollen parts of the body, dislocated or broken bones. It also serves as general body immunity and as prevention of arthritis. Mr. Vice Chancellor Sir, some of these claims from Yoruba traditional doctors are not scientifically substantiated. However, the efficacy of some of these concoctions may not be in doubt.

Hazards Faced by Fish

Fishes are not immune to natural disasters; hence various calamities often befall them.

Tornado

A tornado is a rapidly rotating column of air that is in contact with both the surface of the earth and a cumulonimbus cloud.

A waterspout can sometimes suck small animals such as fish out of the water and all the way up into the cloud. Even if the waterspout stops spinning, the fish in the cloud can be carried over land, buffeted up and down and around with the cloud's winds until its currents no longer keep the flying fish in the atmosphere. Depending on how far they travel and how high they are taken into the atmosphere, the fish are sometimes dead by the time they rain down.

(Plate 13 a & b)

Plate 13 (a & b): Fish kill after tornado in Miami.
(Strader *et al*., 2017)

Similar tragedy befall the fish after the incidence of hurricane or cyclone (Plate 14)

Plate 14: Fish kill as a consequence of hurricane.
(David *et al*., 1998)

Volcano and Earthquakes

A volcano is a rupture in the crust of a planetary-mass object, such as earth, that allows hot lava, volcanic ash, and gases to escape from a magma chamber below the surface.

The eruption of Chile's Calbuco volcano threatens widespread, lasting economic damage, turning cattle pastures barren and choking fish with volcanic ash in one of the world's top salmon producing countries, (Plate 15). Earthquakes can have a variety of follow up effects on water, such as landslides and tsunamis. Landslides can cause smothering; the covering of plants and fish by an excessive flow of mud and other thick substances into bodies of water, smothers them, completely blocks sunlight and so photosynthesis cannot take place leading to oxygen depletion and fish kill. Landslides could also displace a farm that has used chemical fertilizers and bring them down to the water. This would be leaching and lead to eutrophication. Tsunamis and their attendant consequences can occur. The 22nd February 2011 earthquake in New Zealand affected Christchurch's waterways following liquefaction sand/silt bank slumping, uplift of streambeds and input of raw waste water. Immediately following the February earthquake, large volumes of wastewater were discharged into the river with higher discharged volumes. In March and April, dissolved oxygen concentrations were very low (close to zero). In this reach, fish kills were inevitable, (Plate 15).

Plate 15: Fish kill as a consequence of volcanic eruption (Stenchikov *et al*., 1998)

Plate 16: Fish kill arising from earthquake (Marano *et al*., 2010).

Anthropogenic Source

The change in the natural quality of the environment brought about by physical, chemical or biological factors is termed pollution. Each of these pollutant factors in water has its effects on fisheries and human health. Various by-products of man's activities, and increase with rise in population form the pollutants. Every organism produces some polluting waste product, but in a balanced ecosystem, the wastes of one kind of organism are used as food by another, so that they do not accumulate and are broken down, and there is no 'unfavourable' alternation.

However, industrialization and increase in the human population of large cities results in rivers becoming the drains of waste material. Domestic waste sewages and industrial effluents are generally allowed to be added to the rivers without any pretreatment, thus causing pollution of water.

Pollution by fertilizers and insecticides

The use of pesticides to control agricultural pests is on the increase every day. Several kinds of insecticides like DDT are used in large quantities to control diseases like malaria and filaria. These chemicals are poisonous and are washed into the rivers, lakes and ponds endangering fish life.

Marine Pollution

Dumping of sewage in the ocean has always been considered the cheapest and the easiest way of disposal (Plate 17). The billions of tons of litter end up in the ocean each year. Report also suggests that littering makes the aquatic life in the oceans and seas worse in these days. Among all sorts of activities that pollute the oceans, dumping involves depositing all the waste materials from factories and industries, tankers and ships and sewage waste, chemical, particles, some include radioactive material into the oceans and seas. The adverse effects of these are borne by marine creatures and plants. There is marked oxygen depletion, leading to mass death of mammals and other fishes.

Plate 17: Trash filled coasts (National Geographic, 2014)

Oil pollution

Large quantities of oil discharged into water, either by accident or by design, are extremely toxic and immediately affect the living organisms. Villagers in the Niger Delta rely on the fishing season to raise extra capital. Oil pollution has become a serious problem of the sea water all over the world. Accidents occurring due to collision or fire result in the leakage of large quantities of oil from ships and tankers. Oil reservoirs and offshore oil fields are also sources of pollution of sea water.

Corroded pipes sabotage, and bunkering which were made possible by high level of conspiracy between the security forces, the community and oil workers to steal the oil were responsible for consistent oil spillage in Niger Delta region. In all these, fishes are the most affected, causing high mortality and depletion of fisheries.

Obnoxious fishing methods

Poisons:

Chemo-fishing is an old age fishing method all over the world (making the water poisonous to fish by applying chemicals). Although, the use of poisons and locally-made hand grenades is generally prohibited throughout the country, the small-scale fisher folks still use ichthyotoxic plant poisons, chemicals and locally made hand grenades in Nigerian waters either to kill, shock or daze fish.

Chemical narcosis of fish involves the use of synthetic chemicals such as Adrex 40, Gamalin 20, as well as Didimacs 25 and ichthyotoxic plants in inland waters. The synthetic chemicals which are usually in liquid forms are simply poured on the water surface of small ponds, rivers and creeks to narcotise and kill fish. Ichthyotoxic

plants commonly used are *Tephrosia vogelii*, "Magunfa" is pounded and applied on the water surface to poison fish. Others are listed in Table 6 below.

Table 6: Commonly used Ichthyotoxic plants

Scientific name	Plant part	Common name	Yoruba name
Parkia clappertoniana	Pulp	African locust beans	Igba
Boerhaavia coccinea	Leaves	Hogweed	Etiponla
Derris elliptica	Roots	Poison vine	
Acacia pennata	Back of skin	Climbing wattle	Ewon
Mundulea sericea	Leaves	Cork bush/Silver bush	
Tetrapleura tetraptera	Leaves	Aridan	Aidan
Baillonella toxisperm	Leaves	African pearwood	

Grappling and wounding gear

This is a gear used to impale (wound and kill) fish. In Nigeria, this gear is commonly used in rivers, creeks and shallow lakes.

Mr. Vice Chancellor Sir, as if unto war, at night, fisherfolks are equipped with spears, guns, axes and machetes using torches, flares and hunters' carbide lamps to attack and catch large fishes such as *Lates niloticus*, *Gymnarchus niloticus* and *Chrysichthys nigrodigitatus.* Many of these fishes will escape with fatal wounds. And this is the group of animals that are of great benefit to man and important to his existence.

Aquarium Keeping

When it comes to aquarium, problems are usually inevitable, and it is one of the areas where fishes are ethically violated. Overcrowding and poor water condition could signal abnormal behaviour in fishes such as loss of appetite, difficulty in swimming and rubbing the body against tank objects. These are often symptoms of disease. Similarly, fish are known to die of boredom, therefore you should never place just a single fish in an aquarium.

Harmful Fishes

Mr. Vice-Chancellor Sir, just like we have dangerous elements (kidnappers, ritual killers, armed robbers and Boko Haram) in our midst, let me quickly add that some fishes are harmful and dangerous to man. Some are intermediate hosts of many parasites causing diseases in man and other animals. For example, sharks are extremely dangerous in the sea, injuring fishermen and damaging their nets. Certain species of fish have poisonous sting or spine (e.g. Sting ray and scorpion fish) and cause painful wounds, which might prove to be fatal. Some electric fish are capable of discharging a current of about 500 volts on land but in water it is reduced to about 250 volts. This is sufficiently strong enough to give a severe shock to man. (Khanna, 1970).

Food Poisoning:

Fishes sometimes cause ill effects or sickness in man when eaten fresh or preserved, if not properly cooked or carefully preserved. Certain species such as the Puffer fish, Diodon, and Tetrodon are poisonous and carry toxins in their flesh or blood. They cause gastrointestinal disorders,

paralysis, convulsions and respiratory problems, if eaten in improperly cooked conditions. However, fish species which are not poisonous may also cause illness. Some people are allergic and show gastrointestinal disorders after eating fish species like Herrings, Cod fish and Flat fish.

Some of my Contributions

Mr. Vice Chancellor Sir, over the years, my area of research work ranged from general fish biology, fish ecology, fish nutrition, fish reproduction, and water quality assessment, let me highlight a few.

Abnormal development in the ovaries of *Oreochromis niloticus*

In the course of my research work, I found that fish could also have certain abnormalities apart from diseases.

Specimens of *Oreochromis niloticus* were collected from Oba Dam reservoir, a man-made lake situated within the campus of University of Ibadan, Nigeria. During the course of the morpho-anatomical analysis, the abnormalities in the ovaries of five of the specimens were observed. One of these specimens was found to posses two ovaries one of normal size with 2 lobes, the other, with one greatly distended lobe (Plate 18) and the rest had one pair each, with very unequal lobes.

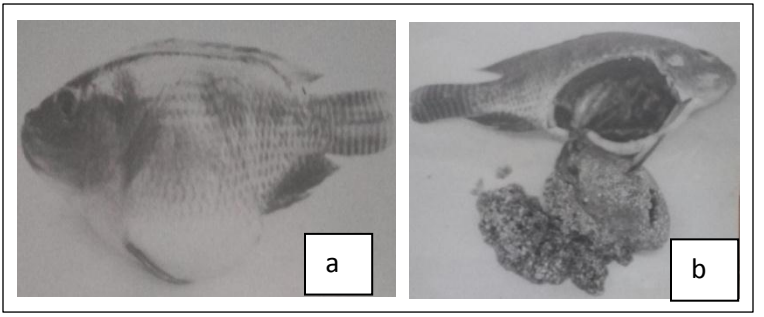

Plate 18(a & b): Unequal development of ovary lobes before and after dissection

Three of these specimens of *O. niloticus* were found with miniature or reduced left lobe while two other specimens had their left lobe highly distended due to accumulation of eggs. This is very rare in *O. niloticus*. A situation whereby between 20% and 43% of the energy is expended on egg production is biologically a waste of gonadal material and economically undesirable for a fish farmer whose interest is in the production of fish protein. The cause of such a massive development of eggs in a mouth brooder such as *O. niloticus*, is not yet known, but it could be inferred from the available data that such a condition could be consequent to a break-down in hormonal and nervous coordination during the breeding period, which might arise from environmental alteration. It could however, be of advantage in a hatchery system. (Omotosho, 1987).

One of the hazards faced by fishes is the lack of enough Vit-C in their diets. Several authors have described clinical symptoms and histopathological lesions associated with ascorbic acid (Vitamin C) deficiency in fish such as

Salmonids. In Nigeria and in many parts of Africa, currently *H. longifilis* has become established as an important and one of the most promising species used for stock enhancement and food production. An experiment was conducted to test whether Vitamin-C is necessary in the nutrition of *H. longifilis*. Basal diet of 42.5% crude protein was enriched with Vitamin-C at levels of 0 and 50mg kg^{-1} diet using L-ascorbic acid from "TUYIL" Pharmaceutical Company Nigeria Limited, Ilorin.

After 8 weeks, irregular movement, and manifesting loss of appetite were preceded by death in control treatment with a careful observation of most of the revealed abnormal swellings between the opercula and cardiac region. When such fish was sacrificed and the muscle carefully removed to expose the skeleton, vertebrae curvature (Lordosis) was noted.

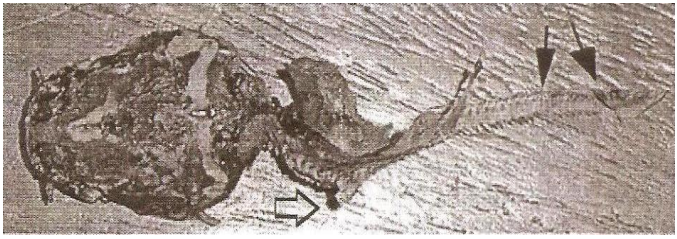

Plate 19: Lordosis in *H. longifilis*

Condensation of the vertebrae was visible and fragility of the vertebrae occurred at the points of condensation. The curvature occurred at the 8^{th} and 11^{th} vertebrae. Erosion of the dorsal part of the operculum and skin discoloration was also evident. Haematological analysis revealed a significant increase in packed cell volume (PCV) and the haemoglobin concentration in the

fish fed with the vitamin C supplemented diet. The significant ($P<0.05$) improvement in most of the parameters measured in this trial with respect to the vitamin C enriched group is an indication that vitamin C is essential in the diet of *H. longifilis* fingerlings. (Ibiyo, et al., 2007).

An Assessment of the Physico-chemical Properties of Moro Lake

Assessment of the physico-chemical properties of Moro Lake was carried out with the aims of determining the water quality and productivity and to assess nature or man's impact on the physico-chemistry of the lake with a view to engendering better management, conservation, and sustainable exploitation of the lake resources. Physical Parameters (temperature, transparency, water velocity) and chemical parameters (dissolved oxygen, carbon dioxide, calcium, magnesium, total hardness, sulphate, phosphate, nitrate, silica, pH, conductivity) were sampled at the downstream section of the dam site, the first station (lentic section of the river) while the second station was at the river course (lotic section of the river).

Of all the ions studied in the lake, phosphate has the lowest concentration (0.2 – 0.5mg/l) in both stations. In contrast to phosphate, nitrate concentration in the lake was higher. The concentration varied between 16.4 and 22.4mg/l in station 1, and 5.2 - 8.6mg/l in station 2. Silica was the most abundant ion in the lake. The concentration varied between 30.0 and 52.0mg/l in station 1, and 18.60 to 42.40mg/l in station 2. In summary, the surface water quality of Moro Lake could be classified as Class 1 (excellent), according to Prati et al., (1971). The lake is also productive and will support diverse number of organisms

from planktons, and benthos to fishes and macrophytes going by the abundance of chemical ions needed for interconversion of energy and production of organic materials present in the lake. The only threat to its productivity was the case of cultural eutrophication which was observed in the lake. This could be mitigated by proper education and enlightenment. The physico-chemical data obtained in the lake could be used as a baseline and reference point when assessing further changes caused by nature or man in this lake (Mustapha and Omotosho, 2005).

The Effect of Food and Frozen Storage on the Nutrient Composition of some African Fishes

It has long been observed that shortage of fish supply is not only due to poor fish production, but poor post-harvest storage methods. As much as 15% of the total fish catch in the Kanji Lake is lost because of spoilage (Mayboom, 1974). This has drastically reduced the cheap protein available from fish because the traditional methods of fish preservation (smoking, sun-drying, salting, etc.) are no more suitable or adequate. With the advent of technology, freezing is the most popular method of food preservation. Our primary aim of this research work was to determine the degree of nutritional changes that occur in frozen fish. Five species of fresh water fish were used; *Tilapia zillii*, *Clarias lazera*, *Channa obscura*, *Synodontis schall* and *Scomberomorus tritor*. The result shows that the percentage of total lipid and protein decreased significantly after each succeeding frozen-storage and moisture content shows a trend similar to other parameters in all the species. The longer we deep freeze our fish, the less of the nutrients are available (Omotosho and Olu, 1995).

Analysis of Fish Species Composition of Oyun Mini Dam, University of Ilorin, Ilorin

The primary aim of damming Oyun River in March 1984 was to impound a sufficiently large volume of water for construction work at the permanent site of the University of Ilorin. Domestic usage and research work were other added objectives. In the absence of pre-impoundment investigation of fish species composition of River Oyun, analysis of fish species diversity became imperative so as to understand the effects of habitat change on the new resident population of fish species.

The ecological changes which result from damming of a river could affect breeding habit of some fish species and consequently the species composition (Dadzie, 1980). The knowledge of existing species composition and the state of balance between fish population in a body of water is crucial to an efficient management programme with the view to enhancing fish production. Subsequent analysis of fish population of the dam will reveal the status of the water body and the dynamics of species composition. The result of my investigation (Table 7) indicated that fourteen fish species from 8 families were present in Oyun Mini-Dam after the inundation. (Omotosho, 1993).

Table 7: Fish Species Composition of Oyun Mini-Dam

Family	**Species**
Cichlidae	*Sarotherodon galilaeus* (Artedi) Trewavas *Oreochromis niloticus* (Linn.) Trewavas *Tilapia zillii* (Gervais) *Hemichromis fasciatus* (Peters)
Clariidae	*Clarias senegalensis* (Valenciennes)
Characidae	*Alestes nurse* (Ruppel)
Cyprinidae	*Labeo sengalensis* (Boulenger) *Barilius senegalensis* (Steindachner) *Barbus callipterus* (Boulenger)
Mochokidae	*Synodontis gambiensis* (Gunther)
Mormyridae	*Mormyrus rume* (Cuvier and Valenciennes) *Marcusenius cyprinoides* (Linn)
Channidae	*Channa obscura* (Gunther)
Schilbeidae	*Schilbe mystus* (Linn)

Icthyofauna Diversity of Asa Reservoir, Ilorin, Nigeria

In most man-made Lakes, Asa Reservoir inclusive, the formulation of effective and long term plans is often handicapped by lack of sufficient and adequate data. This puts the Biologists and Fisheries Scientists at a serious disadvantage because the changes caused by the creation of the lake cannot be realistically assessed nor the endemic fish species ascertained. Therefore, investigations on the fish species composition and fisheries potential of Asa Reservoir is essential at this period of national need for adequate protein in Nigerian diets. Twenty-one fish species from 10 families were sampled from Asa Reservoir in Ilorin Kwara State. With this, Asa Reservoir could be described as a body of tropical man-made lake that is fairly rich in both variety and abundance of fish species. Akinyemi *et al*., 1986

recorded 36 species for Asejire Reservoir in Ibadan, a comparable artificial lake with Asa Reservoir and 104 species for Kainji Lake. The low diversity index recorded for Asa Reservoir could be on account of paucity of investigations conducted on the reservoir (Omotosho 1993). Further work is likely to reveal more species. The family Cichlidae dominated the population both in number and weight. This is known to be connected with their high fecundity, multiple spawning habit, and ability to tolerate harsh physical and chemical conditions that could be lethal to other species. Swingle (1950) had earlier reported that a balanced population is that in which the ratio of forage to carnivorous (F/C) species is most desirable between 3:1 and 6:1. The forage – carnivore ratio of 1.4:1 obtained in this work is grossly inadequate for any realistic strategy that could be employed for maximal exploitation of the fish population in Asa Reservoir. Hence, stocking of forage species such as *Heterotis niloticus* and *Citharinus* species or employ a deliberate systematic cropping of carnivorous species to raise the prey – carnivore ratio of the Reservoir to a more acceptable level in order to boost the productivity of the lake.

Effect of Dietary Alternative Lipid Sources on Haematological Parameters on Serum Constituents of *Heterobranchus longifilis* Fingerlings

The worldwide increase in aquaculture production and the decrease of wild fish stocks has made the replacement of fish oil in aquafeed industry a priority. Therefore the use of terrestrial animal fats and vegetable oils which has lower cost and larger supplies may be good as substitute for fish oil. Babalola et al., (2009) investigated

the effects of total replacement of fish oil by two terrestrial animal fats (Pork lard and Poultry fat) and three vegetable oils (Palm kernel oil, Sheabutter oil and Sunflower oil) on haematological and serum biochemical profile of *Heterobranchus longifilis* over 70 days. Fish oil-diet was used as the control. The haematological parameters were significantly affected by dietary lipid sources, serum total protein was not influenced by the dietary lipids. However, serum cholesterol was significantly higher in fish fed diet containing sunflower oil. Glucose and activities of liver enzymes in blood serum were significantly reduced in fish fed with alternative lipids when compared with the control. These results indicated that fish oil can be replaced completely with alternative lipids without any serious negative health impacts in *H. longifilis*. In the event of paucity of fish oil or undesirable high costs, alternative lipid could be used by the aquaculturist, thus proactively preparing for the "rainy day" (Babalola, et al., 2009).

Xenobiotes and Heavy Metal Contamination of Fish Species

One of the several 'pains' fishes undergo is the contamination of heavy metals that are washed into their habitats.

Heavy metals are regarded as one of the most serious pollutants due to their environmental persistence and tendency to accumulate in aquatic environments.

The contamination of heavy metals in aquatic habitats raises a serious concern about the health of fishes and in turn, the health of consumers. Metal accumulation in fish is of great importance to human health because it can cause pain for fish consumers. Thus, the determination of

heavy metal accumulation in the tissues of fish could serve as a radical way of establishing the relationship between aquatic pollution and the stress response of fish resulting from this, and could also be used in the biomonitoring of aquatic environment.

Asa River is a major river passing through Ilorin and other major towns in Kwara State, Nigeria. It forms a major bulk of the water used for both domestic and industrial purposes in this part of Nigeria. Tributaries empty into the river carrying wastes from homes, run offs from farms, leachates and effluents from industries (Eniola and Olayemi, 1999). These materials contain amongst other things and in varying degrees, heavy metals which are not biodegradable. Concentration of these heavy metals; Cadmium (Cd), Manganese (Mn), Iron (Fe), Mercury (Hg), Lead (Pb), Nickel (Ni), Chromium (Cr) and Zinc (Zn) in the tissue of selected fishes (Tilapia and Catfish) from the river was investigated, for both downstream and upstream ends of Asa river. Apart from manganese level in both fish species, it could be noticed that other heavy metals showed higher concentrations in the Catfish than Tilapia. This might be attributed to the difference in the nature of skin; while Tilapia has scales on the body; the catfish body is smooth and shiny. There was significant difference in the metal accumulated in the two species at 95% probability level for Zn, Mn and Fe. Significance was also recorded in respect of Mn, Pb, and Zn, concentration in each fish at upstream and downstream ends of Asa River.

The contamination of fish species and their environment is another serious hazard resulting from anthropogenic activities. The use of synthetic chemicals such as pesticides, herbicides, etc. in order to boost

agricultural production is a widely accepted practice. However, this practice has become a source of environmental concern, particularly in aquatic systems, due to their negative impact.

Fishes are at risk of xenobiotes in water bodies and culture systems that are in proximity to agricultural farmlands where large quantities of herbicides and pesticides are used. This can easily be washed into water bodies as runoff and can cause serious havoc to aquatic organisms.

One of the most commonly used herbicides in the northern parts of Kwara State (e.g. Shonga, Pategi, Lafiagi etc) where rice is mostly grown is atrazine. Atrazine is mainly used against birds, the pests of rice, in these areas. Since the herbicide could easily get into water bodies, an in vivo study became necessary to evaluate the toxicity of the herbicide on fish. Thus, we carried out a study aimed at evaluating the acute and chronic effects of atrazine on the enzymatic/biochemical responses of *Clarias gariepinus*, assess which of the tissues would be more sensitive to atrazine, and the possibility of identifying a prospective biomarker of atrazine pollution in aquatic ecosystems. The results of the study showed that exposure to varying concentration of atrazine causes oxidative stress and significant alteration in enzymatic and metabolic parameters in the tissues investigated. These alterations however, depend on the defensive ability of tissues examined. All the parameters investigated during the study can be considered as potential complementary biomarkers used in the assessment of atrazine toxicity in fish (Owolabi and Omotosho, 2017).

Estimation of the likely amount of each metal which could be taken in from the consumption of these fishes per day by an average adult was done. Table 8 shows that for the two species of fish at both upstream and downstream ends, the level were within WHO limits, except for lead (Pb). It is suggested that industrial, human activities, especially the metal industry and mechanical workshop located along river Asa should be strictly controlled to save the environment from the increase in the levels of these trace metals and avert endangering some aquatic lives and possible disappearance of some species. At the moment, there is no known reported case of metal poisoning arising from direct consumption of fish from this river, but the increase in the levels of these toxicants could pose a potential health hazard for the inhabitants of Ilorin and its environs. (Eletta et al., 2003).

Table 8: Estimation of the likely amount in mg/kg of metal being ingested by an average adult (50 kg) from Tilapia or Catfish per day

Heavy Metals	*Mn*	*Fe*	*Pb*	*Zn*	*Cr*
F_1S_1	0.77	1.60	0.33	3.18	0.04
F_1S_2	0.16	1.16	0.26	1.61	0.03
F_2S_1	0.22	2.51	0.45	4.32	0.07
F_2S_2	0.18	1.08	0.22	2.09	0.07
WHO	1.0	2.0	0.10	30.00	1.00

F_1: Tilapia; F_2: Catfish; S_1: downstream; S_2: upstream

Conclusion

Mr. Vice-chancellor Sir, in this lecture, I have tried to catalogue the economic importance, therapeutic values, and indigenous healing potentials that could be derived from fish. Also discussed were the natural disasters that are ravaging both the freshwater and the ocean, the unholy human practices that have polluted freshwater, seas and ocean, the harm, danger and cruel treatment fish receive from man, who is the most beneficiary of fish and fish products. With these various desirable uses of fish, human have no reason to constitute themselves as their worst enemy. Unfortunately, less attention is paid to fish welfare because they are unable to organize coup d'etat, go on strike, neither are they eligible to vote, a language the government of Nigeria seems to understand so well. Fish are still largely caged and subjected to both physical and physiological stresses that should be by all means minimized.

Distinguished audience, the time of ignorance God has overlooked, but now everyone has been called to repentance (Act 17:30). Fishes are species of animals that should be offered improved ethical consideration.

Recommendations

1. At the local level, human activity especially the metal industry and mechanical workshop should be discouraged from settling along river sides. Those located along river Asa should be strictly controlled to save the environment from the increase in the levels of these trace metals and avoid endangering the fish population through metal poisoning arising from this river, which is a potential health hazard for the

inhabitants of Ilorin and its environs. On the national and international fronts, there should be no more dumping of wastes, chemicals, particles and invocated discharge from industries and factories into oceans and seas.

2. I am of the opinion that there should be a research organization in Nigeria that will develop institutional guidelines that are based on the best scientific evidence currently available concerning the biological nature of fishes, so as to address animal welfare considerations.
3. Byron, a poet famously described angling as "the cruelest, the coldest and the stupidest of pretended sports". Sport fishing should be immediately banned. Festivals such as Argungun Fishing Festivals, in Kebbi State, Nwonyo Fishing Festival, in Taraba State, Pategi, Regatta, in Kwara State etc, should be reorganized to eliminate stress and pain in fishes in the process.
4. Research involving living animals including fishes must be based on experimental designs that will put the welfare of the test animals into consideration. Researchers need to take great care to avoid inducing stress and pain in experimental subjects, especially those on prolonged bases. Tagging and marking of fish for research purposes, if improperly done might also cause pain and discomfort for fish.
5. With a coastline of some 850 kilometers and a continental shelf area of about 25,000 – 40,000 square kilometers, Nigeria is blessed with an abundant and rich fishing ground. The Federal Government should strengthen the monitoring, control and surveillance mechanism of our Exclusive Economic Zone (EEZ) to

check illegal exploitation of the marine fishery resources by foreign vessels and dumping of sewage in this water body.

6. While strong laws do protect fish and fisheries in some cases (e.g. U.S. Endangered species act), they are not the norm globally. Only one-third of countries with inland fisheries even submit catch statistics to the Food and Agriculture Organization of the United Nations (FAO 2010).There should be reliable fish production records and fish catch statistics. Government should enforce procedure to guide irresponsible fish exploitation and obnoxious fishing methods and operations through monitoring and surveillance.

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The Vice-Chancellor, distinguished audience, it is now time to express my appreciation to those who have significantly contributed to my academic and intellectual achievement. My greatest adoration goes to God Almighty, the maker of heaven and earth and the sustainer of my life, who has made today a reality. I am eternally indebted to my late parents, Elder Jacob Akangbe Omotosho, who taught me the Yoruba alphabet (a b d e f g gb), and first demonstrated to me how to hold a pencil. My mother Mrs. Ponle Ajoke Omotosho, I cannot forget your persistence in chasing me out of the goat pen each time I played truancy after my father might have left home for the farm. My loving parents to you I dedicate this inaugural lecture.

Mr. J.A Oladipo of blessed memory ensured that I did not call it quits after losing admission to Ilorin Teachers College (I.T.C) in 1964 having stayed out of school for four years. My admission to I.T.C in 1965 was the spring-board of my education and to him I remain grateful.

My late elder sister and my elder brother who both became my “mother” and “father” respectively having lost my

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Mr. Vice Chancellor Sir, distinguished guests, ladies, and gentlemen, thank you for listening, may Almighty God reward you abundantly.

References

Adewoye, S.O. and J.S. Omotosho (1998): Nutrient Composition of some fresh water fishes in Nigeria. *Bioscience Research Communications* 11 (4).

Adewumi, D.O. and J.S. Omotosho (1990): Modeling of population of fishes in a fluctuating environment: A case study of Oyun Mini-Dam, Modeling simulation and control 21 (3), 16 – 21

Akihiko, M., Michael, C. W. (2010). Spatial Patterns of Obesity and Associated Risk Factors in the Conterminous U.S. *American Journal of Preventive Medicine*, vol. 39:2, 1-12.

Akinyemi, O., Ita, E.O. and Sado, E.k. (1986): A preliminary assessment of the post-impoundment fisheries of Lake Eleiyele and Lake Asegire, Oyo State, *Nigeria. Kaniji Lake Research Institute 1985 Annual Report*, 44-50.

Alves, R.R.N., (2009) Fauna used in popular Medicine in Northeast Brazil. *Journal of Ethnobiology and Ethnomedicine*, 5:1

Babalola, T.O.O., M.A. Adedayo, D.F. Apata, J.S. Omotosho (2009): Effect of dietary alternative lipid sources on heamatological parameters and serum constituents of *Heterobranchus longifilis* fingerlings: Tropical Animal Health Production 41:371-377.

Baocheng, X., Peiwu, L., Fei, M., Xiuping, W., Bertrand, M., Ran, C., Qingqing, Y., Wen, Z., and Qi Z. (2015). Skin, bone and muscle collagen extraction from the trash fish, leather jacket (*Odonus niger*) and their characterization. *Food Chemistry*, Vol. 178, 128.

Bentham, J. (1879). *An Introduction to the Principles of Morals and Legislation*. Clarendon Press.

Burgess, G.H., Bruce, B.D., Cailliet, G.M., Goldman, K.J,, Grubbs, R.D. and Lowe, C.G. (2014). A Re-Evaluation of the Size of the White Shark (*Carcharodon carcharias*) Population off California, *USA. PLoS ONE* 9(6)

Cahu, C., Salen, E., and Lorgeril., M.D., (2004) Farmed and wild fish in the prevention of cardiovascular diseases: Assessing possible differences in lipid nutritional Values. Nutrition Metabolism and Cardiovascular disease 14:34-41

Carbone, L. (2004): What Animals want: Expertise and advocacy in Laboratory Animal Welfare Policy. Oxford University Press 149.

Cunningham, S., (2009) Food-nibbling *Garra rufa* fish risks and health Benefits of Turkish "doctor fish" Spas. http://www.suite101.com

Dadzie, S. (1980) Recent changes in the Fishery of a new tropical man-made Lake, Lake Kamburu (Kenya). J. Fish Biol. 16, 361-367

David, A. S., Jonathan, B. L., and Thomas, W. S. (1998). Impact of a Catastrophic Hurricane on Island Populations. *Science*: Vol. 281:5377, 695-697.

Duggan, I.C. (2010). The freshwater aquarium trade as a vector for incidental invertebrate fauna. Biol Invasions, 12: 3757, 1387-3547.

Ehinmore, O.M. and Ogunode, S.A., (2013): Fish in Indigenous Healing Practices Among The Ilaje of Coastal Yorubaland of Nigeria: A Historical Perspective. *European Scientific Journal*, Vol. 9, 14: 199-200.

Eletta, O.A.A.F.A. Adekola and J.S. Omotosho (2003): Determination of concentration of Heavy metals in two common fish species from Asa River, Ilorin, Nigeria. Toxicol. And Environ. Chem. Vol.85,1 – 3. Pp 7 – 12

Eniola, K.I.T. and A.B. Olayemi (1999) Impact of effluents from detergent producing Plant on some water bodies in Ilorin, Nigeria. *International Journal of Environmental Health Research*, 9, 335-340.

Grant, W.B (1997): Dietary links to Alzheimer's disease. Alzheimer's disease Review 2:42-55

Hay, S.I., Guerra, C.A., Tatem, A.J, Atkinson, P.M., and Snow, R.W. (2005). Urbanization, malaria transmission and disease burden in Africa. *Nat Rev Microbiol.*, 3: 81-90.

Ibiyo L.M.O. J.O Atteh J.S Omotosho C.T. Madu (2008). Response of *Heterobranchus longifilis* fingerlings to supplemental dietary vitamin E. *Journal of Fisheries and Aquatic* Sciences 3 (1): 22- 30

Ibiyo L.M.O., J.O. Atteh, J.S. Omotosho, C.T. Madu and A.N. Okaeme (2007). Possible Improvement in Income with Vitamin C fortified Diets in Practical farming of *Herterobranchus logifilis* fingerlings. Journal of Animal and Veterinary Advances 6(4) 479-484.

Ibiyo, L.M..O., J.O. Atteh, J.S. Omotosho and C.T. Madu (2007): The use of Baobab pulp as a source of vitamin C in the diet of NileTilapia, *Orechromis niloticus* fingerlings. *Nigeria Journal of Fisheries*. Vol.4 (2) 190 - 197

Ibiyo, L.M.O., J.O. Atteh, J.S. Omotosho and C.T. Madu (2007): Vitamin C (ascorbic acid) requirement of *Heterbranchus longifilis* fingerlings. *Nigeira Journal of Biotechnology*. Vol.6 (13) 1559-

Keefer, M.L., Moser, M.L., Boggs, C.T., Daigle, W.R. and Peery, C.A. (2009). Variability in migration timing of adult pacific lamprey (Lampetra tridentate) in the Columbia River, U.S.A. *Environ Biol. of Fish,* vol. 85:3, pp: 253-264.

Marano, K.D., Wald, D.J. and Allen, T.I. (2010). Global earthquake casualties due to secondary effects: a quantitative analysis for improving rapid loss analyses. *Nat Hazards*, 52: 319.

Mayboom, J., (1974). Fish handling and processing in the Kainji Lake basin and suggestions for improvement and future research. Kainji Lake Research Institute New Bussa, Nigeria, 34-35.

Mills, C.F. (1980) The mineral nutrition of Livestock: Underwood E.J. (Ed) Commonwealth Agricultural Bureaux. P.1-9

Mohanty, B.P., Sudheesan D., Sankar, T.V., Das, M.K, Sharma, A.P., (2011): Therapeutic value of fish, central inland Fisheries Research Institute. Bulletin No 70.

Mosley, C.A (2005) "Anesthesia and analgesia in reptiles" Seminars in Avian and Exotic pet Medicine. 14(4) 243-262 doi: 10.1053/j. saep 2005.09.005

Mossman, M., (2007) Fish that go skin deep. Scientific America.

Mozaffarian, D. and Rimm, E.B (2006): Fish intake contaminants and human Health eradication, the risk and benefits. JAMA, 296(15); 1885-1889

Mustapha, M.K. and J.S. Omotosho (2001): Composition and relative abundance of phytoplankton and aquatic macrophytes in a seasonal pond in Ilorin, Kwara State. Nigeria Journal, Botany.

Mustapha, M.K. and J.S. Omotosho (2005): An assessment of the Physico-Chemical Properties of Moro Lake. *African Journal of Applied Zoology and Environment Biology*. 7: 73 – 77.

Nagarajan, M., Robinson, J.S., Durairaj, S., and Jeyasekaran, G. (2013). Skin, bone and muscle collagen extraction from the trash fish, leather jacket (Odonusniger) and their characterization. *Journal of Food Science and Technology*, Vol. 50:6, 1106.

Olufeagba, S.O., P.O. Aluko, J.S. Omotosho, S.O. Oyewole, O. Ogundele and A Raji (1997): Early growth and survival of cold shocked *Heterobranchus longifilis* (Val.) 1840 (Pisces; Clariidae). Proceeding of the 10th Annual Conference of Biotechnology Society of Nigeria held at Minna. 2nd Aprill, 1997, 213 – 220.

Omotosho, J,S. (1987): Development of Eggs and Larvae in *Tilapia zillii* (Gervias) *Nigrian Journal of Science* 22 (1) & 2), 24 – 28.

Omotosho, J.S (1987): Studies on Eggs and Larval Development in *Sarotherodon niloticus (*Linn.) Trewavas. NJRFH – *Nigerian Journal of Fisheries and Hydrobiology* 2: 45 – 54.

Omotosho, J.S. (1987): Abnormal development in the ovaries of *Oreochromis niloticus* (Linn.) Perciformes: Cichlidae in Nigeria Rev. De.Biologia Tropical 35:83 – 85.

Omotosho, J.S. (1993): Analysis of fish species composition of Oyun Mini Dam, University of Ilorin, Ilorin. *Nigerian Journal of the West African Science Association* 36: 37 – 48.

Omotosho, J.S. (1993): Morphological and histological features of gonadal maturation in *Oreochromis niloticus* (Linm.) *Trewavas Journal of the West African Science Association* 36: 23 – 36.

Omotosho, J.S. (1998): Icthyofauna diversity of Asa Reservoir, Ilorin, *Nigeria Journal of Applied Sciences.* 10 (1), 75 – 81.

Omotosho, J.S. and M.O. Oyebanji (1996): Spatial distribution and some body parameters of Sting Ray, *Dasyatis margarita* (Grunther) in the inshore waters of Nigeria. *Nigerian Journal Pure and Applied Sciences.* 11: 382 – 391.

Omotosho, J.S. and M.O. Oyebanji (1997): On some aspects of the Biology of *Dasyatis margarita* (Gunther) from Nigeria Continental Shore. Centrepoint 7 (1), 26 – 35.

Omotosho, J.S. and O.O. Olu (1994): The effect of food and frozen storage on the nutrient composition of some African fishes (Rev. De. Biologia Tropical. 43 (1-3) 289 – 295).

Omotosho, J.S., Fagade, S.O. and A.A. Adebisi (1990): Studies on some aspects of the reproductive biology of two cichilds: *Tilapia zillii* (Gervias) and Sarotherodon niloticus. *Nigerian Journal of Natural Sciences* 5(1 & 2) 27 -32

Owolabi, O.D. and J.S Omotosho (1999): Aspect of the biology of Synodontis gambiensis (Gunter) from Asa Lake, *Nigerian Journal Pure and Applied Sciences*. 14: 778 – 785.

Owolabi, O.D. and J.S. Omotosho (2017). Atrazine-Mediated Oxidative Stress Responses and Lipid PERoxidation in the Tissues of *Clarias gariepinus*. *Iranian Journal of Toxicology* 11(2). http://www.ijt.ir

Prabhakar, A.K and Roy, S.P., (2009) Ethno-medicinal uses of some shell fishes by people of Kosi Basin of North Bihar, India. Ethno-med, 3(1); 1-4

Prati, L. Paranello, R and Pesarin, P (1991): Assessment of surface water quality by single index of pollution. Water Research 5, 741-751.

Radner, D.X and Radner. M (1989) Animal Consciousness. Prometheus Books: Buffalo.

Rajakumar, K. (2003) Vitamin D. Cod-liver Oil, Sunlight, and Rickets; A historical Perspective, Pediatrics 112(2); 132-135

Sadiku, S.O.E and Oladimeji A.A (1991). Relationship of proximate compositions of *Lates niloticus* (L.) and *Synodontis schall*. Research Communication 3(1): 29-40

Sahto, A. (1998): Environmental physiological Studies of Haruan in Sabah. Bsc thesis, University of kebangsaan, Malaysia.

Sidhu, K.S (2003) Health benefits and Potential risk related to consumption of fish or fish oil. Regulatory Toxicology and Pharmacology. 38:236-344.

Sladky, K.K & Mans, C. (2012) "Climcal analgesia in reptile" *Journal of exotic pet medicine* 21(2) 158-167 doi: 10.1053/ j. jepm. 2012.02.012

Stenchikov, G. L., Ingo, K., Alan, R., Hans,F. G., Juan, C.A., Grainger, R. G., Alyn, L., and Larry, T. (1998). Radiative Forcing from the 1991 Mount Pinatubo volcanic eruption. *Geophys. Res.* 103(D12), pp. 13837-13857.

Strader, S.M., Ashley, W.S., and Pingel, T.J. (2017). Projected 21st century changes in tornado exposure, risk, and disaster potential. *Climatic Change*, Vol. 141:2, 301–313.

Thomas, A.M, (2003): Side effects and therapeutic effects. Medscape General Medicine; 5(1).

Thorsteinn, S., Vilhjalmur, T., Leifur, G. (2006); *In situ* tagging of deep-sea redfish: application of an underwater, fish-tagging system. *ICES Journal of Marine Science*, Vol. 63:3, 523–531.

Turkmen, A., Aro T., and Kallio, H., (2005): Heavy metals in three commercially valuable Fish species from Iskenderun Bay, Northern East Mediterranean Sea, Turkey, Food Chemistry. Vol. 91: 167-172

Von-Schacky, C., and Harris, W.S., (2007). Cardiovascular benefits of omega-3 fatty acids; *Cardiovascular Research Journal* 73: 310-315.